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WETLAND DEPLETION FROM URBANIZATION: A COMPARATIVE ANALYSIS OF CHANCHAGA - MINNA, LANDZUN - BIDA AND KONTAGORA WETLANDS, NIGER STATE, NIGERIA

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Abstract *- Wetland depletion from urbanization was investigated. The aim is to make a comparism interim of wetland depletion from urbanization activities in parts of Niger State, specifically Chanchaga-Minna, Landzun - Bida and Kontagora wetlands. Four multi-date landsat satellite imageries; TM of 1988, 1998, ETM+ 2008 and OLI 2018 were utilized to generate data. The Normalized Difference Built up Index (NDBI) was used to extract built up features with indices ranging from -1 to 1. The results indicate that land use and cover distribution over Landzun - Bida exhibited more concentration of built up area on the wetland as compared to Chanchaga-Minna and Kontagora. In Landzun - Bida, the built up areas occupied 12.35km^2 while at Chanchaga - Minna, it occupied 8.2km^2 and in Kontagora it is 7.8 km^2. Wetland depletion shows that 3.1km^2 for Bida, 4.3km^2 for Minna and 4.2 km^2 for Kontagora are what is left as at 2018* *indicating urbanization effects. The conclusion is that spatio-temporal change in wetland land use and land cover showed that the wetlands changed into different land use and land cover types due to population increase, farmland cultivation and increase in built up areas.*

Keywords: *Wetland; Urbanization, Depletion, Landuse, Ecosystem, Environment*

1. Introduction

Wetlands are generally flat-floored, relatively shallow and occupy the lower reaches of watersheds of large rivers, which are either located near the coast and generally do not have large flood plains (Windmeijer and Anclriesse, 2013). They comprise valley bottoms and floodplains which may be submerged for greater part of the year. The hydromorphic fringes and contiguous upland slopes contribute water to the valley bottom through runoff and ground water flow. Wetland ecosystems, including rivers, lakes, floodplains and marshes, provide many services that contribute to human well-being and poverty alleviation (Millennium Ecosystem Assessment, 2015). The wetland is increasingly subjected to intense pressure from multiple human activities such as water diversion, pollution, over-exploitation of natural resources, and reclamation. One of the most important concerns of the world, nowadays, is the change in eco-environment that are caused by human exploitation.

In Nigeria many of the wetlands are being threatened by anthropogenic drivers such as land use activities, urbanization, agricultural activities in addition to the emerging threats of climate change (Nwankwoala, 2012; Pepple, 2011; Kindscher*et al.*, 2015; Orji, 2014). The research domain (Minna, Bida and Kontagora) in Niger State are economic nerve centers lying on landscape endowed with wetlands and other ecological assets. With rapid urbanization and intense development pressure, some of the fringing wetlands and other land cover in the areas have been converted to urban and agricultural landscapes.

Previous studies on the effect of urbanization on wetland ecosystem management both locally and internationally were carried out (for example, Abiola *et al*. 2012; Pieter *et al*. 2013; Ayande and Proske 2015; Okonkwo *et al* 2015; Adiege *et al*. 2017; and Sunday 2018) but did not cover the study areas as it relates to provision of necessary information on urbanization effect and resultant loss of wetland in Niger State. Therefore, a comparative approach is adopted to ascertain real time situation in the study area.

2. Study Areas

The study area lies between latitudes 8°20´N and 11°30´N, and longitude 3°30´E and 7°20´E (Figure 1) The State is bordered to the North by Zamfara State, to the North-west by Kebbi State, to the South by Kogi State, to the South-west by Kwara State; while Kaduna State and the Federal Capital Territory border the state to the North-east and South-east respectively.

A part of Minna is traversed by the Chanchaga river which run from extreme Northern part of Minna towards the South western part, from vast wetlands. The Landzun wetland is to be found in the hearth of Bida town. It forms the core of the drainage system and is subjected to massive and continuous built up environment and agricultural activities particularly irrigation farming. The Kontagora wetland shared similar attributes with the Landzun - Bida but differed slightly in terms of pressures from population resulting from built ups but more increased farming activities.

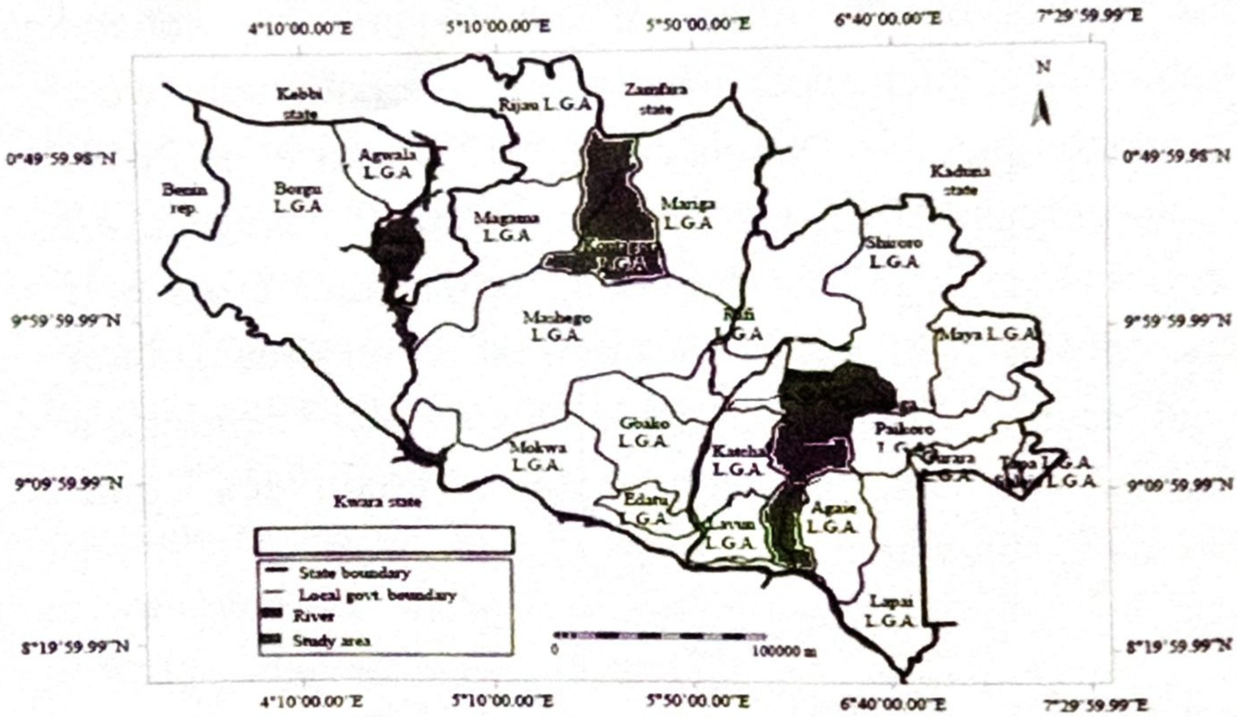


Figure1: Study Areas (Chanchaga - Minna, Landzun - Bida and Kontagora, Niger State, Nigeria)
Source: Mawashi, 2019.

