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CHANGE DETECTION ANALYSIS OF LAKE CHAD'S WATER BODY USING REMOTE SENSING

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ABSTRACT

Lake Chad is a vitally crucial wetland in the semi- arid Sahel region of Africa provides the basis of many millions of livelihoods which defends on its water and seasonal fluctuation to renew irrigation, fish stocks, and farmland. This research is examining lake shrinking and livelihood changes in the context of multiple stressors through a case study of "lake Chad of" with the help of remote sensing data, in the continent of Africa, research on Livelihoods about regions shows declined in water body fluctuations has largely focused on the wellbeing and security of people on the lake shore. The demonstrates that limited opportunities outside agriculture, the influx of mixed ethnic migrants, Boko Haram of Northern Nigeria which is terror group occupy lake part of Nigeria that led people of the area migrate as refugee to other state and city of Maiduguri and the increasing spate of violence all enhance livelihood changes. Livelihood opportunities Centre on the renewal effects of seasonal floods pulses on lake waters and learning opportunities triggered by past droughts. Although the reverse of the water body has brought new adaptive changes to the shore of basin behaviors on seasonality, traditional prognostic factors and availability of assets, responses have remained largely reactive. The research is focus on the factors responsible for the changes in socioeconomic activities of the people who are reside on the lake shore, and suggests that awareness of the particularities of the mechanisms that connect lake drying to livelihoods ca.

1. INTRODUCTION

Water bodies is the part of the earth's surface covered with water 3/4 of the earth's surface is surrounded with water. Water is distributed throughout the planet earth in different forms and shapes, called the various water bodies. These water bodies differ in size, right from huge ones like oceans and seas to the small ones like ponds. "They invaded our territorial waters"; "they were sitting by the water's edge" Thus the various water bodies we see on the earth's surface are in the form of oceans, seas, lakes, rivers, ponds, waterfalls etc.

Lake Chad. once known as *"the Pale-Chadian Sea* ", was the fourth biggest lake in Africa in 1963 with a surface area of 25 000 km2 (MBODOU, 2020). Situated in the Sahel region of Africa and bordered by four countries Chad to the east *(50%),* Niger to the northwest (17%). Nigeria to the west *(25%)* and Cameroon to the south (8%), this lake was one of the largest bodies of fresh water on the African continent.

The geographical or drainage basin with its surface area of 2,381,636 km2, making out 8% of the African continent's surface, is shared by Algeria, Libya, Cameroon, Nigeria, Niger, the Central African Republic (CAR), Sudan, and Chad. (LCBC 2020).

The Lake Chad hydrological basin covers almost 2.4 million km lies between 6° and 24°N and longitudes 7° and 24°E. About 60 per cent of the basin lies in an arid zone on the southern edge of the Sahara Desert. The countries concerned are Algeria. Cameroon, Niger, Nigeria, the Central African Republic, Sudan and Chad. The Lake Chad basin is the largest endorheic basin globally, covering an area of approximately 2,500,000 km2 (8% of the African continent). Annual precipitation in the Lake Chad basin diminishes significantly from the southern region (over 1000 mm yr./i) to the northern region (less than 100 mm yr./i) (Niel et al 2024).

2. METHODOLOGY

Data Required and Sources

The following data will be used for the purpose of this study:

Aster GDEM data which are in tiles and in 30m resolution will be sourced online through Earth Explorer data set. The DEM data will be process to generate the elevation map of the Study area from which the terrain of the study area will be assess and analyze.

Multi-temporal Landsat (WRS2: 184/51, 185/50, 186, /50, and 184/50) TM1989 and (L08 1999) and ETM 2009,2024 imageries remote sense dataset will be assemble and analyze for land use land cover and lake changes in the study

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area. The spatial resolution of one pixel of ETM+, TM and L08+ IMAGE was 30m and by 30 m and second it pixels is 60m by 60m.

GPS data of some points that are frequently engaged in Agricultural activities during both the raining, and irrigation periods to be taking.

Ancillary data and software packages

County-level topographic map geologic map, socio-economic map, meteorological data, and all the thematic layers will be generated in GIS environment at the scale of 1:25000. The software Packages to be used for this research were ERDAS 10.0 for image processing, ARCGIS 10.7.0, QGIS 7.8.1for analyzing and presenting the result.

