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Normalised Difference Vegetation Index (NDVI) and Land Surface Temperature (LST) Analysis of Chamarajnagara District Karnataka India Using Landsatdata

*[1]Krishnamurthy *Department of studies in Geography University of Mysore, India*
[2]Irfan Manzoor Bhat *Department of studies in Geography University of Mysore, India*
[3]Dr. Asima Nusrath *Department of studies in Geography University of Mysore, India*

Abstract
Ecology and climate are significantly impacted by the loss of vegetation brought on by changes in land use. Monitoring and managing land use dynamics would help in land use planning and mitigation of environmental impacts. This study's objective is to quantify how the vegetation and land surface temperature have changed over the recent years. Normalized Difference vegetation index (NDVI) and Land Surface Temperature (LST) were assessed using Remote sensing and GIS technology. Landsat 8 data were used to retrieve the Normalized Difference Vegetation Index (NDVI) and Land Surface Temperature (LST). The spatial technologies of Remote Sensing and GIS are effective approaches to monitoring and analyzing vegetation changes, surface temperature, and water bodies. The examination of the climatic and vegetation data for the study region from March 2016 to March 2022 showed a progressive loss of dense forest and water bodies as well as a rise in temperature and built-up area, which are the causes of changes in NDVI and LST.
Keyword. *Changes in land use, Normalized Difference vegetation index (NDVI), Land Surface Temperature (LST), Remote sensing, GIS*

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I. Introduction

There are several ways to quickly monitor the environment and climate using satellite data. Especially in remote locations where a field survey is challenging. Without physically touching them, different earth observation satellites with varying geographical and spectral resolution can be used to gather information on things, places, or phenomena including vegetation, climate change, agriculture, and water resources. The NDVI is a simplistic yet effective metric for quantifying green vegetation. It correlates chlorophyll absorption at red wavelengths with near-infrared leaf scattering in green leaves. The most straightforward method available for evaluating the greenness and density of the vegetation shown in a satellite image is the Normalized Difference Vegetation Index (NDVI). We may use the very characteristic spectral reflectance curve that distinguishes healthy plants by calculating the difference between two bands—visible red and near-infrared. An NDVI value, which ranges from -1 to 1, is used to measure that difference.

Land Surface Temperature (LST) is a global scale land surface process. It is the temperature of Earth's crust. It is not a constant parameter as it kept on changing due to climatic conditions and human activities. It is not possible to get accurate estimation of LST because many parameters rely on it. Rapid industrialization and urbanization leads to decrease in natural land cover area into built up area, which is one of the major problems of increase in LST and climatic changes. In order to estimate accurate LST automated mapping algorithm was used. Remote sensing and GIS techniques provide an advanced and reliable technique for calculating LST using automated technique by satellite imagery.

Chamarajanagara is situated in the semi-arid zone with high temperature and low rainfall. Increasing temperature due to global warming affects the land surface temperature in the study area which affects the flora, fauna and living environment of the study area. The main objective of this study is to analyze the changes in NDVI and LST in the study area from 2016 to 2022.

Study area

The Chamarajanagara district is located in the southern tip of Karnataka state and lies between the North latitude 11° 40' 58" and 12° 06' 32" and East longitude 76° 24' 14" and 77°46' 55".the district shared border with Tamilnadu and Kerala states. It falls in the southern dry zone. Topography is undulating and mountainous with north south trending hill ranges of Eastern Ghats. It comprises of 5 taluks are Hanur, Yelandur, Gundlupete, Kollegala, Chamarajanagara with total Geographical area of 5101 sq. km. and population of 102791 as per 2011 census. 27.12% of average annual temperature and average 751 mm annual precipitation. The districts yearly temperature is 27.12℃ and it is 1.15% higher than India's averages.