3. Materials and Methods

(a) Data Used

Landsat satellite imageries for 1988 1998, 2008, 2018 were utilized and sourced from Global Land Cover Facility (GLCF) and National Space Research and Development Agency (NASRDA), Abuja, Nigeria. Landsat Thematic Mapper (TM) and Enhanced Thematic Mapper plus with Thermal Infrared Sensor (TIRS) images were used. The maps were projected using Universal Transverse Mercator (UTM) and datum WGS 84 of Zone 32.

The Geo-referencing properties of 1988, 1998, 2008 and 2018 made up of universal Transverse Mercator (UTM) projection, and datum WGS 84, Zone 32. IDRIS Terrset, ArcGIS 10.3, Microsoft Word Office 2013, Microsoft Excel were used.

Table 1: Details of Satellite Data utilized

S/N	Sensor	Path /Row	Source	Year of Acquisition		Scale/ resolution
1	LANDSAT TM	188/055	GLCF	1988	1988	30
2	LANDSAT TM	188/055	GLCF	1998	1998	30
3	ETM+	188/055	GLOVIS	2008	2008	30
4	OLI	188/055	USGS	2018	2018	30

(b) Method of Data Analysis

(i) Maximum likelihood classification scheme with five (5) landuse and land cover classes (wetland, water body, built-up, agriculture and vegetation) was used to establish the land use and land cover changes. Calculation of the area in hectare of the resulting land use and land cover types for each study year and subsequently comparing the results.

Percentage change to determine the trend of change is calculated by the value of the preceding year and multiplied by 100. The equation is given as:

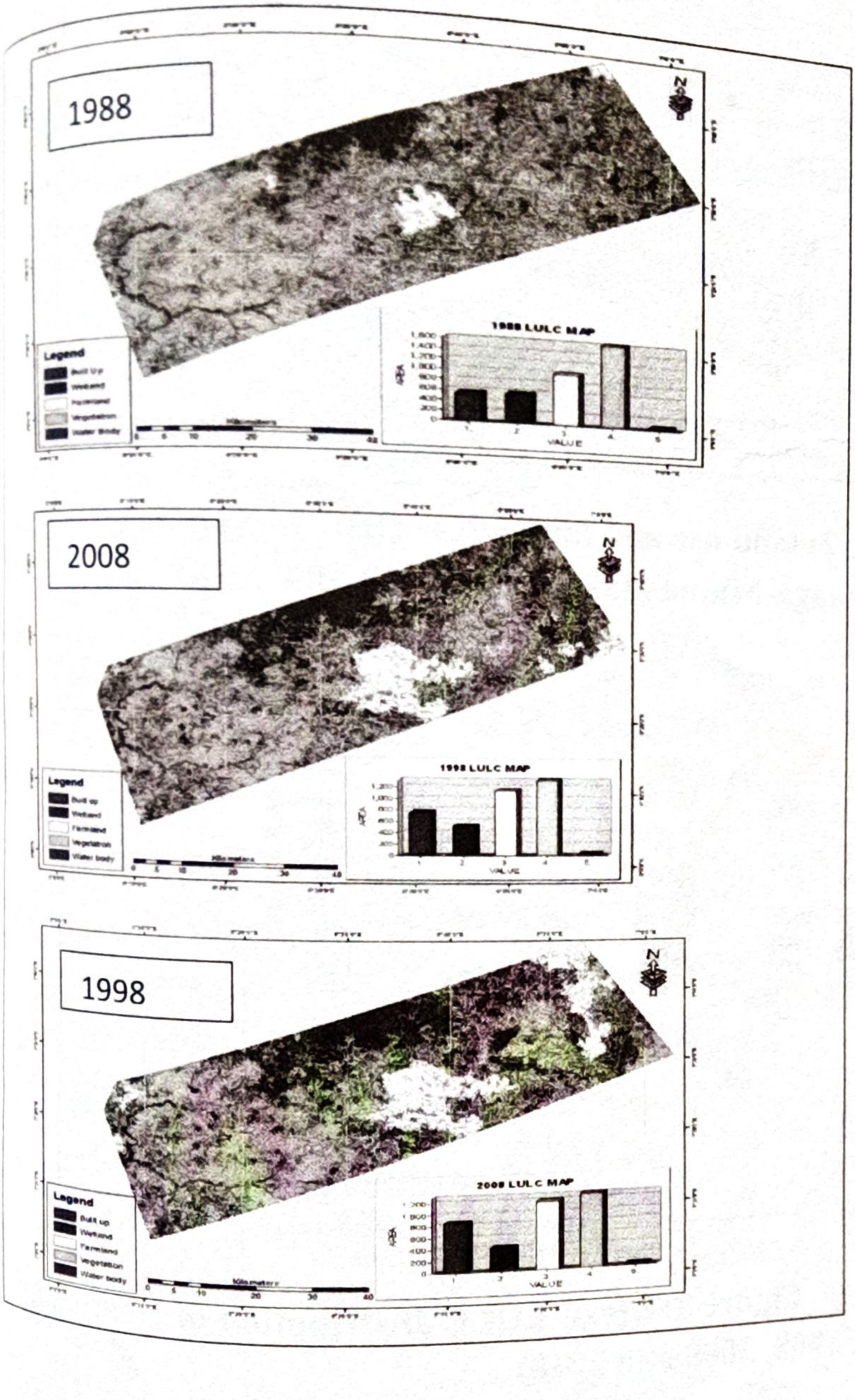
$$(\text{Trend})\text{Percentage change} = \frac{\text{Observed change X 100}}{\text{Value of the preceeding year}} \qquad (1)$$

(ii) Normalized Difference Built-up Index (NDBI) to extract built-up features and have indices ranging from -1 to 1.
The equation is given as:
NDBI = (SWIR – NIR)/(SWIR + NIR)
(2)
Where;
SWIR= Shortwave Infrared
NIR=Near-Infrared

4. Results and Discussion

The classification results for the LULC dynamics of all land use/land cover classes in the for the periods 1988, 1998, 2008 and 2018 for the three wetland location were analyzed to quantify the changes over time and space. The wetland environment classification used sub themes such as the general land area as well as the 500 meter buffer in Kontagora and Bida then 1km buffer for Chanchaga.

