

MAPPING THE DYNAMICS OF AGRICULTURAL LAND USES FOR CONFLICT RESOLUTION USING GIS AND MULTI-TEMPORAL REMOTE SENSING DATA IN PARTS OF KEBBI STATE, NIGERIA

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Abstract

Nigeria is one of the countries where substantial progress has not been made in reducing farmer herder's conflicts despite decades of inter-communal transformations, revitalizing the traditional institutions and series of conflict resolution mechanisms. This paper mapped out the dynamics of agricultural land use with a view to addressing conflict resolution using geospatial techniques, analyzed the spatial variation of land use dynamics in the study area between 1989-2022; identified the conflict zones and suitable areas for grazing or farming in the study area and suggested scientific sustainable remediation measures that can be developed, adopt for mitigating the conflict. Methods and procedures include primary and secondary datasets were used for this study. Primary and secondary datasets were used for this study. Primary data through questionnaire administration was used to extract information on sampled respondents. Secondary data of Topographic map (1992) and Grazing route map (1989) covering the study area was acquired from the department of Geography, Bayero University, Kano and updated using the Google earth visualizer (2020). The study shows LULC of the various years of interval, areas of conflicts zones, areas suitable for farming and grazing were identified. Its further reveals that bare land has increased by 24.7% within 1982 to 2022. Built-up increased by 28.4% in 2002 and 47.9% in 2022. Waterbody was made exposed implying that they increased from 3.2% in 2012 to 7.6% in 2022, farmlands in 2002 by 23.4% and 42.8% in 2022 which shows that most people are into the farming due some certain factors. Vegetation cover reduced significantly from 470,557.1 hectares to 89,033.5 that is approximately 81.1% loss. This shows that deforestation is high and there are no environmental control measures in the area or the enforcement is low. Therefore, the grazing lands in small villages and local government regions should be demarcated as reserves for the herdsmen who travel short distances on various grazing trails, Water conservation and supply via modest dams, man-made ponds, or wells alongside the grazing paths; Raising public awareness of the need to protect the environment and the consequences of climate change in order to reduce conflict; and finally, to ensure proper, equitable conflict resolution, resource management, and implementation, farmers and herdsmen should be involved in the planning process at all levels.

Keywords: Mapping, Dynamics, Agricultural land uses, Conflict resolution, Geospatial techniques.

Introduction

Nigeria's conflict has consistently remained high over several decades, and it is becoming a frequent occurrence catching the attention of national and international headlines. Since the advent of the fourth Republic in 1999, farmer-herder violent conflict have killed more than

20,000 people and displaced hundreds of thousands more across the northern part of Nigeria, even though the conflict is in existence as far back 60's (Saidu, 2019). Deteriorating environmental conditions, desertification and soil degradation have led herdsmen from Northern Nigeria to change their transhumance routes. Access to pastureland and watering points in the available areas are essential for herdsmen travelling within the North of the country (Sadeeqe, 2019). The problem however, is that most studies and programs on farmers/herders conflicts have tend to focus on regional, ethnic and climatic conditions while land use related conflict are now prone to some communities within Latitudes 11° N to 13° N and Longitudes 4°E to 6°E among nomadic cattle herdsmen and local indigenous farmers as a result of competitively motivated conflicts between arable crop farmers and herdsmen over land and resource-use (Gefu and Kolawole, 2002; Nyong and Fiki, 2005; Chikodiri and Chukwuemeka, 2019). In Kebbi State, disputes ranging from communal to ethno-political clashes had sprung-up in the recent times leading to land use change which had affected the grazing corridors and farming areas. In view of this, shortage of rangeland for grazing and attacks by villagers/farmers when their farms are encroached or invaded had propelled herdsmen devising new means of protecting themselves and animals with guns which had led to theft cases, competition and infringement on the territories of farmers, thereby causing destruction of crops, loss of life for both humans and animals (cattle) during clashes, resulting in food crop shortage and security challenges in the local social structure.

Unlike other states that has compounded crisis, in Kebbi state, clashes were purely communal (farmers herdsmen) in most times leading to rapid land use change which had affected grazing corridor and farming areas. A significant portion of land in the Kebbi state of Nigeria, which is part of the Sudan and the Sahel savannah, has recently lost its ability to serve as farmland, allowing for the rapid invasion of land for a different purpose that causes conflicts in communities and served as the impetus for this study. The uniqueness of land use change is that changes are time-bound and change agents are frequently influenced by a variety of factors including environment, culture, technology, or demography that also change over time and are linked to conflict. Despite the development of remote sensing science, few scholars have used remote sensing images to characterize agricultural land use intensity dynamically and in real time (Li *et al*, 2020, Jeremy and Josef, 2003, Adjei and Antwi, 2023, Gondwe, Lin and Munthali, 2021). On the other hand, the impact of agricultural land use intensity on socio-economic development has been shown to be mainly concentrated around the relationship with population (Feng, Lui and Qu, 2019), urbanization (Ferreira *et al*, 2022), rural transformation, food production, and food security (Lamarin and Mayfroid, 2011) which have effectively guided the coordinated and sustainable development of intensive agricultural land use. Research on the impact of agricultural land use intensity on the ecological environment has also become widespread in recent decades, mainly focusing on the impact on biodiversity (Canelas and Perreira, 2023), plant diversity (Yuxin *et al*, 2023), the microbial living environment (Yujing and Rong, 2021), landscape structure (Watt, 2020), river health (Nicholas, *et al*, 2019), and so on.

Conflicts have arisen at various sizes prior to these shifts in land use. This study used low resolution satellite imagery from Landsat for the forty-year wet season period because it has proven to be very useful for land use/cover studies, it is available in a variety of channels, including the infrared region of the electromagnetic spectrum, which is sensitive to vegetation, it is available as high-quality images with little to no cloud cover given a time series coverage, and it provides data sets that are guaranteed to have a reasonable level of data coherence (Obiahu and Elias, 2020).The research investigation was conducted using imageries of less/no cloud cover for the years 1982, 1992, 2002, 2012, and 2022 because the study took a seasonal approach and

easily available imageries were not suitable for a consistent epoch for analysis. The main aim of this study is to map out the dynamics of agricultural land uses for the use in conflict resolution using GIS techniques and multi-temporal Remote Sensing data in some parts of Kebbi state, Nigeria. The specific objectives are to: analyze the spatial variation of land use dynamics in the study area between 198-2022; identify the conflict zones and suitable areas for grazing or farming in the study area; Suggest scientific sustainable remediation measures that can be developed, adopt for mitigating the conflict.

Study Area

Kebbi State is located in the north-western part of Nigeria with its capital in Birnin Kebbi. The State was created out of the then Sokoto State in 1991. Kebbi State is bordered by Sokoto State to the North and East, Niger State to the South, Dosso Region in the Republic of Niger to the Northwest and the Republic of Benin to the West. The State has a total land area of 36,985 Sq. Km and an estimated population of 4,617,431 according National Bureau of Statistics (2018). The State enjoys a tropical type climate, which is generally characterized by two extreme seasons: the hot and cold temperatures. Mean annual temperatures vary considerably but usually range between 70°F and 100°F, while mean annual rainfall is about 500mm. There are 21 Local Government Areas in the State. The main ethnic groups are Hausa, Fulani, Zabarmawa, Kambari, Dakarkari, with minor tribes like Yoruba, Nupe and Igbo. The main occupations of the inhabitants are farming, rearing of animals, trading and fishing. Islam and Christianity are the predominant religions with some practicing traditional religion. Like most states in the region, Kebbi State has low socio-economic indicators.