Data Analysis

Steps

(a). Descriptive Statistics (b). Spatial Analysis

I. Pre-processing of images: the pre-processing for the dataset includes image registration, radiometric calibration, and radiometric normalization. Rectification and registration of TM and ETM+ imageries will be based on control points collected from vector files of the lake at the study area using thirty ground control points (GCP). The remotely sensed dataset will be geometrically corrected in the datum WGS84 and projection.

UTM N38 using the first order (linear) of polynomial function and closest Neighbor rectification re-sampling, which will be chose in order to preserve the radiometry and spectral data in the imagery Image-to-image registration will be done in order to register the ETM+ image with geo-coded TM image (master image). And ETM image with geo-coded TM image. The Land sat imageries will be radiometric calibrated for sensor differences, converted into spectral radiance and normalized for illumination properties through differences in sun - elevation angle and sun - earth distance by recalculating the pixel values into at-satellite reflectance.

ii. Post-processing of images: Two interaction goals followed in this study. In the first stage, remote-sensing techniques are use in evaluation of surface changes and determination of the type of land use classes. In the next stage, the area is evaluated for environmental change by using a prominent land degradation indicator method and GIS tools and then to analyze the impacts of lake shrink/cover class expansion on environmental impact assessment. The geometrically rectified and radio-metrically calibrated TM, L08, ETM+ bands 3, 4, 5, 6,7,8 will used to derive the studied indices. Satellite-derived index images were produced to portray surface changes. In this research, two methods were used to retrieve class boundary, namely, unsupervised classification (An ISO cluster unsupervised classification (Iso)) and indices. The five indices covered in this study will be tested for vegetation changes; Normalized Difference Vegetation Index (NDVI), Build-up Index (NDBI), Water Index (NDWI), salinity Index (NDSI), and Topsoil Grain Size Index (GSI) were calculated on basis of the following equations, respectively: Normalized Difference Vegetation Index (NDVI). The most common form of vegetation index is the Normalized Difference Vegetation Index or NDVI. The NDVI is basically the difference between the red and near-infrared band combination divided by the sum of the red and near-infrared band combination or: NDVI = (NIR — R) / (NIR + R) where R and NIR are the red and near-infrared bands.

Normalized Different Built-up Index (NDBI): To retrieve urban land from the Landsat imagery, a new index (NDBI) was used by this study's authors as follows, which is sensitive to the built-up area. NDBI was proposed by analyzing the spectral characteristics of different land use/cover types. NDBI = [(band5)—(band4)] / [(band5)+(band4)] where bands (band4 and band5) of the Landsat TM or ETM+ images.

Normalized Different Water Index (NDWI): This study showed that the NDWI was developed to Geo-Spatial Information Science 14(l):39-47 delineate open water feature.

NDWI = (band 4 — band5) / (band 4 + band5) (3) where band4 and band5 represent the spectral bands of the Landsat images.

Normalized Differential Salinity Index (NDSI): This index (NDSI) is just the reverse of the NDVI index for vegetation. The NDSI is basically the difference between the red and near-infrared band combination divided by the sum of the red and near-infrared band combination, or the algorithm used was: NDSI = [(band3) — (band4)] / [(band3) +(band4)]

Image Mosaicking

Because of the large extent of Lake Chad images for the four separate dates had to be mosaicked together. In all, fifteen separate images were mosaicked together.