Figure 2 and 3 shows the LULC of Chanchaga-Minna. It indicate vegetation with the highest value accounting for 13.4 km^2, farmland 11.2 km^2, built up area 8.2 km^2 and wetlands 4.3 km^2. The water body is the lowest about 2.1 km^2.


1988
1988 LULC MAP
Legend
VALUE
2008
1998 LULC MAP
Legend
Built up
Wetland
Farmland
Vegetation
Water body
VALUE
1998
2008 LULC MAP
Legend
Built up
Wetland
Farmland
Vegetation
Water body
Kilometers
VALUE

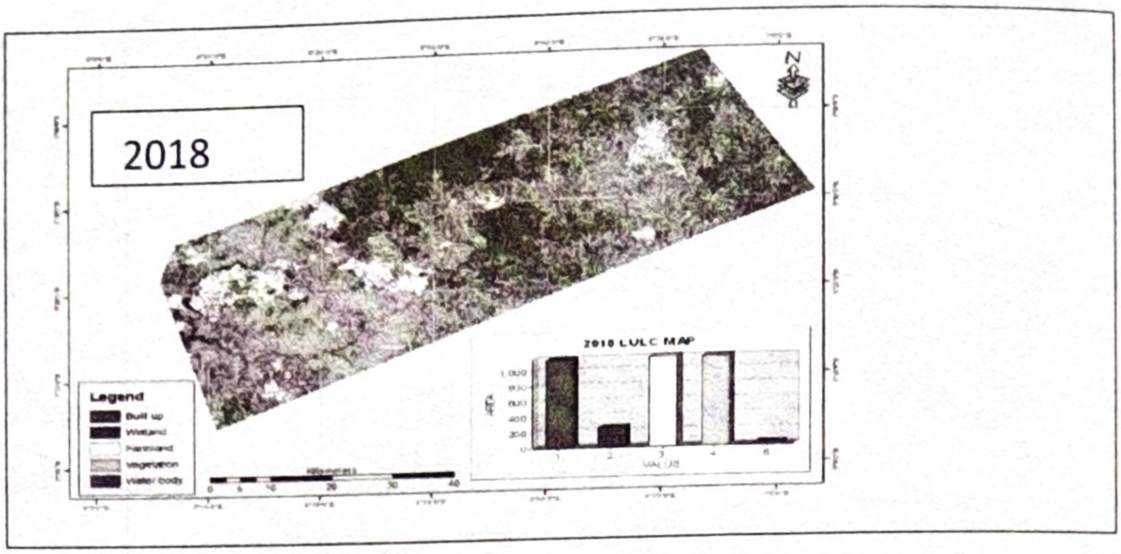


Figure 2: land use and land cover Distribution of Chanchaga-Minna (1988, 1998, 2008 and 2018)

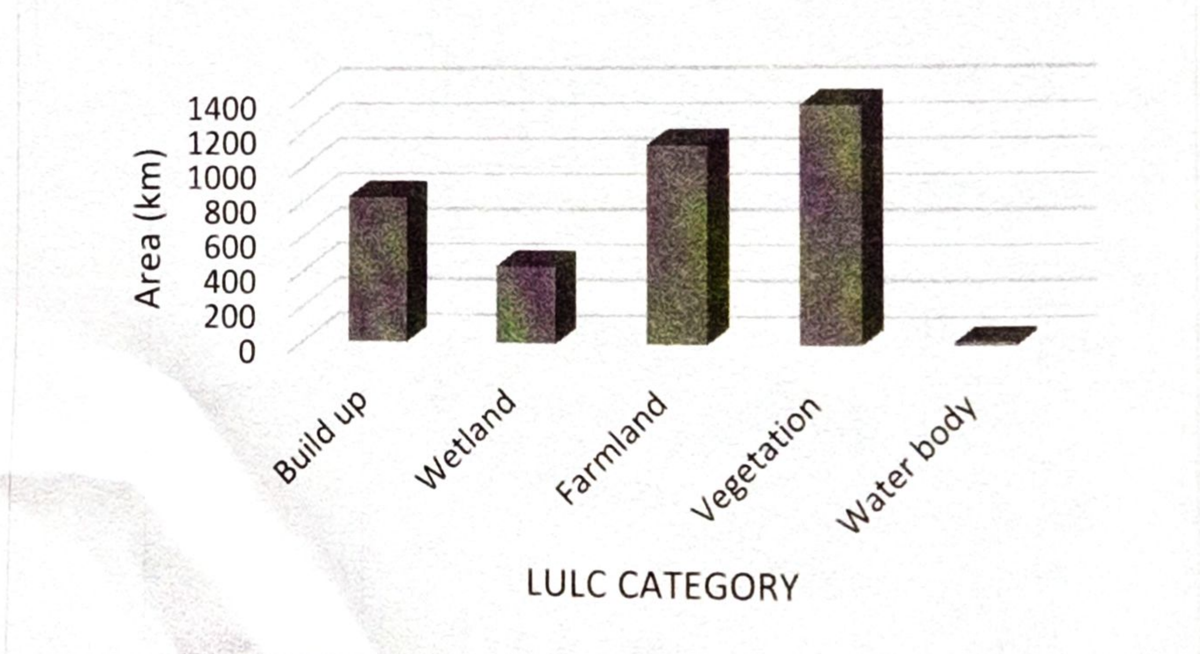
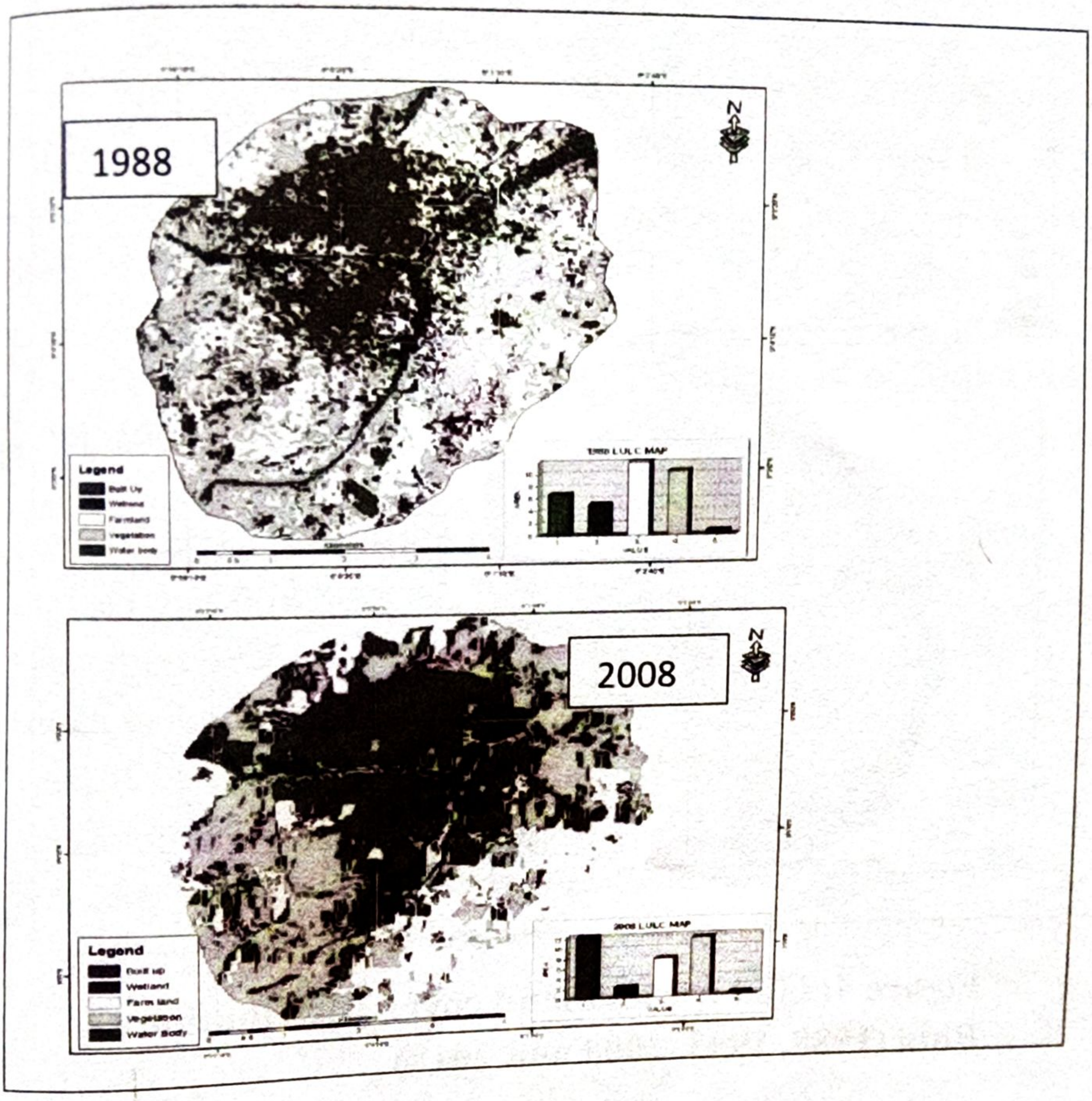