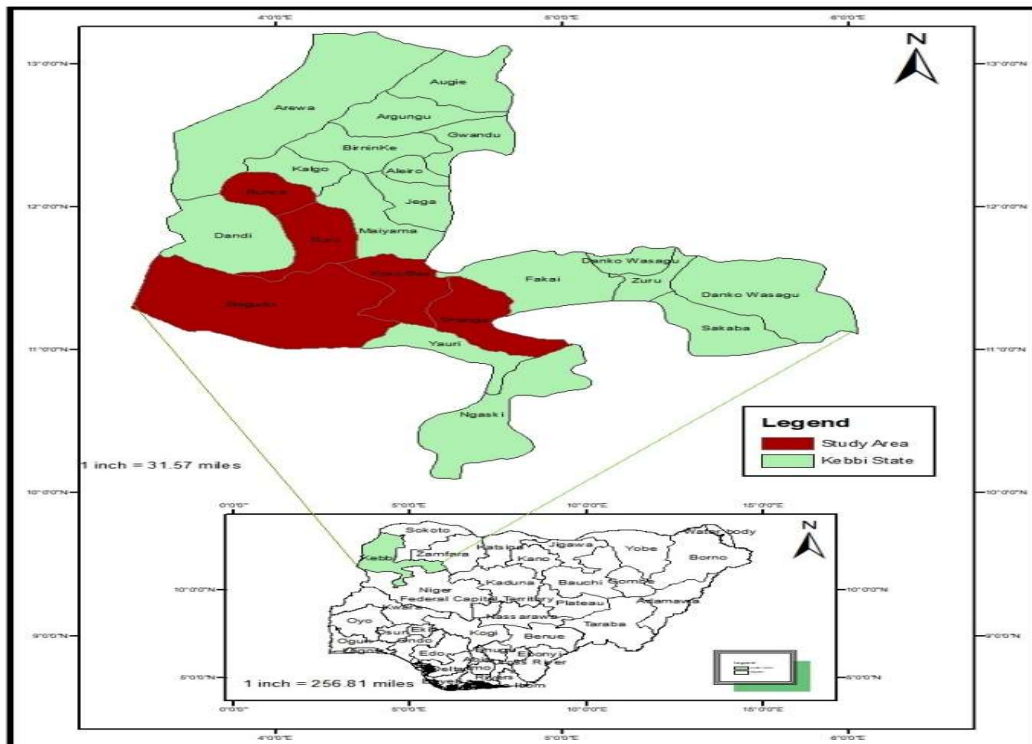


Figure 1: Map of the Study Area

Source: Authors Analysis 2023

Methods

Data Acquisition

Primary and secondary datasets were used for this study. Primary data through questionnaire administration was used to extract socio-demographic, conflict information on sampled respondents. Secondary data of Topographic map (1992) and Grazing route map (1989) covering the study area was acquired from the department of Geography, Bayero University, Kano and updated using the Google earth visualizer (2020). Conflict information was downloaded from the Nigerian Bureau of Statistics website (<http://factsnigeriaviolence.org/spreadsheet/2014-2/>). Five Landsat images of 5 January 1982, 3 April 1992, 6 February 2002, 7 May 2012 and 6 December 2022 of the Landsat world reference system path 188 and row 053 scene and SRTM (2022) elevation data covering the study area were obtained from the United States Geological Survey website on earth resources observation and science center.

Table 1: Summary of Datasets and their Properties

The table below shows the Summary of Datasets and their Properties of the imageries

Data	Location on WRS	Dimensions (in Pixels)	Acquisition Date	Resolution/ Scale	Source
Landsat Imagery (TM 1982)	Path 188 Row 53	7772 x 7315	05/01/1982	30m	GLCF
Landsat Imagery (TM 1992)	Path 188 Row 53	7772 x 7315	03/04/1992	30m	GLCF
Landsat Imagery (ETM+2002)	Path 188 Row 053	8061 x 7021	06/02/2002	30m	USGS
Landsat Imagery (OLI-TIRS 2012)	Path 188 Row 053	7549 x 8707	07/05/2012	30m	USGS
Landsat Imagery (ETM+2022)	Path 188 Row 053	8061 x 7021	06/12/2022	30m	USGS
Administrative boundary map	-	-	-	1:1000	OSGOF
Topographic Information	-	-	2022	1:50,000	Global Mapper software
Conflict data	-	-	-	Digital MS Excel format	http://factsnigeriaviolence.org/spreadsheet/2013-2/
Grazing route map	-	-	1989		Geography Department, Bayero University Kano
SRTM	-	-	December, 2022	30m	USGS

Source: Authors Analysis, 2023

Data Processing

Image pre-processing

The satellite images were processed and stacked up in TerrSet software version 2020 to produce an enhanced image composite (channels 4 in red, 3 in green and 2 in blue) for Landsat-TM and ETM⁺ data. The spectral channels combined produced false colour composite (FCC) display, among other multi-spectral combinations as described in Mohammed and Mostafa, (2021) and Raphael and Joseph, (2018). A shape file defining the boundary of the study area was used to mask the interest area from the Landsat satellite imageries.

Image Classification

Adopting Anderson (1976) classification scheme level I USGS and the author's familiarity with the study area alongside field observation, the enhanced images were each subjected to supervised classification employing the Maximum Likelihood Classifier. This classifier was selected because the algorithm evaluates the chance that a given pixel belongs to a particular highest class by assuming that the statistics for each class in each band are normally distributed. The pixel remains unclassified unless a probability threshold is classified. The algorithm's advantage is that it includes the covariance matrix (Swain and Davis, 1978) and (Oyinloye and Oloukoi, 2013) data. Thereafter, a change detection method was used to assess the changes in land use/cover trend between 1982, 1992 and 2002, and between 2012 and 2022 (Rawat and Kumar, 2015). Figure 2 summarises the detailed procedure followed in the data processing and analysis.

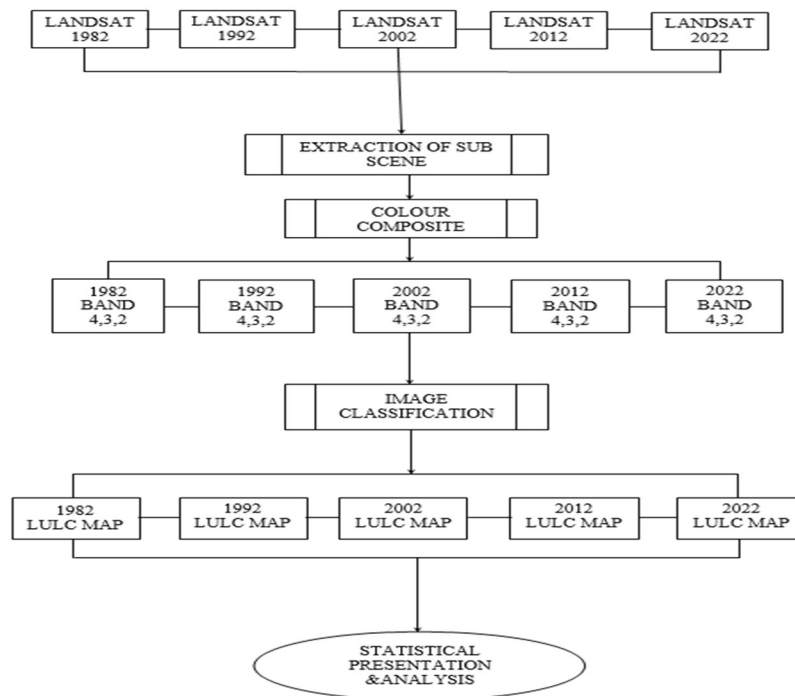


Figure 2: Image Analysis Work Flow Diagram

Derivation of the Optimal Grazing and Farmland Areas

This study employed pair wise comparison approach proposed by Saaty (1980) in evaluation of criteria by assigning weight to enable adequate overlay of the assessing parameters. The suitable areas were determined from the Boolean classes of the classified image result for the current year

(2022) and other convectional dataset layers of topographic features and existing trek routes were considered. In order to determine optimal areas for farming, the following factors were considered: bare-land, agricultural land, water body, slope and rock-outcrop with farmlands and settlements as constraints. In determining the optimal grazing areas, the factors considered were vegetation, Built-up area, flooded area, waterbody, farmland and Bare land. The Weighted Linear Combination overlay method was adopted to proffer an adequate decision by employing this equation (2).

$$s = \sum WiXi * \prod Cj \dots\dots\dots (2)$$

Where:

S – Is the composite suitability score; **xi**– factor scores (cells); **wi**– weights assigned to each factor; **cj**– constraints (or Boolean factors); $\sum$ -- Sum of weighted factors; $\prod$ -- Product of constraints (1-suitable, 0-unsuitable).

The results of both were subjected to spatial overlay for further analysis so as to derive the suitability maps.