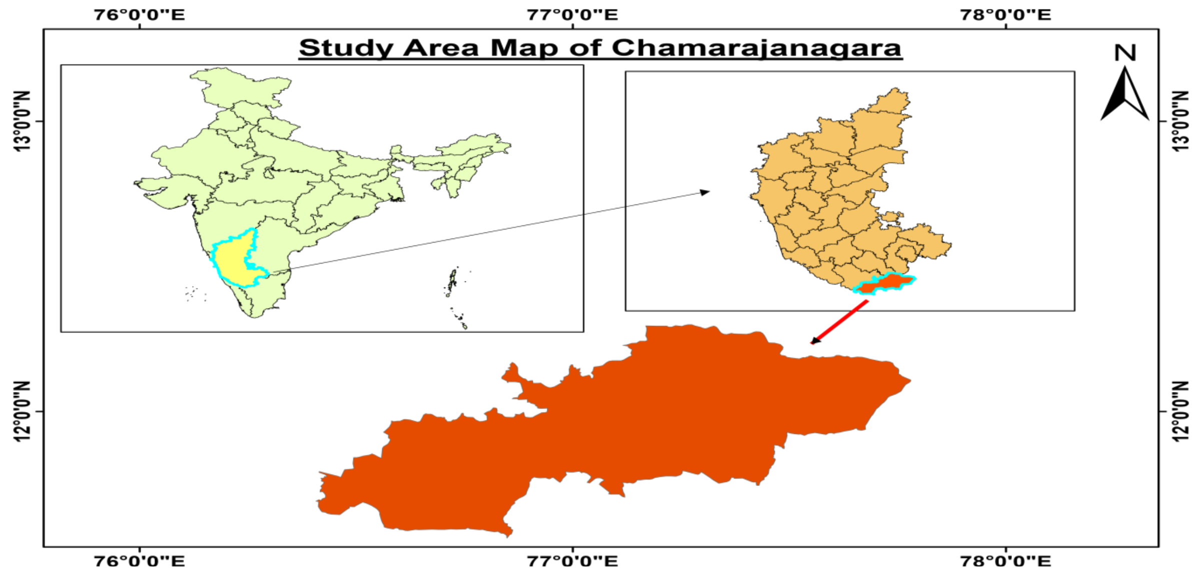

Figure 1. Study area map of Chamarajanagara District

Table.1 Data used

RADIOMETRIC RESOLUTION	SATTELLITE/SENSORS	PATH/ROW	DATE	BANDS	SPATIAL RESOLUTION
30M (visible,NIR,SWIR 100M (thermal) 15m)panchromatic)	LANDSAT 8 OLI	144/052	MARCH 2016	4 5&10	12 BIT
30 M	LANDSAT 8 OLI	144/052	MARCH 2022	4,5&10	12 BIT

II. Methodology

In this study remotely sensed satellite imageries are used which are downloaded from USGS (EARTH EXPLORER)/Landsat TM. Landsat TM images were extracted for the particular area that is Chamarajnagara district using spatial analyst tools using ARC Map. Automated mapping algorithm has been used for calculating the brightness temperature and emissivity which helps to calculating the LST values. For the retrieval of NDVI and LST following steps are involving conversion of pixel values of the Landsat8 data Band 4 Band 5 Band10

Retrieval of NDVI

Normalized Difference Vegetation Index, (NDVI). Quantifies vegetation by measuring the difference between near infrared (which vegetation strongly reflect) and red light (which vegetation absorb).

NDVI ranges from -1 to +1.

NDVI RANGE	FEATURE
-1 to 0	Water, Snow, Cloud
0 to 0.2	Barren land/built up/rock
0.2 to 1	vegetation

$$NDVI = \frac{NIR - RED}{NIR + RED},$$

Land Surface Temperature Estimation (LST) Algorithm

1. STEP – TOA {Top of atmospheric spectral radiance}

$L_\lambda = M_L + Q_{cal} + A_L - O_i$

Where,

$L\lambda$ = Spectral radiance
M_L = Band specific (here band 10) multiplicative rescaling factor = 0.000334
Qcal = Band 10 image
A_L = Band specific additive rescaling factor = 0.100000
Oi = Correction for band 10

2. STEP – Conversion of digital number nos. into reflection

3. STEP – Conversion of spectral radiance to brightness temperature (BT): The radiance values are next converted to brightness images using thermal constants given in metadata file. The conversion formula used is as follows;

$BT = K2 / \ln[(K1/L\lambda) + 1] - 273.15$

T= Satellite brightness temperature in Kelvin
$L\lambda$= Spectral radiance.
K1= Band 10 thermal coefficient derived from metadata file.
K2= Band 10 thermal coefficient derived from metadata file.
So, brightness temperature calculation equation is as follows;
T=1321.0789/ {In (774.8853/BAND10) +1}-273.15

4 STEP – Normalized Difference Vegetation Index, Landsat 8 bands 6 and 5 as; red (R) and near-infra red (NIR) bands were used to generate NDVI with the following formula:

NDVI = (Band 5 (NIR) − Band 4 (R)) / (Band 5 (NIR) + Band 4 (R))

5 STEP- LAND SURFACE EMISSIVITY: The ability of a surface to emit the absorbed radiation is called emissivity of material. It is an important parameter determining the surface temperature of a material. Emissivity calculation is carried out through various methods, but for this study following method is applied,

LSE = µV * PV + µS * (1-PV)
µV= emissivity of vegetation at band 10 (0.986).
µS= emissivity of soil at band 10 (0.914).
PV= proportion of vegetation.