Figure 3: Mean LULC Distribution of Chanchaga (1988, 1998, 2008 and 2018)

Figure 4 and 5 illustrates the mean LULC distribution over Bida (1988-2018). The Built up areas account for 12.3 km^2, wetland 3.1 km^2, vegetation 1.3 km^2, farmland 8.3 km^2 and water body has the lowest distribution of 0.6 km^2. the highest distribution pattern of built up area results from continuous increase in the urban population over the years.



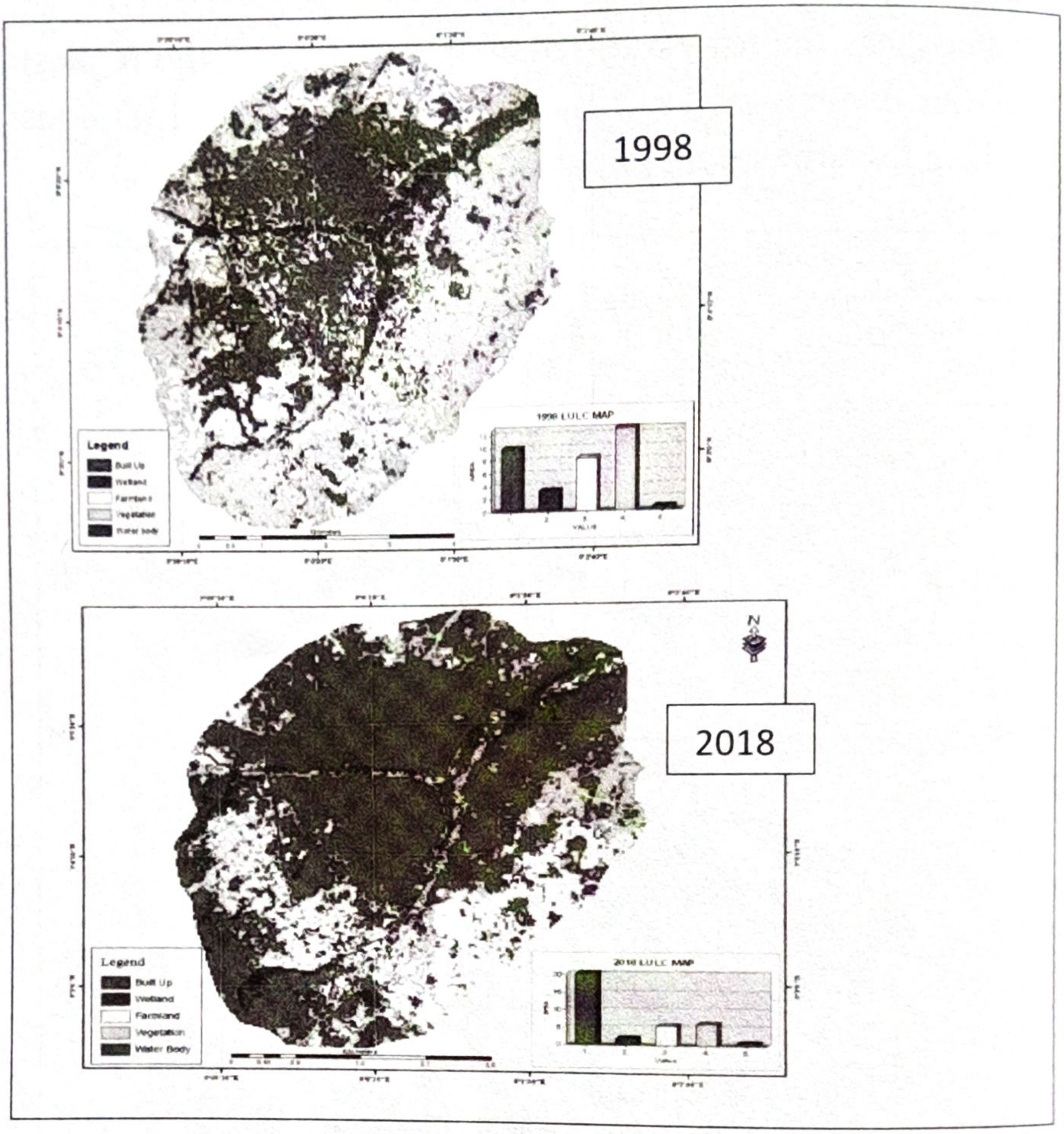


Figure 4: land use and land cover Distribution of Bida (1988, 1998, 2008 and 2018)