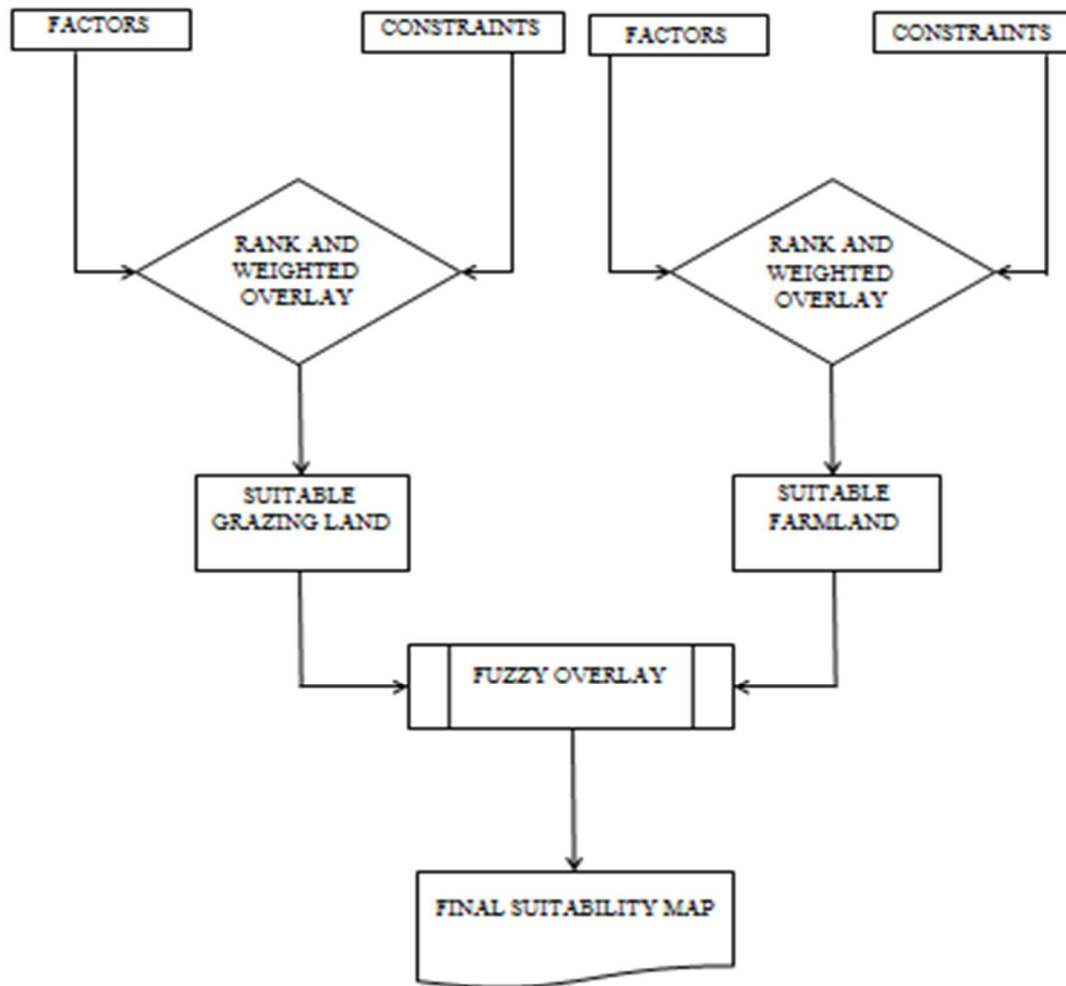


Figure 3: Flow Diagram of Multi-criteria analysis

Results

Land Use Land Cover Change Detection

Six classes were distinguished: waterbody, built-up area, bare-land, vegetation, flooded area, and farmland. The waterbody comprises of rivers, streams, ponds and reservoirs. The built-up area includes scattered and clustered settlements while bare-land includes open spaces and sandy areas. Vegetation comprises of riparian vegetation, shrubs and orchards. Flooded area comprises of marshy areas and wetland. While the farmland comprises of farmlands and arable lands. The analysis of the land use/cover dynamics in *Figure 4, 5 and 6* reveals that bare land has increased by 24.7% within 1982 to 2022. Built-up increased by 28.4% in 2002 and 47.9% in 2022. Waterbody was made exposed implying that they increased from 3.2% in 2012 to 7.6% in 2022. Also on the increase are the farmlands in 2002 by 23.4% and 42.8% in 2022 which shows that most people are into the farming due some certain factors. Vegetation cover reduced significantly from 470,557.1 hectares to 89,033.5 that is approximately 81.1% loss. This shows that deforestation is high and there are no environmental control measures in the area or the enforcement is low. Flooded areas also called marshy lands remain the same between 1982 to 2012 and had a sharp increase in 2012 to 2022 by 37.8%. Post classification accuracy assessment was carried out. An overall accuracy of 99.7%, 99.2%, 99.4% was obtained for the 1982, 2002 and 2022 images respectively

From 1982 to 2022, the dynamics of land use/cover units was marked by a sharp decline of dense vegetation cover for the benefit of light vegetation, built-up area, agricultural land, bare soil, and flooded areas. All these changes have significantly altered the ecological landscape of the area under study. Two major conversion processes can be marked in this period of environmental transformation namely; anthropogenic and natural, which have induced variations on climatic parameters, contributing to climate change (Odjugo, 2010; Odoh, & Chilaka, 2012; Alhassan, 2013, Egboka, Okoye and Chibuzor, 2022).

Carrying out an intensity analysis of the change in landuse/cover units reveals that the landscape had undergone changes of 82.4% within the years, change was intensified with about 37.3% from 1982 to 2002 and other changes of 45.1% from 2002 to 2022 having an average range of 18.7 and 22.6 respectively (*chart in Figure 4*). Individually, noted from 1982 to 2002, the study identified an increase of the area of settled areas, bare land, waterbody, vegetation and especially farmland, Light vegetation, as compared to the area of dense vegetation. Between the years of 2002 and 2022, the result of the analysis indicated that there was an increase in the area of built-up, waterbody, farm land, bare-land and flooded area. As dense vegetation and light vegetation reduced by 37 % and 45 % respectively. The average annual change in intensities of land use units of 51.8% between 1982 and 2022.

Table 1: Land Use Land Cover Classifications of the year 1982

LULC 1982	Area (Ha)
Water Body	10375.8
Vegetation	470557.1
Flooded Area	2334.8
Farmland	502672.2
Built-Up	2596.6
Bared land	1090.1
Total	989626.6

Source: Authors Analysis, 2023

Table 2: Land Use Land Cover Classifications of the year 1992

LULC 1992	Area (Ha)
Water Body	10375.8
Vegetation	354961.8
Flooded Area	2334.8
Farmland	617299.0
Built-Up	3565.1
Bared land	1090.1
Total	989626.6

