

# Estimation of Land Surface Temperature of Kumta Taluk Using Remote Sensing and GIS Techniques

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## ABSTRACT

*The present study addresses the potential of Landsat-8, Landsat4-5 data for estimation of Land surface temperature in parts of Kumta Taluk of Uttara Kannada District region. The area lies between 14.427°N and 74.418°E with the total area of 55,512 hectares. The NDVI map for the year 2017 was prepared and the results indicated that there are five classes and NDVI varies from -0.162 to 0.549 and NDMI map for the year 2017 was prepared and the results indicated that there are five classes and it ranges from -0.264 to 0.392. The Land surface temperature map for the study area indicated that the temperature ranges 24 °C to 39.58° C. The NCEP Reanalysis data download and the data is downscaled to a regional scale from grads software, the results show that annual temperature for the year 2017 ranges from 18.93 °C to 34.97° C and the annual Relative humidity, runoff and soil moisture is 22.37 %, 2.61kg/m<sup>2</sup>, and 0.23kg/m<sup>2</sup>. The results show that surface temperature was high in the barren and settlement regions whereas it was low in the thick vegetation cover region. As from the Single Window algorithm, the LST derived using them were more accurate and reliable. So the result concluded that as temperature increases the relative humidity also increases and soil moisture decreases. Forest regions play the very important role in temperature reduction in the global warming and for the sustainable rural or urban development. The mapping of, LST and NDVI, NDMI was done using ArcGIS Software.*

**Key Words:** LULC, Land surface Temperature, Normalized Difference Vegetation Index, Normalized Difference Moisture Index.

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## 1. INTRODUCTION

Remote sensing is a new technology that can gather information on a target without coming in direct contact, and usually refers to the acquisition and processing of information on the earth's surface. Landsat-8 Satellite data of the study site is utilized for deriving LST. Land surface is integrated with Temperature (LST), the skin temperature of the ground, is identified as a significant variable of microclimate and radiation transfer within the atmosphere. Visual interpretation is one of the successful methods of delineating spatial features of the Earth by a geospatial expert. Because of increase in the green house gases and other climatic parameters, it tends to increase in the LST for that area.

## 2. STUDY AREA

The city of Kumta is located on the Arabian Sea coast in the district of Uttara Kannada in the state of Karnataka. Kumta is adjacent to the vast Western Ghats 14.42°N 74.4°E. It has an average elevation of 3 metres. The town experiences a tropical wet and dry climate. About 85% of rainfall occurs in June to September i.e in South West monsoon season. The town receives 350-400cm of rainfall every year.

### 3. OBJECTIVES

The objectives of the present study are as follows

1. Study of Land surface temperature for Kumta Taluka of Uttara Kannada District using Landsat-8 data
2. Study of NDVI and NDMI for the study area using Landsat-8 data.

### 4. MATERIALS AND METHODS

Landsat-8 is the latest among the Landsat series of NRSA. The data of Landsat 8 is available in Earth Explorer website at free of cost. In this study, Landsat-8 OLI Images of pertaining to the study area was used to calculate NDVI and the estimation of LST. Single – window algorithm method has employed to find out LST in the study area. Vegetation proportion calculation, emissivity calculation, LST calculation etc were executed in ArcGIS9.3 software platform. The image was processed using ERDAS Imagine and classify the Land use Land cover thematic map with ground truth data collected from GPS for LISS3 data supervised classification.

#### 4.1. Image Acquisition and Pre-processing

The images were already rectified to WGS-1984-UTM-Zone\_43N. The next step involved is the conversion of DN (Digital Number) to spectral radiance given in the metadata file and the Thermal band to at-Satellite Brightness Temperature. The file with extension .MTL provided in the Landsat-8 image set contains the thermal constants.

#### 4.2. Land surface temperature analysis

The Landsat-8 OLI sensors acquire temperature data and store this information as a digital number (DN) with a range between 0 and 255. The detail step by step procedure for Land Surface Temperature (LST) calculation is given below.

$$LST = \frac{BT}{1 + W \cdot (BT/p)^{\epsilon}}$$

Where:

BT = At satellite temperature W = Wavelength of emitted radiance (11.5 μm) p = h \* C / S (1.438 \* 10<sup>-2</sup> mk)

h = Planck's constant (6.626 \* 10<sup>-34</sup> JS)

s = Boltzmann Constant (1.38 \* 10<sup>-23</sup> J/K) C = Velocity of light (2.998 \* 10<sup>8</sup> m/s) p = 14380