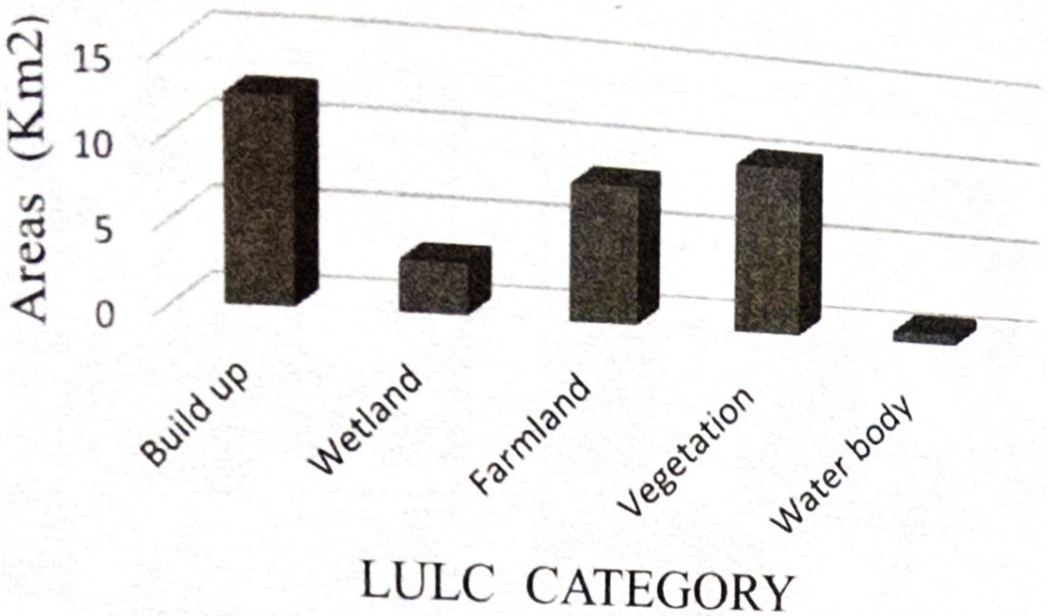


Figure 5: Mean LULC Distribution of Bida (1988, 1998, 2008 and 2018)

Figure 6 and 7 shows the mean LULC for Kontagora. Result showed that farmland has the highest value of 78.8 km^2, vegetation 59.7 km^2, wetland 42.8 km^2, water body 3.2 km^2 which is the lowest.

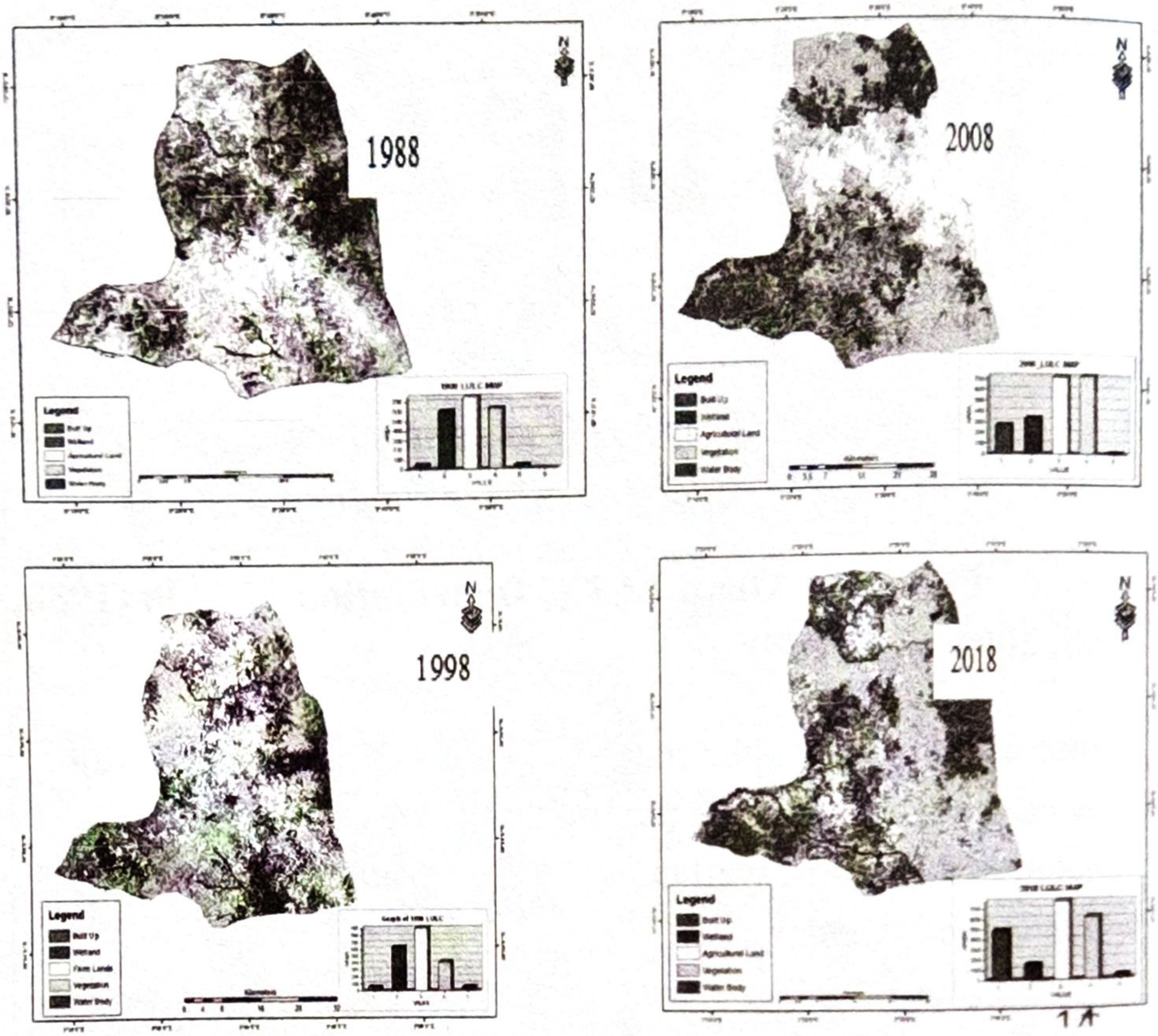


Figure 6: land use and land cover Distribution of Kontagora (1988, 1998, 2008 and 2018)