Source: Authors Analysis, 2023

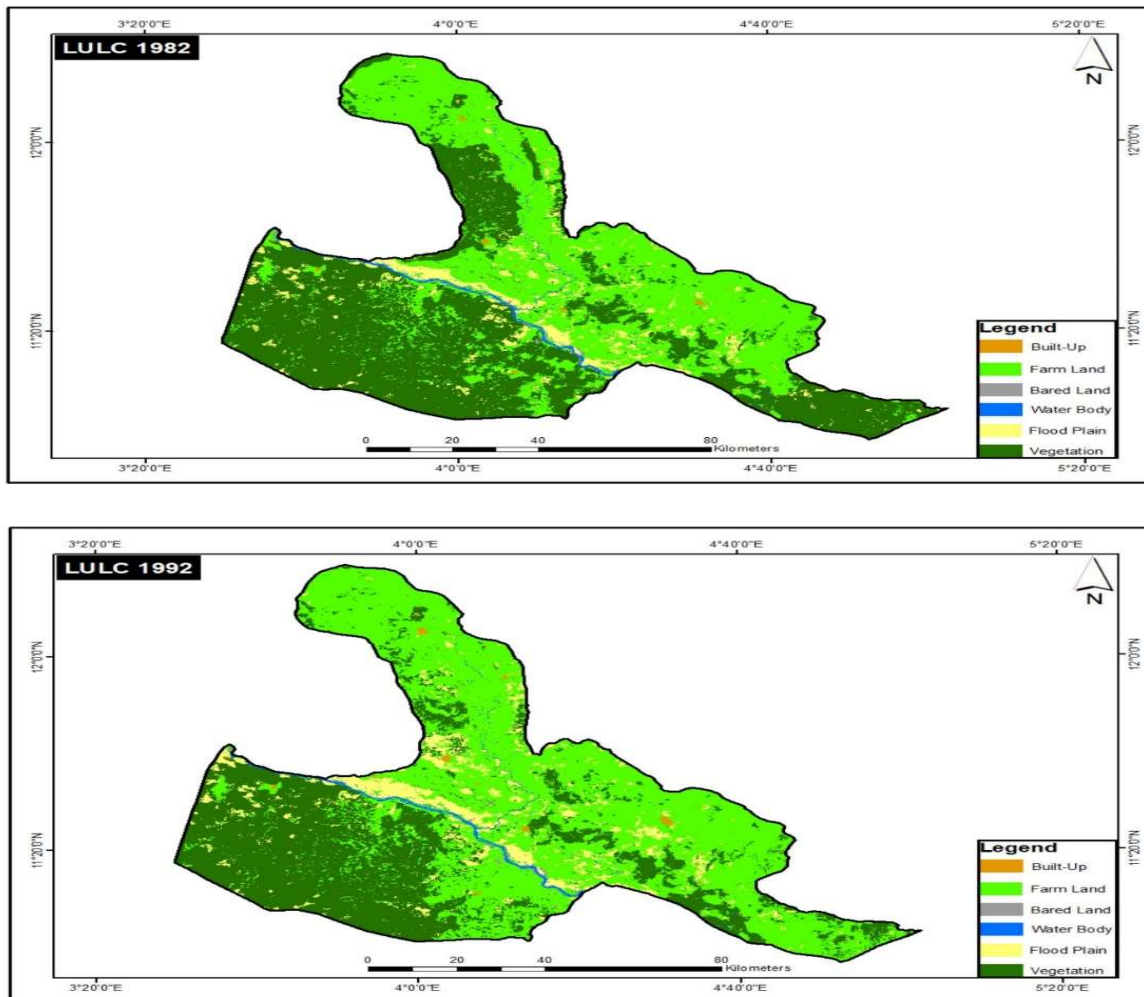


Fig. 4: Land Use Land Cover Classifications of the year 1982 and 1992

Source: Authors Analysis, 2023

Table 3: Land Use Land Cover Classifications of the year 2002

LULC 2002	Area (Ha)
Water Body	10375.8
Vegetation	298664.5
Flooded Area	2334.8
Farmland	673596.2
Built-Up	3565.1
Bared land	1090.1
Total	989626.6

Source: Authors Analysis, 2023

Table 4: Land Use Land Cover Classifications of the year 2012

LULC 2012	Area (Ha)
Water Body	10867.2
Vegetation	127395.2
Flooded Area	8114.0
Farmland	838256.4
Built-Up	3889.7
Bared land	1103.6

Source: Authors Analysis, 2023

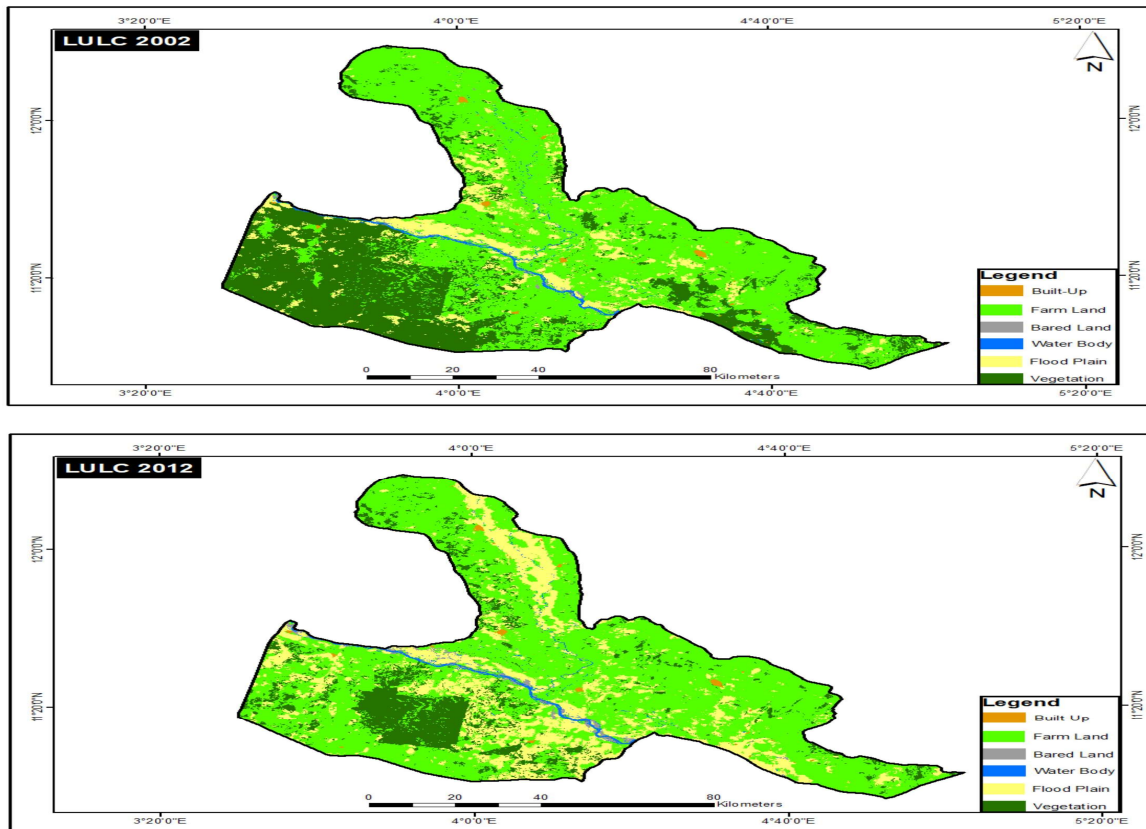


Fig. 5: Land Use Land Cover Classifications of the year 2012 and 2002

Source: Authors Analysis, 2023

Table 5: Land Use Land Cover Classifications of the year 2022

LULC 2022	Area (Ha)
Water Body	11227.9
Vegetation	89033.5
Flooded	3755.7
Farmland	879180.9
Built-Up	4982.3
Bared land	1447.4
Total	989627.6

Source: Authors Analysis, 2023

Table 6: LULC Classifications of the years 1982, 1992, 2002, 2012 and 2022

	LULC 2022 (ha)	LULC 2012 (ha)	LULC 2002 (ha)	LULC 1992 (ha)	LULC 1982 (ha)
Water Body	11227.9	10867.2	10375.8	10375.8	10375.8
Vegetation	89033.5	127395.2	298664.5	354961.8	470557.1
Flooded	3755.7	8114.0	2334.8	2334.8	2334.8
Farmland	879180.9	838256.4	673596.2	617299.0	502672.2
Built-Up	4982.3	3889.7	3565.1	3565.1	2596.6
Baredland	1447.4	1103.6	1090.1	1090.1	1090.1
Total	989627.6	989626.1	989626.6	989626.6	989626.6