6 STEP- LAND SURFACE TEMPERATURE CALCULATION: Land surface temperature is radiative surface temperature of land surface depending on vegetation cover and soil moisture. In present work for calculation of LST single channel algorithm has been utilized using band 10 of Landsat 8 TIRS. The equation is given below

$$LST= BT/ \{1 + [(\lambda\ BT/p) \ln(LSE)\}$$

BT= Brightness temperature.
LSE = Land surface emissivity.
p=h*c/s=14380 mK
H= plank's constant (6.626*10-34Js)
S= Boltzmann constant (1.38*10-23 J/K)
C = Velocity of light (2.998*108 m/s)
Hence the equation used is as follows
LST= BT (Band 10)/ {1 + [(10.895*BT (Band10)/14380) *ln(LSE)}
BT (BAND10) = Brightness temperature of band 10 TIRS.
LSE = Land surface emissivity

III. Result and discussion

The NDVI of Chamarajanagara district was estimated using Landsat8 band 4and band 5 for the March 2016 and March 2022. This study implies that the dense forest and moisture reduced because of land use changes in these following years. Because of urban development the green space reduced. Figure 2.1 shows values range from -0.1769 to 0.5948 of 2016 and figure 2.2 indicate value ranges from -0.1674 to 0.5444 of 2022 when compare these two Landsat data set its shows varies in dense vegetation and barren land/urban land

The land surface temperature (LST) of Chamarajanagara district was studied using Landsat 8 band 4, 5 and 10 from March 2016 to march 2022. This study implies that the LST in the study area was increased around 2℃ from 2016 to 2022. Figure 3.1 indicates value ranges from 3.178 to 30.8115 of 2016 and figure 3.2 shows value range from 16.984 to 46.613 when ewe compare these two data images the temperature and moisture content varies from 2016 to 2022.The temperature increased to 2℃ in the study area and in 2016 rainfall of 144mmwas received which is lesser than average annual rainfall of 751mm in 2021.However the annualaverage rainfall increased to 745.91 mm but increased temperature reduced the vegetation and water resources bodies.