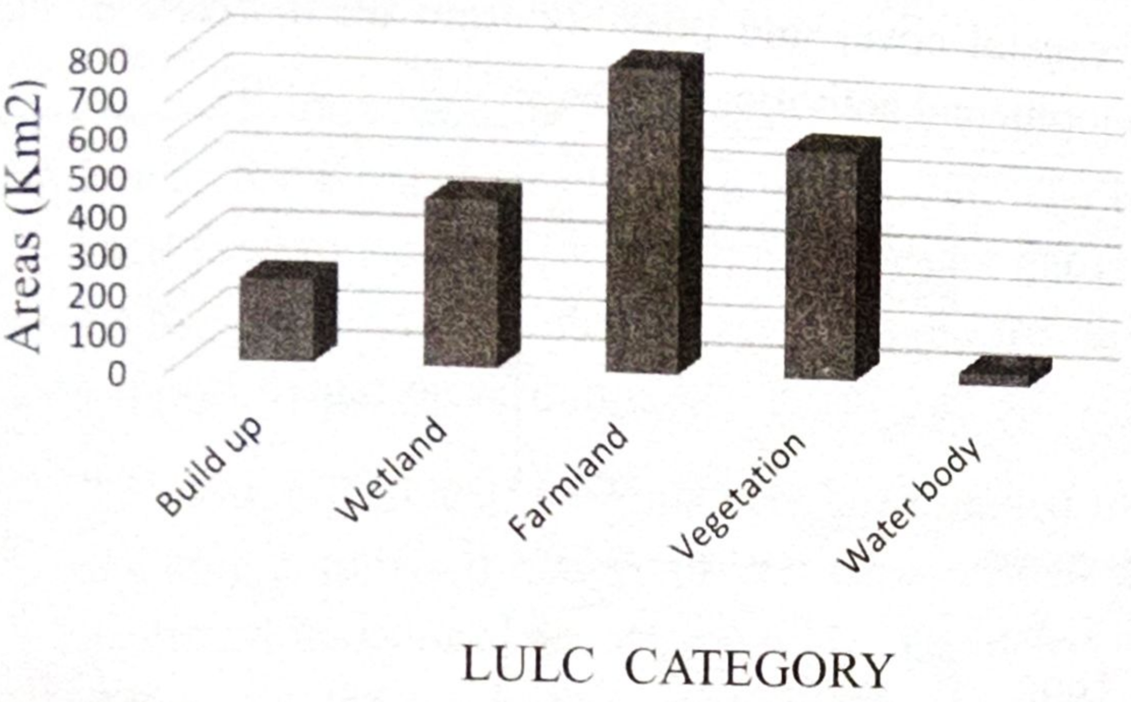


Figure 7: Mean LULC Distribution of Kontagora (1988, 1998, 2008 and 2018)

Wetland depletion from Urbanization in Landzun - Bida, Chanchaga - Minna and Kontagora

The Normalized Difference built-up Index (NDBI) is one of the most widely used built-up indices derived from satellite data for monitoring the location and distribution of built-up changes in a given geographical location. Also, the Normalize Difference Build-up Index value lies between -1 to +1. Negative value of NDBI represent water bodies where as higher value represent build-up areas while NDBI value for vegetation is low.

Figure 8 showed the NDBI images for the years (1988-2018) over Bida. The rate of built up areas increased from 1988 to 2018 with high concentration of built up at the city Centre. The NDBI values increased from 0.16 in 1988 to 0.17 in 2018. The increase in NDBI values is an indication of deforestation and less vegetal cover and possibly from an increase in built up developmental activities.

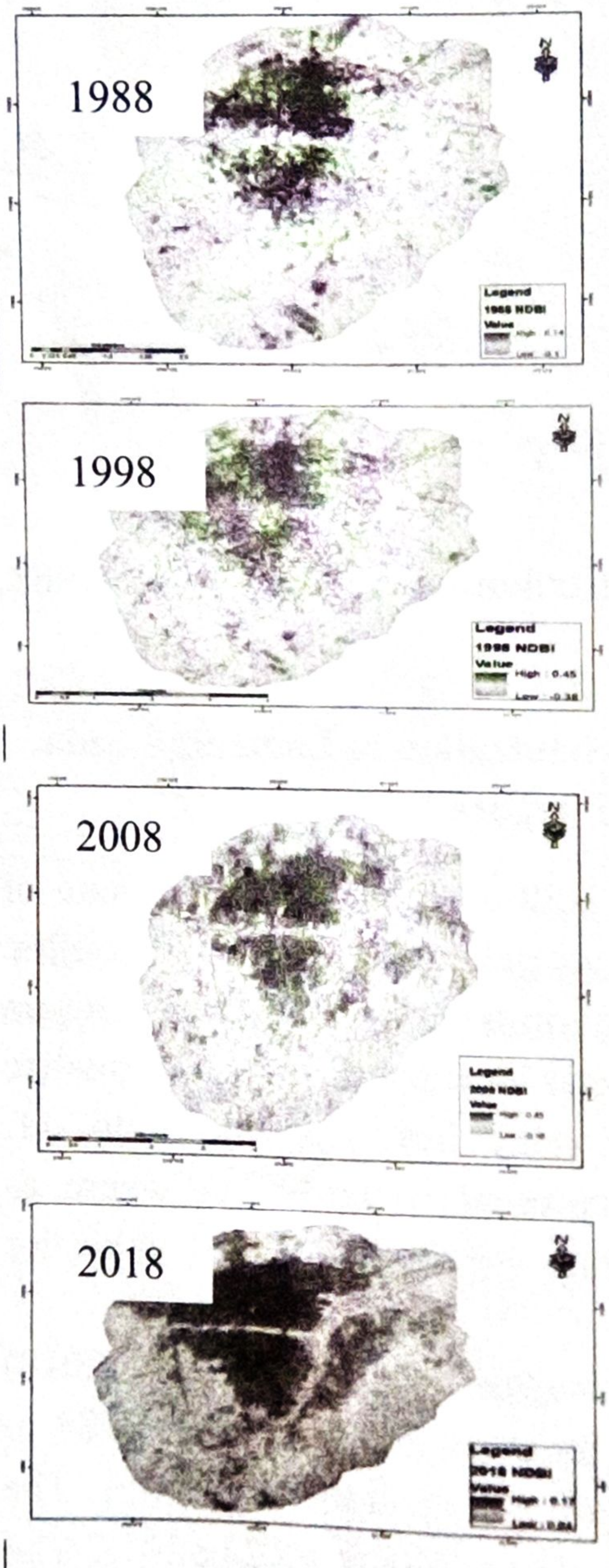


Figure 8: Normalized Difference Build-up Index image for Bida (1988, 1998, 2008 and 2018)

Figure 9 indicates the Normalized Difference Build-up Index image for Kontagora at 500 meter buffer. The built up areas increased towards the wetland areas across the different epoch under consideration due to the fertility of the soil which support irrigation farming.