Source: Authors Analysis, 2023

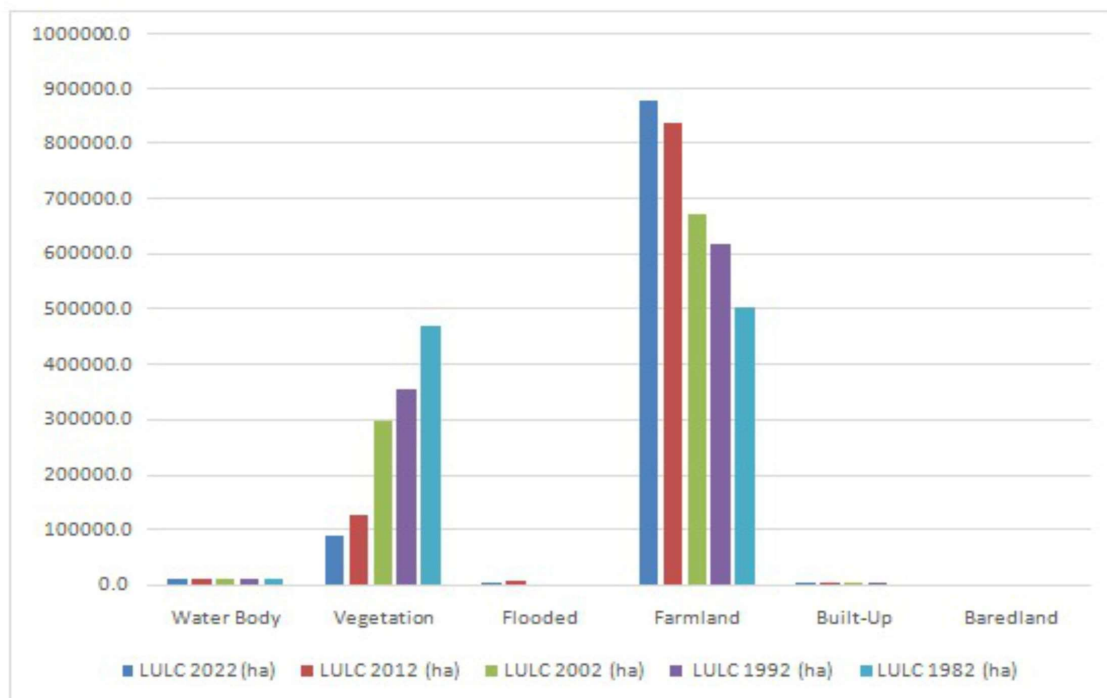
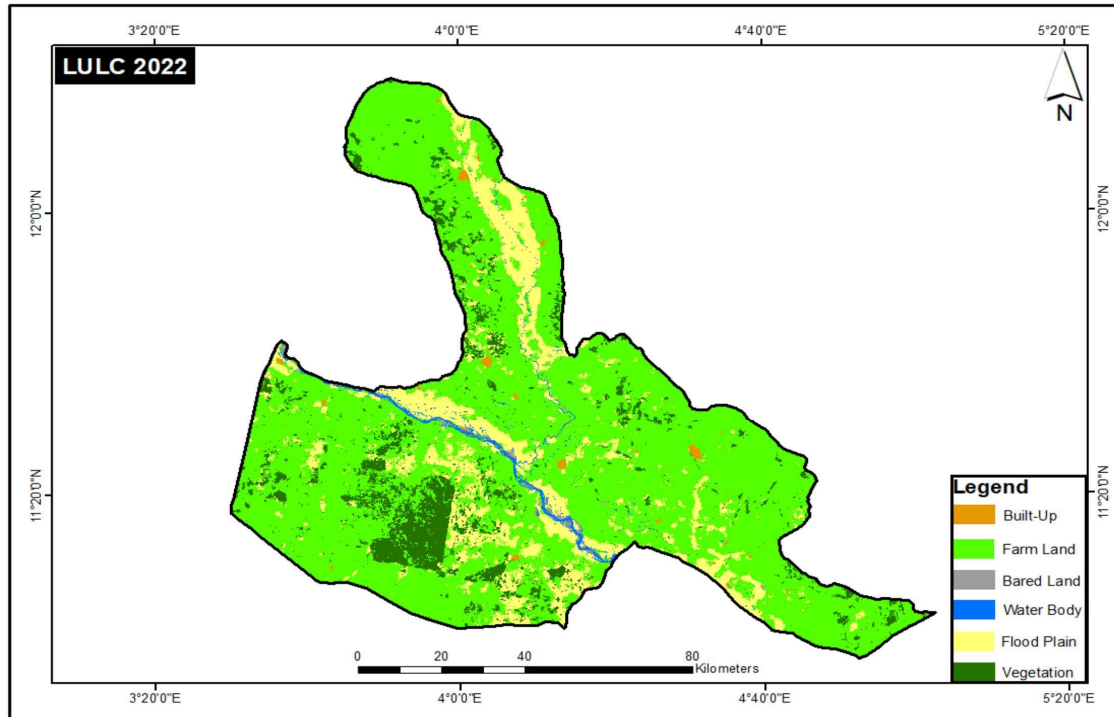


Fig. 6: Land Use Land Cover Classifications of the year 2002 and Chart

Source: Authors Analysis, 2023

The classification consistency assessment was computed by relating the random distributed ground control points for the 2014 classification and used for 1982 to 2022. The validation of the classification results was carried out adopting matrix methods in (Oyinloye and Oloukoi, 2013) where matrix Computation of results was carried out using adopted indexes as formulas given as;

$$CI = \frac{\lambda_{max} - n}{n - 1} \quad (1)$$

$$CR = \frac{CI}{RI} \quad (2)$$

		L.max - n	0.32
L.max	8.32	n - 1	7
CR	0.03	CI	0.05
		RI=1.41	

- CI: Consistency index
- CR: Consistency ratio
- RI: Random index

Table 7: Shows the Consistency Assessment of the Classification

Normalized Pair-wise Comparison Matrix											
Factors	Slope	Built-Up	Access to Water	Rainfall	Soil	Elevation	Vegetation	Road	Sum	Criteria Weights	Criteria weight (%)
Slope	0.3679	0.4232	0.4554	0.3493	0.3326	0.2526	0.2545	0.2222	2.6579	0.3322	33
Built-Up	0.1840	0.2116	0.2277	0.2620	0.2661	0.1895	0.2182	0.1944	1.7534	0.2192	22
Access to Water	0.0920	0.1058	0.1139	0.1747	0.1330	0.1895	0.1455	0.1389	1.0932	0.1366	14
Rainfall	0.0920	0.0705	0.0569	0.0873	0.1330	0.1263	0.1455	0.1389	0.8505	0.1063	11
Soil	0.0736	0.0529	0.0569	0.0437	0.0665	0.1263	0.1091	0.1389	0.6679	0.0835	8
Elevation	0.0920	0.0705	0.0380	0.0437	0.0333	0.0632	0.0727	0.0833	0.4966	0.0621	6
Vegetation	0.0526	0.0353	0.0285	0.0218	0.0222	0.0316	0.0364	0.0556	0.2838	0.0355	4
Road	0.0460	0.0302	0.0228	0.0175	0.0133	0.0211	0.0182	0.0278	0.1968	0.0246	2
									8	1	100
Calculating Consistency											
C.W	0.3322	0.2192	0.1366	0.1063	0.0835	0.0621	0.0355	0.0246			
Factors	Slope	Built-Up	Access to Water	Rainfall	Soil	Elevation	Vegetation	Road	Weighted sum value	Criteria Weight	WSV/CW
Slope	0.3322	0.4384	0.5466	0.4252	0.4174	0.2483	0.2483	0.1968	2.8532	0.3322	8.59
Built-Up	0.1661	0.2192	0.2733	0.3189	0.3339	0.1862	0.2128	0.1722	1.8827	0.2192	8.59
Access to Water	0.0831	0.1096	0.1366	0.2126	0.1670	0.1862	0.1419	0.1230	1.1600	0.1366	8.49
Rainfall	0.0831	0.0731	0.0683	0.1063	0.1670	0.1242	0.1419	0.1230	0.8868	0.1063	8.34
Soil	0.0664	0.0548	0.0683	0.0532	0.0835	0.1242	0.1064	0.1230	0.6798	0.0835	8.14
Elevation	0.0831	0.0731	0.0455	0.0532	0.0417	0.0621	0.0709	0.0738	0.5034	0.0621	8.11
Vegetation	0.0475	0.0365	0.0342	0.0266	0.0278	0.0310	0.0355	0.0492	0.2883	0.0355	8.13
Road	0.0415	0.0313	0.0273	0.0213	0.0167	0.0207	0.0177	0.0246	0.2012	0.0246	8.18
										L.max=	8.32

Source: Authors Analysis, 202

Suitability Analysis for Grazing and Farming Areas

Using the spatial analyst Tool of ArcGIS software, the element considered for optimal areas for grazing and farming were derived using the current land use/cover (2014) Boolean classes,

topographic datasets alongside the elevation SRTM data were used to determine the focus of this study due to the undulating nature of the study area.