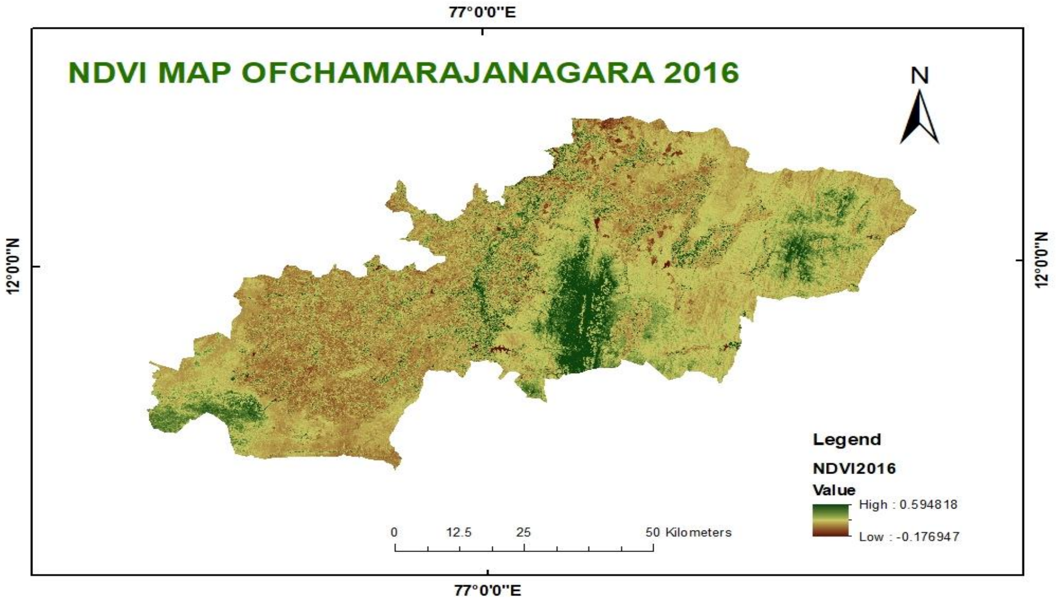

Figure.2.1. NDVI map of Chamarajanagara District 2016

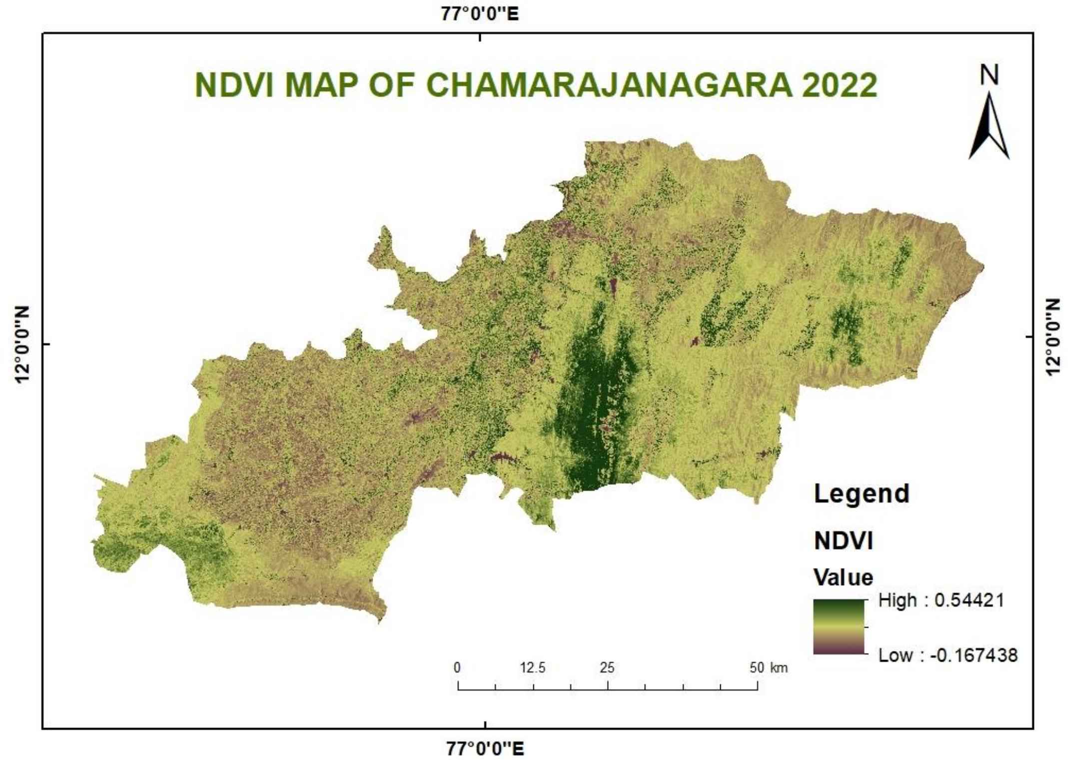

Figure.2.2 NDVI Map of Chamarajanagara District 2022

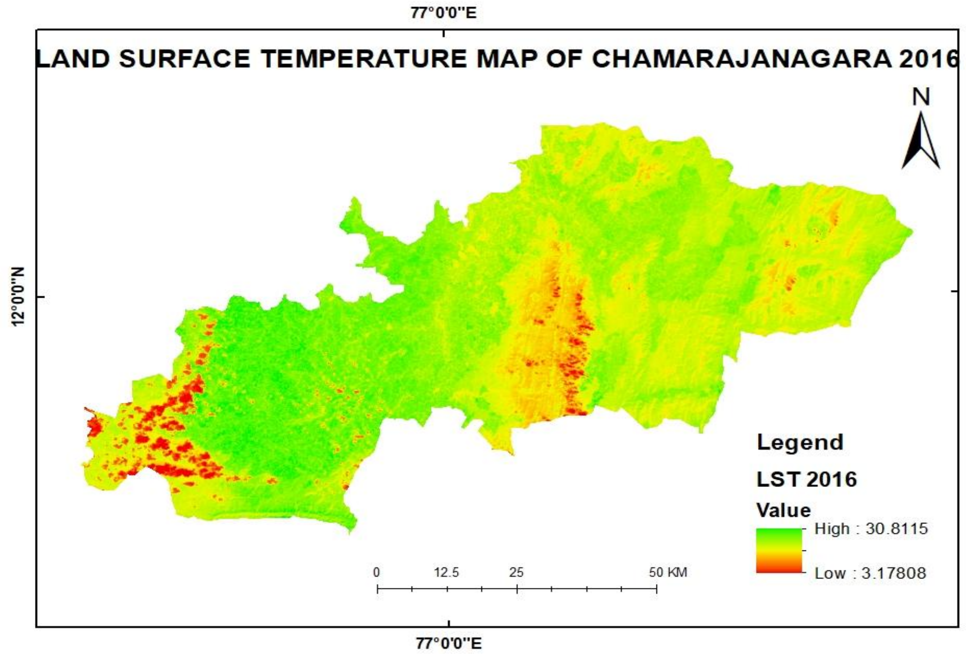

Figure 3.1 LST map of Chamarajanagara District

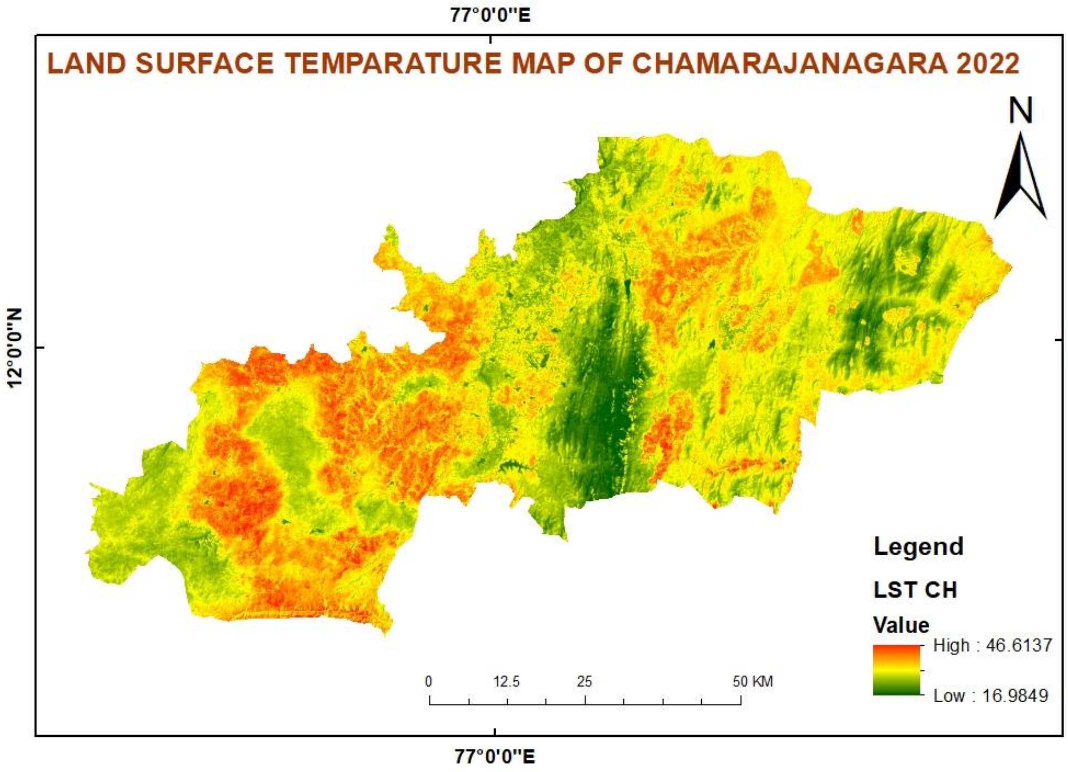

Figure 3.2.LST map of Chamarajanagara District

IV. Conclusion

The changing land use dynamics had a visible impact on the regional ecology and environment and it opens new study arena to researchers. The continuous monitoring with the spatial and other technologies will help in taking measures to reduce the impacts of anthropogenic encroachments. The area falls close to the Biodiversity hotspot region and therefore if not tackled on time it can spill over to the other surrounding areas. There is requirement of filling in the serious communication lag between the various departments in order to restore it. The dense forest reduction and water resource loss can further lead to the land use change and complex associated phenomena.

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