The low NDBI value in this area is attributed to the fact that the area comprised mainly of Peri-urban settlements which are scattered and not concentrated as the nucleated urban centers. Although the area has continued to witness urbanization resulting to depletion of the wetland in the area because of the agricultural benefits derived from the areas.

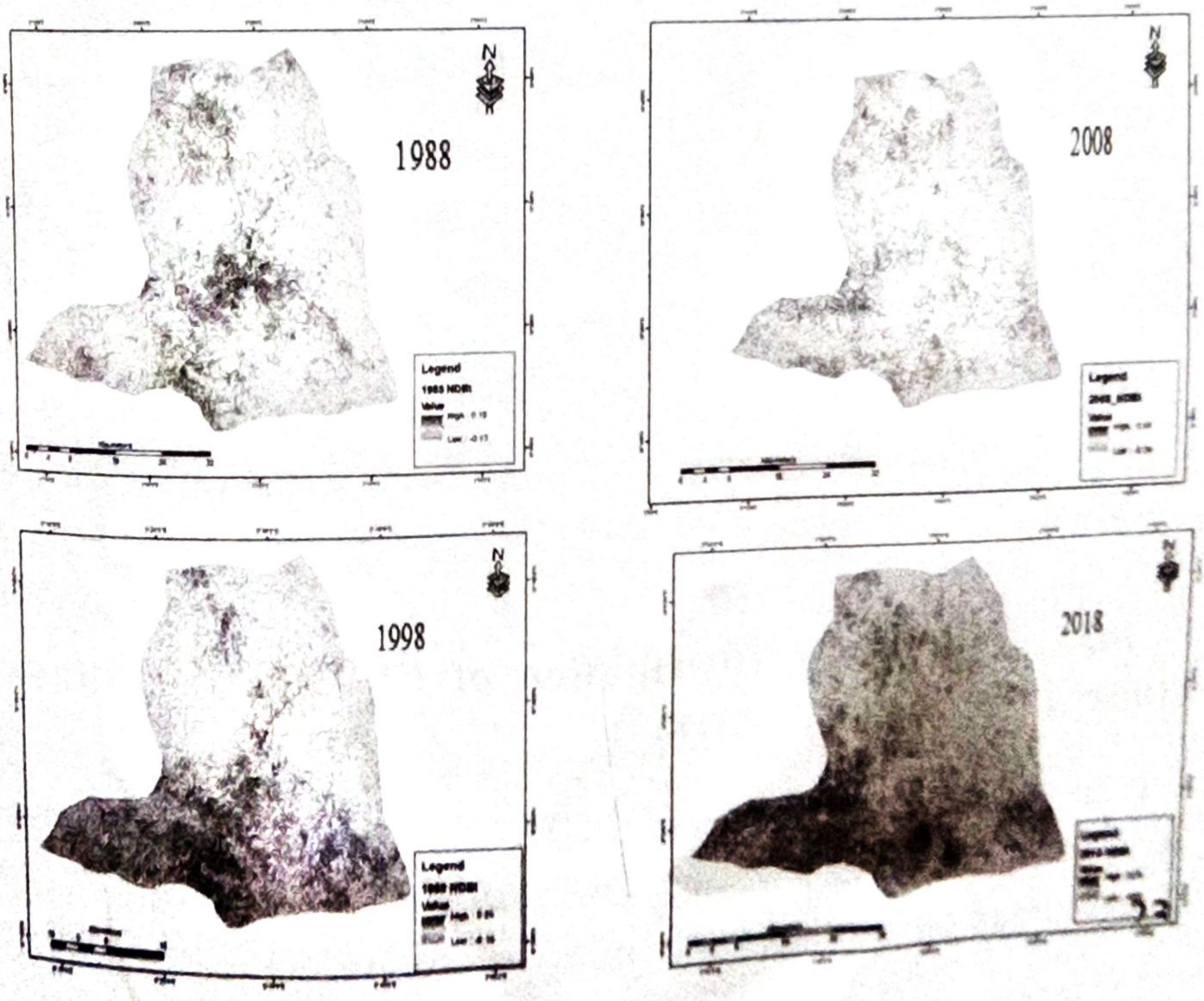


Figure 9: Normalized Difference Build-up Index map of Kontagora (1988, 1998, 2008 & 2018)

Figure 10 is the Normalized Difference Build-up Index image of Chanchaga1km buffer (1988, 1998, 2008 & 2018). The NDBI was low in 1988 (0.19) and high in 2018 with value of (0.27) This means an increase in built up area and measures need to be put in place to check the continuous depletion of the wetland ecosystem.