Pair-wise Comparison Matrix

Factors	Slope	Built-Up	Access to Water	Rainfall	Soil	Elevation	Vegetation	Road
Slope	1	2	4	4	5	4	7	8
Built-Up	1/2	1	2	3	4	3	6	7
Access to Water	1/4	1	1	2	2	3	4	5
Rainfall	1/4	1/3	1/2	1	2	2	4	5
Soil	1/5	1/4	1/2	1/2	1	2	3	5
Elevation	1/4	1/3	1/3	1/2	1/2	1	2	3
Vegetation	1/7	1/6	1/4	1/4	1/3	1/2	1	2
Road	1/8	0	1/5	1/5	1/5	1/3	1	1
Sum	2.72	4.73	8.78	11.45	15.03	15.83	27.50	36.00

Table 8: Shows Grazing and Farming factor Ranking Computation using PCM

Source: Authors Analysis, 2023

Figure 8, 9, 10 and 11 below shows the Boolean class of factors and constraints used for the multi criteria

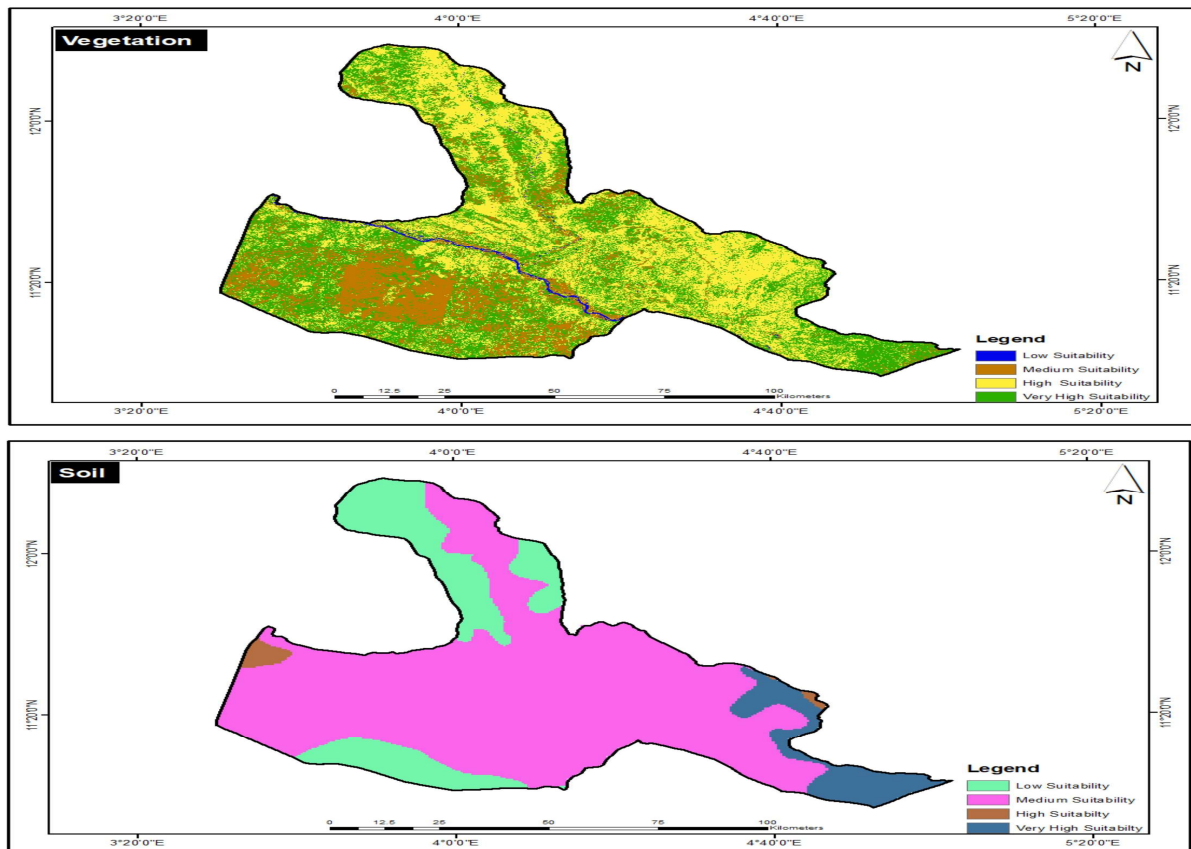


Fig. 8: Vegetation and Soil Reclass of Multi-criteria Analysis

Source: Authors Analysis, 2023

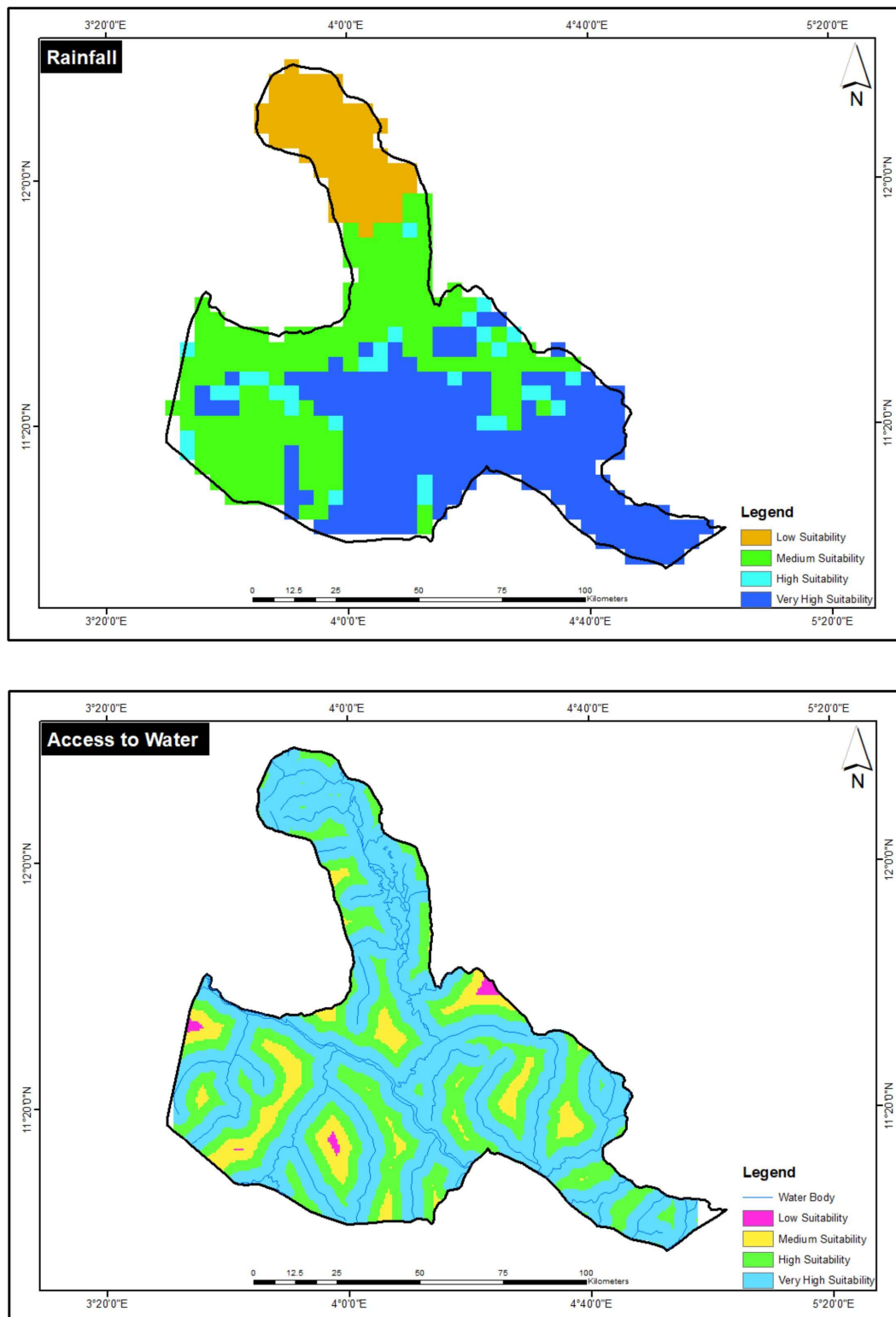


Fig. 9: Rainfall and Access to Water Reclass of Multi-criteria Analysis

Source: Authors Analysis, 2023

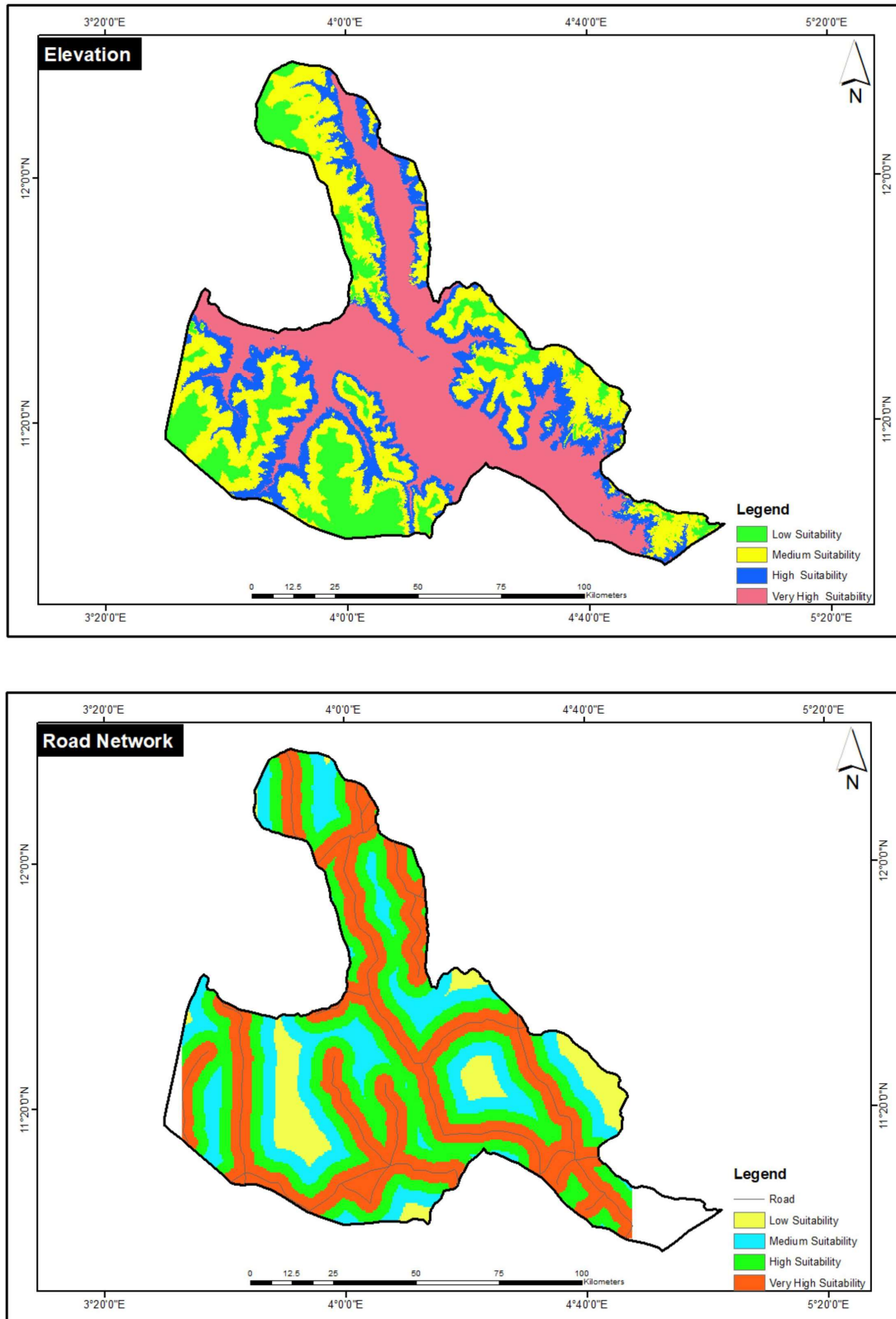


Fig. 10: Elevation and Road Network Reclass of Multi-criteria Analysis

Source: Authors Analysis, 2023