Clipping and Classification

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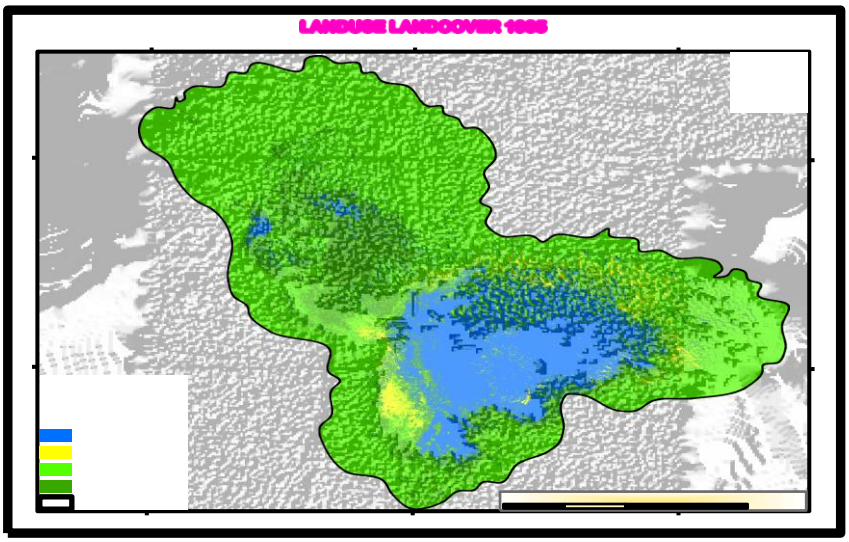
After the images were registered, they were clipped down to a smaller size using a custom-built region of interest or ROI based on the 1975 image and applied to the other two dates. An unsupervised K-Means post classification was then performed to identify three classes' barren land, water, and vegetation.

3. RESULTS AND DISCUSSION

The image from the map shows the whole lake is full of water across all its coverage area with very Small Island dispersed throughout the area. 1975 water analysis shows that water occupies about 52% in area, vegetation covered about 22 while sand with moisture covered about 15% and dry sand covered about 11%. Coverage in 1975 is shown below by the map of the Lake of that year, pictorial presentation of these is given below.

Table 1: Distribution of land cover 1975

Land Cover	Water Body	Vegetation	Sand with Moisture	Dry Land
Area (Km^2)	15447.59	6624.74	4536.26	3109.72

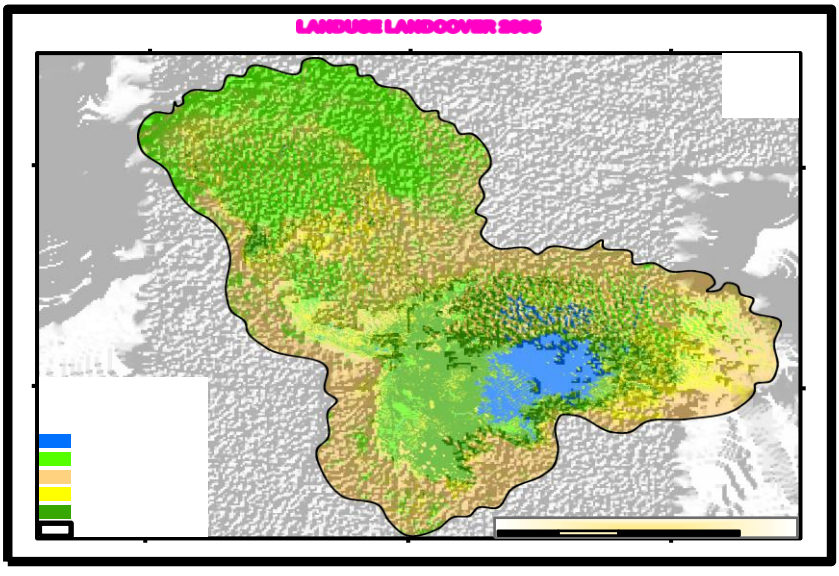


1985 Unsupervised K-Mean's image statistic

In 1985 map of the lake as shown below, there is a major decrease in the area covered by water which used to be *52%* in 1975 to about 24% while vegetation area decreased from 22% to 14% dry land also increased due to the massive shrinking within this period from about 11 % to 37%. This shows that water body, vegetation and sand with moisture have decreased. These are illustrated.

Table 2: Distribution of Land Cover 2005

Land Cover	Water Body	Vegetation	Sand with Moisture	Dry Land
Area (Km^2)	7,088.00	4,329.00	7,359.00	10,952.00