1. **The first step is** convert digital number to radiance using the given below formula

$L_{\lambda}$  is the Spectral Radiance at the sensor's aperture (watts/(m<sup>2</sup>\*ster\* μm))

$$L_{\lambda} = MLQ_{cal} + AL$$

$$L_{\lambda} = 0.0003342 * band10 + 0.1$$

Where:

$L_{\lambda}$  = TOA spectral radiance (watts/ (m<sup>2</sup>\*ster\* μm))

ML = Band Specific multiplicative rescaling factor from the Meta

(RADIANCE\_MULT\_BAND\_X, Where X is the band number 10 or 11)

AL = Band specific additive rescaling factor from the metadata

(RADIANCE\_ADD\_BAND\_X, Where X is the band number)

Qcal = Quantized and calibrated standard product pixel values (DN)

**2. The Second step** is Convert Band radiance (which is derived from equation 2) to brightness temperature using the thermal constant given in Meta data file. The conversion formula is given below

$$T = K2/\ln (K1/ L\lambda+1) - 272.15$$

$$T=1321.08/\ln(774.89/\text{band10radiance}+1)-272.15$$

Where,

T= At – Satellite brightness temperature in Kelvin (K)

L $\lambda$  = TOA spectral radiance (watts/(m<sup>2</sup>\*ster\*  $\mu$ m))

K1 = Band\_Specific thermal conversion from the metadata (K1 – Constant\_Band\_X, where X is the band number)

K2 = Band\_Specific thermal conversion from the metadata (K2 – Constant\_Band\_X, where X is the band number)

272.15 = Convert Kelvin to ° Celsius.

**3. The third step** is deriving Land Surface Emissivity (LSE).

$$e = 0.004Pv+0.986$$

Where, e = Emissivity

PV = Proportion of vegetation which is calculated using NDVI value

NDVI = Normalized Difference Vegetation Index

NDVI can be calculated in ArcGIS by applying the given formula

$$\text{Float } (Band5-Band4)/\text{Float } (Band5+Band4)$$

Where,

Band5 = Infrared Band, Band4=Red band

$$PV = (NDVI-NDVimin/NDVImax + NDVimin)^2$$

Now we can get *PROPVEG* as an output of Proportion of vegetation. Now we can calculate LSE by applying PV value in equation 3

$$\text{That is } e = 0.004 * \text{PROPVEG} + 0.986$$

Now we can get LSE of the study area which shows in map.3

**The final step** is calculating land surface temperature using equation 1. The output such as *BANDSATTEMP* substitute for 'BT' that is brightness temperature in °c, and *LSE* value replaced in 'e' that is emissivity.

$LST = \frac{BT}{1+W*(BT/p)*Ln(e)}$  ----- (Rajeshwari and Mani 2014),

$LST = \frac{\text{Band10satemp}}{1 + \frac{\text{Band10satemp}}{14380} * Ln("LSE")}$

Finally we can get the actual land surface temperature of band10 (LST) and Band 6 of the study area given the statistics of study area of LST. Sun elevation represent the time is probably the morning.

#### 4. RESULTS AND DISCUSSION

The NDVI map showing the Land use and Land cover classes is shown in the Fig.1 for the year 2017 was prepared and the results indicated that there are five classes and NDVI varies from -0.162 to 0.549 and NDMI map is shown in Fig.3 for the year 2017 was prepared and the results indicated that there are five classes and it ranges from -0.264 to 0.392. The Land surface temperature map for the study area is shown in Fig.2 indicated that the temperature ranges 24 °C to 39.58° C. The NCEP Reanalysis data download and the data is downscaled to regional scale from grads software, the results shows that annual temperature for year 2017 is ranges from 18.93 °C to 34.97° C and the annual Relative humidity, runoff and soil moisture is 22.37 %, 2.61kg/m<sup>2</sup> and 0.23kg/m<sup>2</sup>.