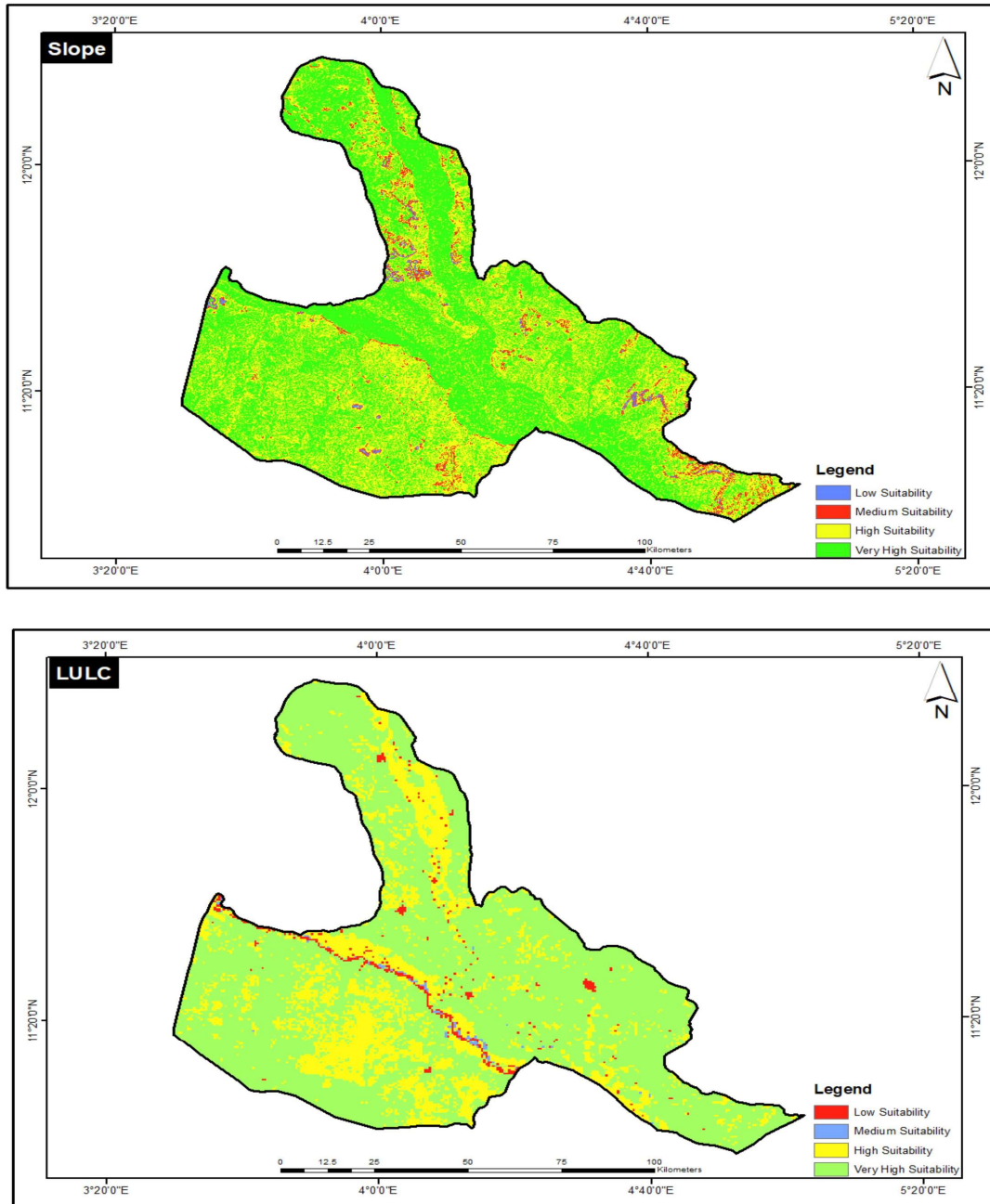


Fig. 11: Slope and LULC Reclass of Multi-criteria Analysis

Source: Authors Analysis, 2023

Multi criteria decision analysis adopting the Satty (1987) ranking comparison model was used to establish weights for suitable areas for farming and grazing considering the factors and constraints within the study area (Table 8). The result of both activities was subjected to fuzzy overlay in the ArcGIS 10.8 environment and the result was then generalized to show dominated areas optimally to be used for farming, grazing and identified conflict areas (Figure 8, 9, 10, and 11). Conflict areas in this context depict the flash point areas under threat of attacks. The both results of the optimal grazing areas and farming areas was generalized and subjected to spatial overlay and the result deduced that potential land for grazing is about 135,667.33 hectares and farming with 532,101.00

hectares with about 285,742.14- and 36,116.09-hectares portion of land as minimum conflict area and highly conflict zone (Figure 13)