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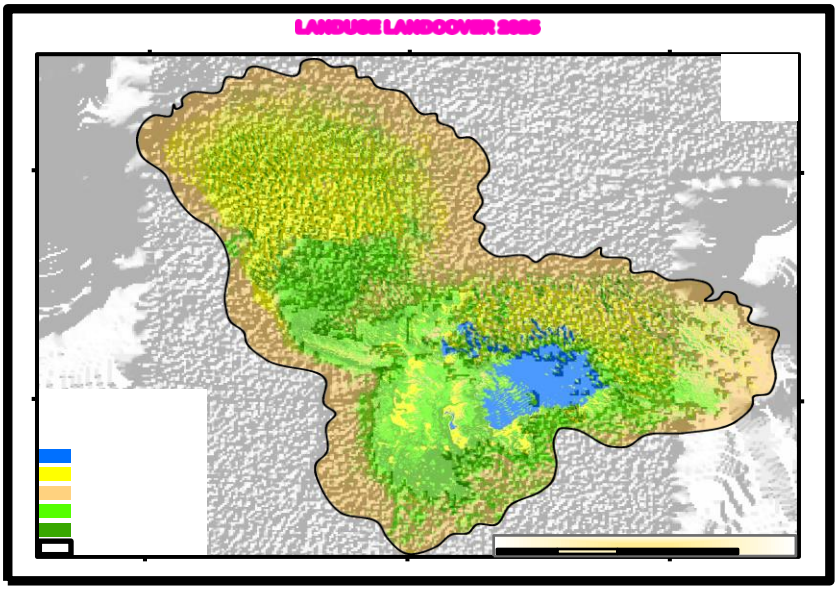
2025 Unsupervised K-Means Image Statistics:

Between 2025 there was a very small difference in the shrinkage rate, it is depicted in the map of the lake shown below. Level of water body is about 3,444.60km^{2}vegetation covered about 5,961.25km^2 while moisture sand was estimated to be 9,265.23 km^2 and dry land covered about 11,047.68 km^2.

Table 3: Distribution of Land Cover 2025

Land Cover	Water Body	Vegetation	Sand with Moisture	Dry Land
Area (Km^2)	1,50.60	5,861.25	10.225.23	12,047.68



4. REFRENCES

[1] Coe, Michael T, Foley J.A (2001), "Human and natural impacts on the water resources of the Lake Chad Basin". Journal of Geophysical Research, 106 (D4): 3340-3356.
[2] http://www.scienceinafriCa.cO.Zal2003lmarchlchadultm.
[3] Carmouze, J.-P. & Lamoille, J. (1983) The lacustrine environment. "Lake Chad" pp. 27-64. Dr. W. Junk Publishers, The Hague.
[4] Hydrology and limn logical aspect of lake monitoring (Pertti Heinoneon) textbook published in 2021, Page 4-6
[5] Michigan inland lake partnership: http://michiganlakes.mSUe.mSU.edO/lake ecology/lake classifications.
[6] National Drought Mitigation Center,
[7] http://www. drouht.uni.edu/whatis/conceyt.htin)
[8] http://www .ncdcnoaa.gov/oalclimate/globalwarmin2.htflll
[9] http://www. giss.nasa. gov/research/
[10] Encyclopedia Britannica dictionary (2015)
[11] Lal R (1994) Tillage effects on soil degradation, soil resilience, soil quality and sustainability. soil tillage research pp,1 8-27
[12] Michael T et al., 2021 human and natural impact the water resources of the Lake Chad Basin. Journal of Geography research, vol 106 no.D4 on, pages 3349-3356, Feb 27, 2001
[13] Prof Savindra Singh Environmental Geography Pravalika publications Allahabad University pages 339-35 1
[14] Food and Agriculture Orgamsation (FAO) 2012, Climate change implications for fishing communities in the Lake Chad Basin. Food and Agriculture Organisation Fisheries and Aquaculture Proceedings 25, Rome, Italy.
[15] McCubbin, S., B. Smit, and T. Pearce. 2015. Where does climate fit? Vulnerability to climate change in the context of multiple stressors in Funafuti, Tuvalu. Global Environmental Change 30: 43—55
[16] Giwa 2012, Global International Waters Assessment Lake Chad Basin, GIWA Regional assessment 43 Published by the University of Kalmar on behalf of United Nations Environment Programmed
[17] Victoria, Tanganyika and Nyassa, 1964. The Lake Chad Basin Commission (LCBC)
[18] World Meteorological Organization (WMO).
[19] Sarch M T and Birkett C 2020 Fishing and fanning at Lake Chad. responses to lake-level fluctuations Geography. 166 156—72