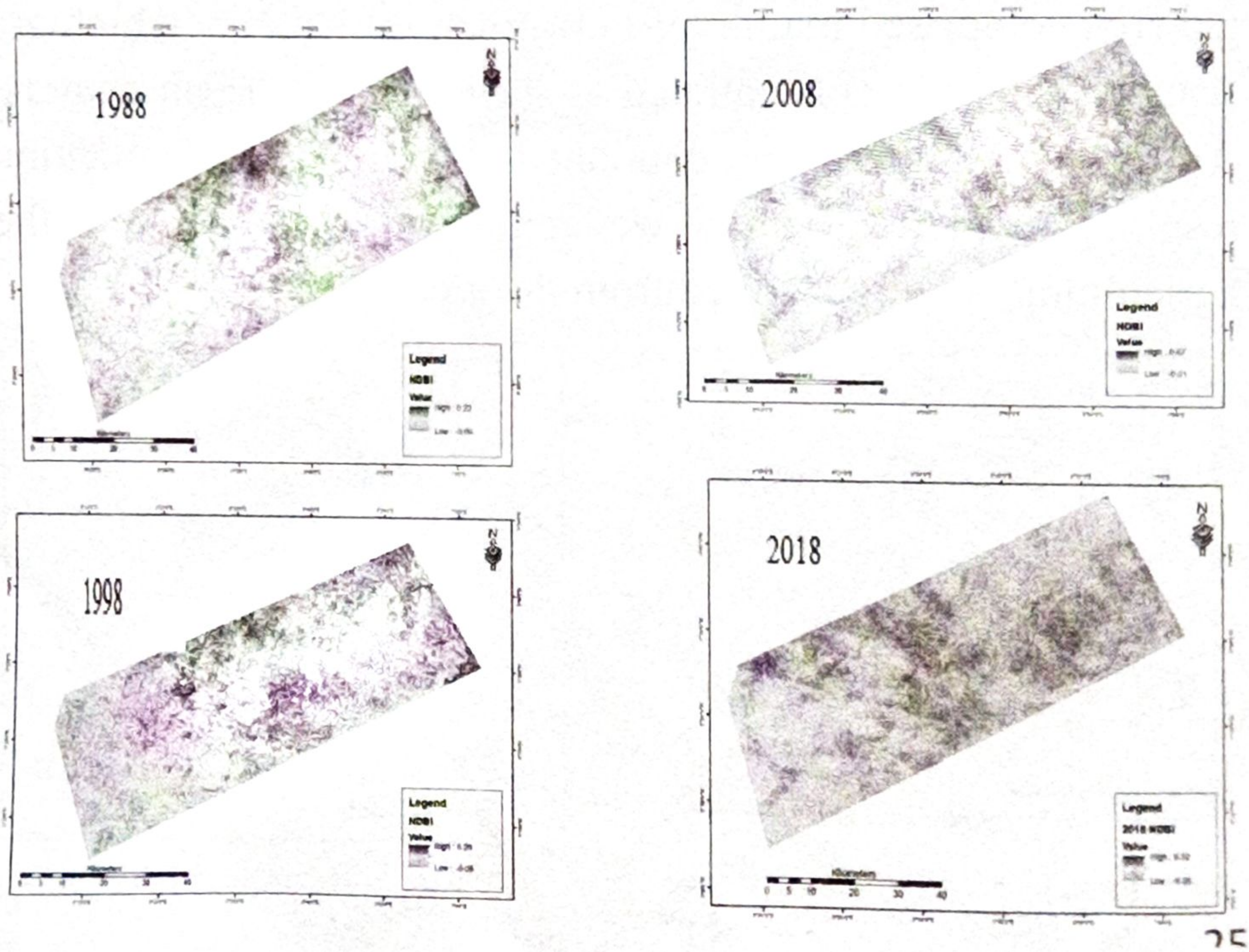
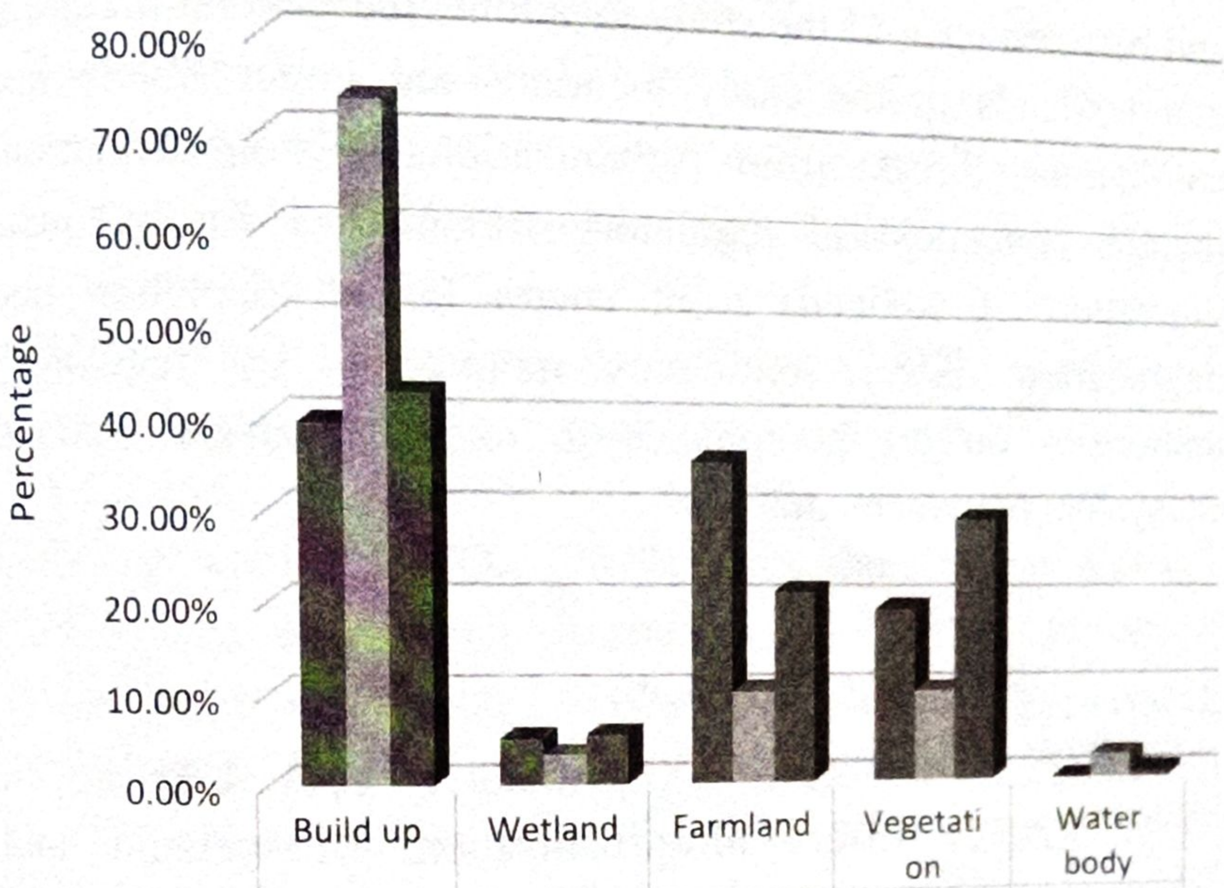


Figure 10: NDBI Distribution of Chanchaga - Minna (1988, 1998, 2008 and 2018)

Figure 11 is the percentage LULC distribution statistics of Kontagora, Bida and Minna The result shows that Bida with 73.67% has the highest built up areas around the wetland. It is followed by Minna 42.91% and Kontagora 39.59 %. Similarly, wetland decrease indicates 5.49% in Minna, 3.33% in Bida and 5.12% in Kontagora.



	Build up	Wetland	Farmland	Vegetation	Water body
Kontagora	39.59%	5.12%	35.82%	19.44%	0.03%
Bida	73.67%	3.33%	10.19%	10.17%	2.64%
Minna	42.91%	5.50%	21.36%	29.56%	0.67%

Figure 11: Comparative Percentage Distribution of LULC Wetland Depletion Attributes over the three Study Locations.

5. Conclusion and Recommendations

The Spatio-temporal changes in wetland land use and land cover showed that the wetland has changed into different land use and land cover types during the study period due to population increase, farmland cultivation and increase in built up areas but most severe between 2008 and 2018. Though, disparities in area coverage and percentage distribution of the various land use types and wetland depletion existed within and between each of the study locations, the general picture is that wetlands in the study locations are under severe and continuous threat from urbanization. Recommendations include enactment of regulatory frameworks for adequate protection of wetlands from encroachment, depletion and degradation. Also, continuous monitoring by regulatory authorities on the compliance to extant laws on wetland ecosystem management.

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