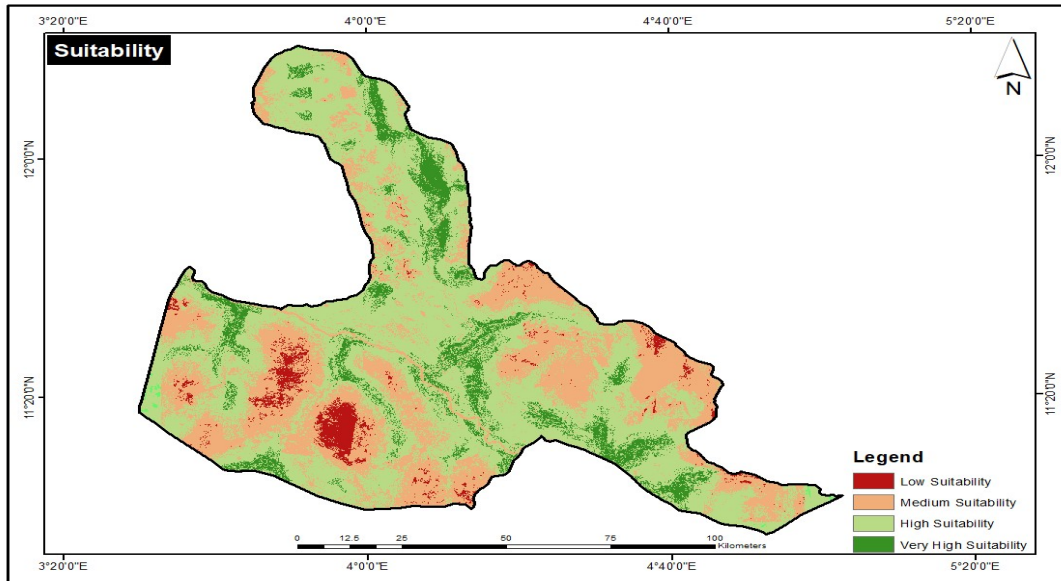


Figure 12: Map for Suitable Areas for Farmland

Source: Authors Analysis, 2023

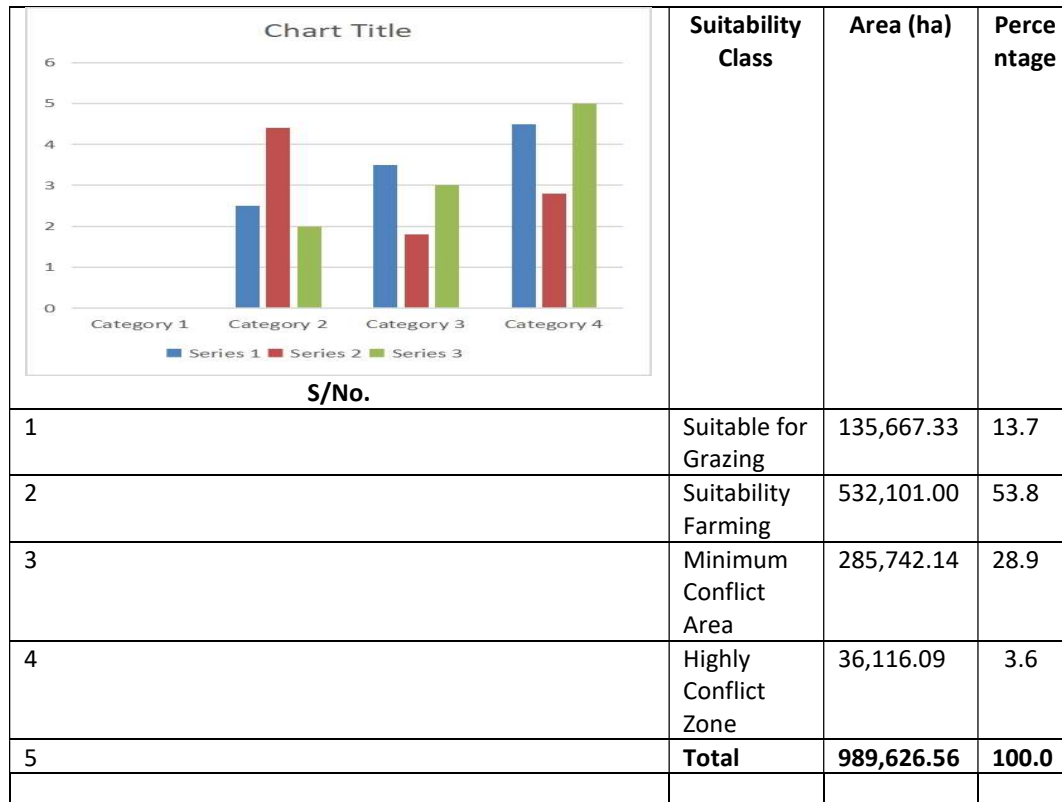


Fig. 13: Shows Suitability Analysis Optimal Grazing and Farming Areas

Authors Analysis, 2023

Summary

Kebbi state is not the only state in Nigeria and the mid-latitude region struggling with issues of violence and conflict between cattle herders and communities. Millions of Naira worth of property and lives have been lost as a result of violent incidences that have been reported in some parts of Kebbi state. According to an Amnesty International report of attacks rural conflict grew and became more destructive from 1 January, 2018 to 30 June, 2018. Despite this, the government tried to manage the disputes that were spreading from urban to rural areas. The majority of the time, isolated residents surrounded by large farms are the target of a rural attack by cattle herders. The impact of the trend on the socioeconomic landscape of the state and our country as a whole makes it alarming. The increasing breakdown of intercommunity relationship between farming rural communities and cattle herders which has derived most of the divers of rural conflicts. Some of Kebbi State's rural areas experience conflict mostly due to the following reasons:

- i. The primary direct causes of conflicts that farmers cite are livestock destruction of crops and damage to other property (such as irrigation systems, reservoirs, and infrastructure) by herders
- ii. The herdsman indicated that burning of rangelands and crop encroachment blocking stock movements and water sources were significant direct causes.
- iii. Farmlands have been constantly stretched throughout time to achieve high yields despite soil degradation
- iv. An increase in the number of cattle thefts, which frequently include violence.

The well-being of the local community settings has been greatly impacted by the disruption and destruction caused by violence. Plans can be created with the express purpose of reducing the impact of these conflicts. According to the findings, a significant amount of farmland and conflict zones are crossed by the current grazing corridor, which tends to fuel conflict between farmers and cattle herders and increases the number of tribes in the state. Because of this, the cattle herders have evolved into a kind of semi-tribal group in recent years as they migrate and establish themselves in one area over time.

Based on the examined facts, it is recommended that the newly proposed grazing area and journey be given careful consideration to prevent and manage future conflicts between farmers and cattle herders in some part of Kebbi state. Additionally, there should be a sufficient re-allocation of land use based on other socio-economic criteria or an appropriate method of rerouting the grazing corridor in order to sustain long-term peace among these conflicting tribes in the areas where the proposed grazing route crosses farmlands and conflict zones.

Conclusion and Recommendations

Land use change is likely to trigger the drivers of conflict in many livelihoods, which in turn will increase vegetation degradation due to climate change, resulting in conflict between farmers and cattle rustlers that will cause property destruction and animal deaths, as well as reduced pasture availability and water scarcity. Poverty and competition for few resources have intensified as a result. Because of their mobility, pastoralists may have contributed to soil erosion and other environmental problems. Pastoralists are adjusting their sources of income to adapt to these changes. However, the survey also showed that farmers had increased the area they farmed in an effort to increase productivity and better support their families. In addition, agriculture is changing because farmers are relocating to other locations to leave their land to fallow because the soil is no longer producing as much as it once did. For example, in dry season farming, the

majority of farmers practice irrigation farming, essentially using the lands along river channels and flood plains that are occupied by cattle rustlers' paths. This logical observation suggests that in order to ensure proper land use delineation (allocation), implementation, and monitoring, additional planning regulations and decision-making procedures must be taken into account.

In the event that these disputes are not settled in a timely manner, issues with environmental and economic sustainability will arise. Nonetheless, we recommend utilizing the following:

- i. The grazing lands in small villages and local government regions should be demarcated as reserves for the herdsmen who travel short distances on various grazing trail
- ii. Water conservation and supply via modest dams, man-made ponds, or wells alongside the grazing paths
- iii. Raising public awareness of the need to protect the environment and the consequences of climate change in order to reduce conflict;
- iv. To ensure proper, equitable conflict resolution, resource management, and implementation, farmers and herdsmen should be involved in the planning process at all levels;
- v. For a more equitable distribution of land use and to ensure enduring peace, other planning criteria ought to be taken into account.

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