The correlation coefficient between NDVI and LST, NDMI and LST is shown in Fig.4 and 5. From the vegetation index, the results indicated that surface temperature was high in the barren and settlement regions whereas it was low in the thick vegetation cover region. And from moisture index the vegetation regions as more moisture content then other regions

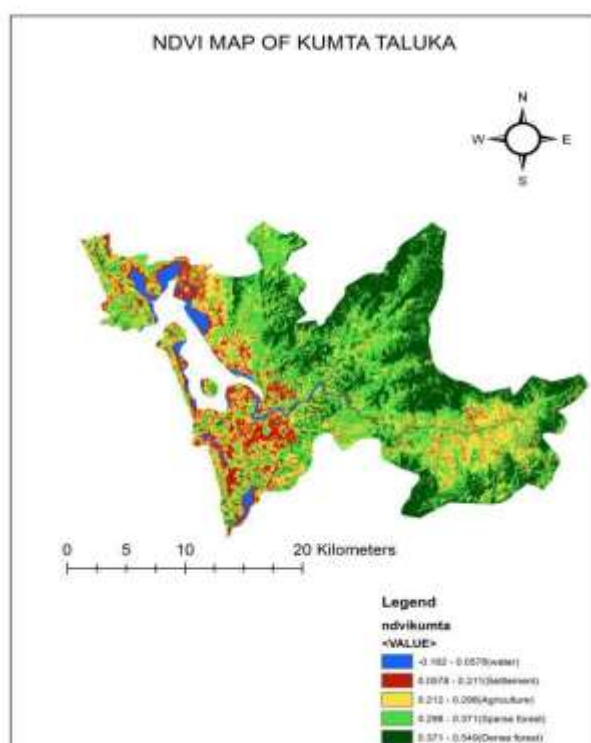


Figure .1 NDVI MAP OF KUMTA 2017

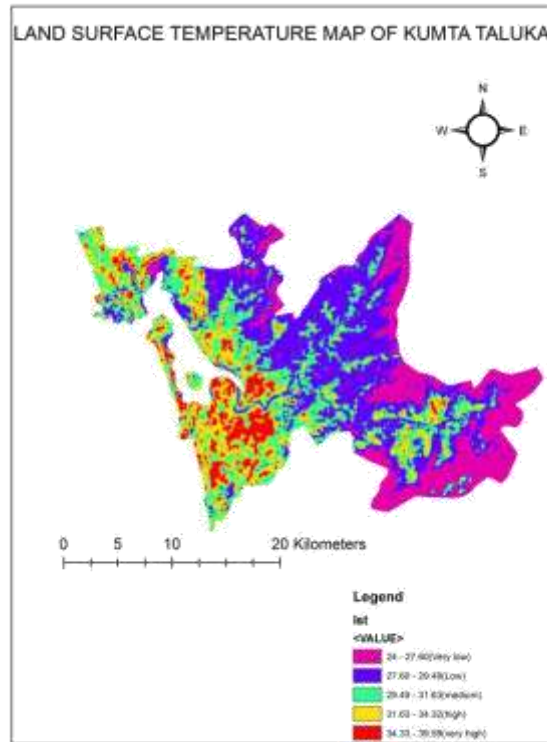


Figure 2 LST MAP OF KUMTA 2017

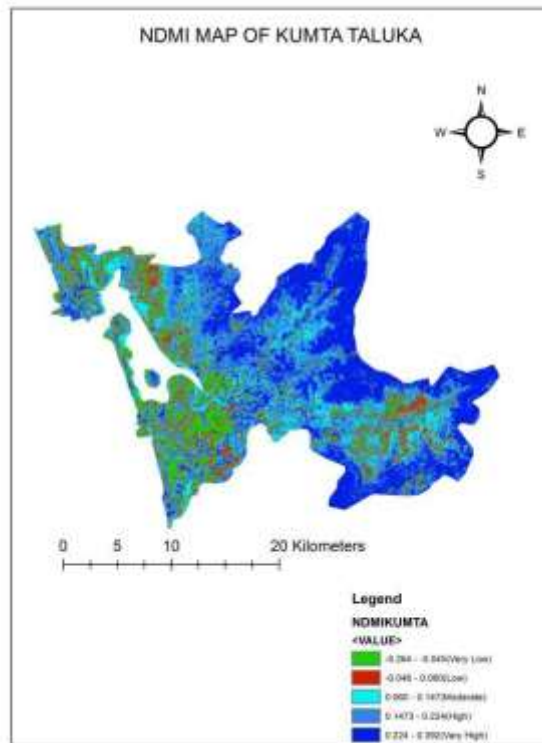


Fig.3 NDMI MAP OF KUMTA 2017

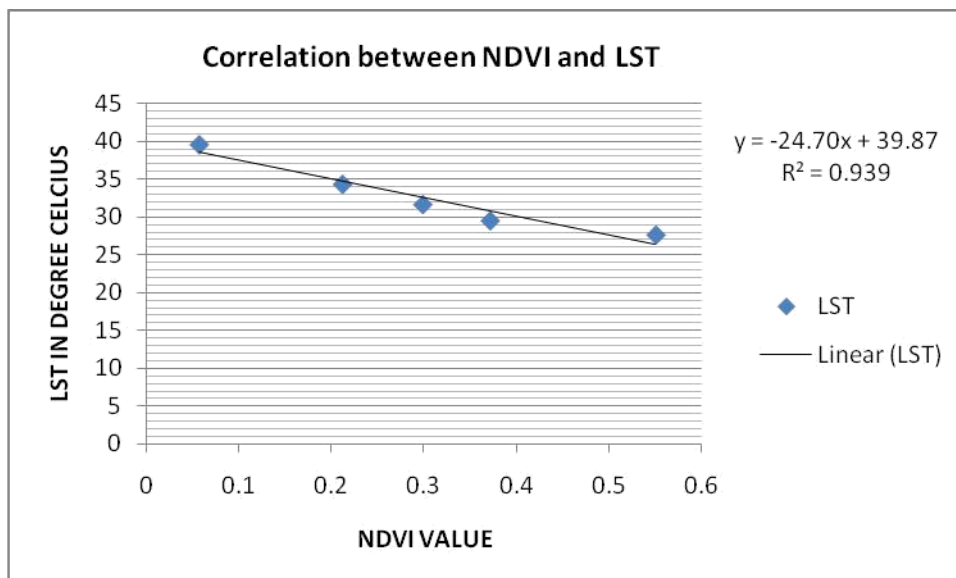


Fig.4 CORRELATION BETWEEN NDVI AND LST OF KUMTA 2017

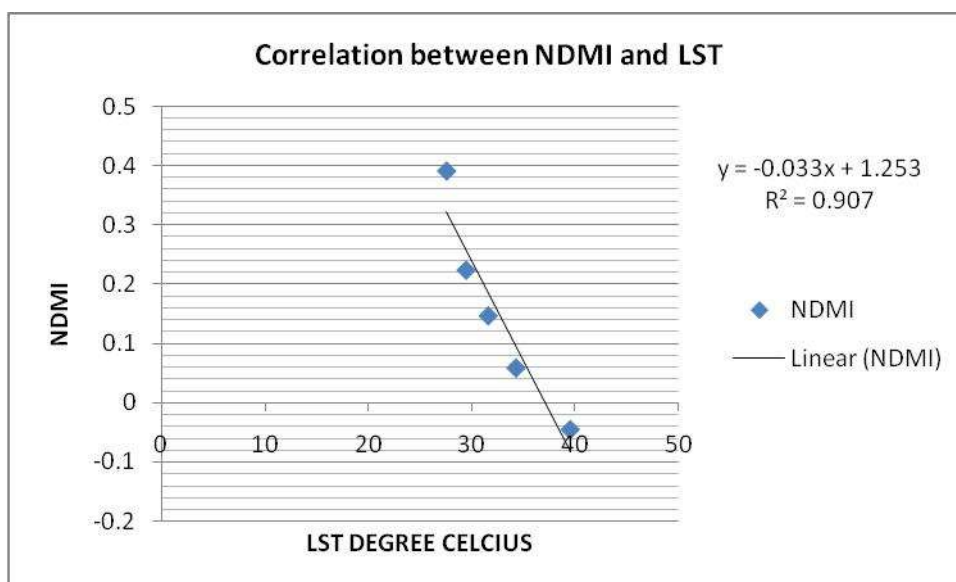


Fig.5 CORRELATION BETWEEN NDMI AND LST OF KUMTA 2017

#### 4. CONCLUSIONS

In this paper, potential of remote sensing to study the temperature variation in Kumta Taluk by estimating LST distribution with the help of Landsat-8 satellite data using thermal bands provided by USGS website for free of cost. Single window algorithm methods are applied to calculate the LST from TIRS factors such as different land use types, vegetation cover and soil in the study area reveals the variation in the surface temperature of different surface patterns. Surface temperature variations controls the surface heat and water exchange with the atmosphere resulting climatic change in the region. Though some climatic parameters phenomenon paly a important role in temperature variation, the major role such as land conversion due to rapid growth of urbanization and also from deforestation etc resulting in temperature variations. The results help us to estimate the micro climate, heat pockets and maximum temperature vulnerable regions in the study area and also I suggested to the government to take the necessary scientific actions like forestation, frequent pollution checking to the vehicles, reduced the plastic incinerations and development of parks to reduce the temperature.



## ACKNOWLEDGEMENTS

Authors are thankful to Department of Natural Resource Management COF Sirsi, UAS Dharwad for the to conduct the research at Lab Uttara Kannada District.

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