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Mapping of Land Surface Temperature using Landsat-8 Data in Selected Districts of Tamil Nadu

Selvaprakash Ramalingam*
* Division of Agricultural Physics
Indian Agricultural Research Institute,
New Delhi-110012

Rabi Narayan Sahoo*
* Division of Agricultural Physics,
Indian Agricultural Research Institute,
New Delhi-110012

Abstract:- **LST (land surface temperature) is the most important phenomenon in earth climate change. Increase in the concentration of greenhouse gas and other atmospheric gas increases the Land Surface Temperature, in turn affects the atmospheric conditions and rainfall pattern like unpredictable, erratic and failure of monsoon which is linked with the performance of agricultural crops and forest plantations. In this present study, Land Surface Temperature was estimated for Perambalur, Salem and Namakkal Districts of Tamil Nadu, India, using Brightness Temperature (BT) and Surface Emissivity (ε) data obtained from Landsat 8 OLI (Optical Land Imager) with 30 m spatial resolution and Thermal Infrared Sensor (TIR) data with 100 m spatial resolution. Emissivity became derived with the assistance of NDVI threshold approach for which OLI bands 2, 3, 4 and 5 had been used and the spectral radiance of TIR 10 and 11 bands used to derive the LST. The output found out that LST became excessive within the agriculture and barren areas while it became low within the hilly areas due to vegetative cover.**

Key Word: Landsat, Temperature, Band, Land and Area

INTRODUCTION

Land surface temperature (LST), also called the skin temperature of the Earth's surface, is an essential parameter of physical, chemical and biological processes at regional and global scales (Ugur Avdan et al., 2016). LST has been widely used in many fields of earth science due to its essential role in the mass balance and energy exchange between the atmosphere and land.

Land surface Temperature (LST) can be defined as the temperature felt whilst the land floor is touched with the hands or it's far from the pores and skin temperature of the floor. It was greatly tormented by the growing inexperienced house gases in the environment as it rises, it melts the glaciers and ices sheets inside the polar area which leads to the occurrence of flood and sea level rise. Increase in LST also affects the climatic condition of the monsoon countries leading to unpredictable rainfall (Guha et al., 2020). Land use/ Land cover (LU/LC) of an area may be used for estimating the quantity of LST as the natural and anthropogenic activities change the LU/LC of an area. Many researchers had calculated LST using diverse algorithms and techniques. Direct area measurements of LST are nevertheless limited in nearby and international-scale research; for that reason, LST retrieval from multisource remotely-sensed thermal infrared statistics is of amazing importance in Agrometeorological research.

Before the invention of Earth Observation Satellites (EOS), it was hard to estimate the LST of an area. Generally, it was calculated for a particular set of sample points and interpolated into isotherms to generalize the point data into area data. With the advent of satellites and high-resolution sensors it is possible to estimate LST spatially as it helps to calculate for an area at a stretch with the use of thermal infrared bands furnished through satellites. Landsat 8 comes with extraordinary units of photos from Operation Land Imager (OLI) sensor with nine bands (band 1 to 9) and Thermal Infrared sensor (TIR) with bands (band 10 and 11) (Rajeshwari *et al*., 2014). In this study area mostly throughout the year cultivated cereals, oil seeds, cash crops, vegetables and fodder crops, so we can try to assess the LST in this area and NDVI is very useful for all agricultural practices.

STUDY AREA

This study was conducted in Salem, Namakkal, Perambalur district, which is located in the Northern part of Tamil Nadu state. Defined area is highly covered by Eastern Ghats (Figure 1). With a yearly average temperature is 32ºC and the climate is very warm, but it has only a very few tropical and humid months. Most precipitation occurs from July to November and soil type is red soil and clay loamy soil. In the most of the study area cultivated by cotton, maize, sorghum, sorghum and Tapioca crops. Landsat 8 Operational Land Imager (OLI) and Thermal Infrared Sensors (TIRS) data were freely downloaded from the USGS.

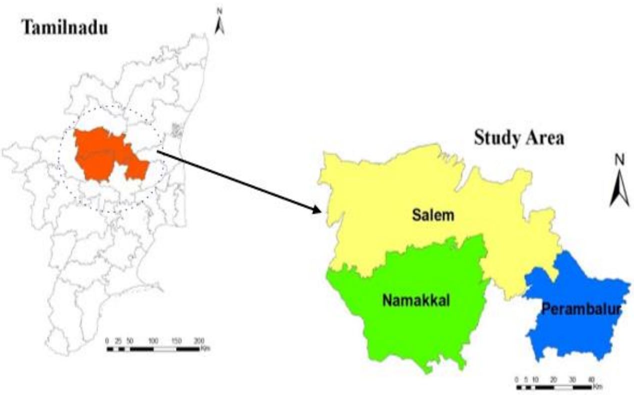
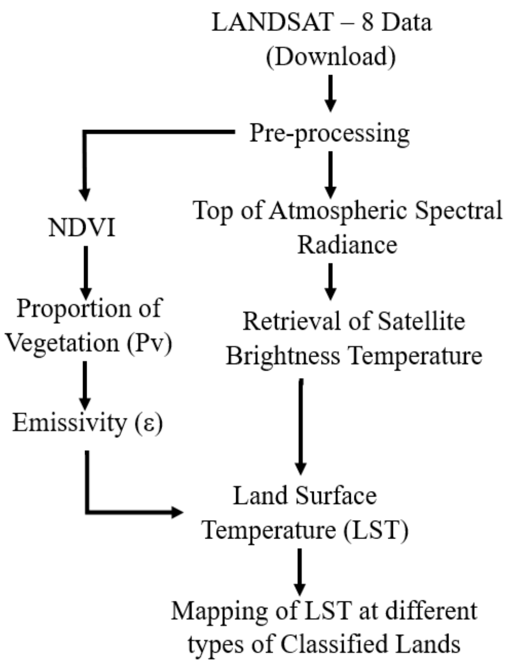


Figure. 1 Study Area

The data were obtained with maximum illumination which is needed in LST related study. ArcGIS 10.1 software was used to conduct the entire computation.

METHODOLOGY

This section describes the general procedures such as Landsat - 8 image processing Land surface temperature estimation, in this study describing the information.



Work flow

1. Land Use Land Cover Map

The study area collected LULC map and acquired satellite images (14-Feb-2021) were classified into four (all types lands) land use and land cover (LULC) classes within a five-classification scheme: Agriculture lands (cover all seasons cropping lands), Forest (tree, grassy, Green and Evergreen areas), Water bodies and Waste lands.

2. Top of Atmospheric Spectral Radiance

The value of Top of Atmospheric (TOA) spectral radiance (Lλ) was determined by multiplying multiplicative rescaling factor (Table.1) of TIR bands 10 and 11 with its corresponding TIR band and adding additive rescaling factor (Table.1) with it.

$$L\lambda = M_L * Q_{cal} + A_L$$

Where,

Lλ - Top of Atmospheric Radiance in watts/(m2*srad*µm)

ML - Band specific multiplicative rescaling factor (radiance_mult_band_10/11)

Qcal - TIR band 10 or11 image.

AL - Band specific additive rescaling factor (radiance_add_band_10/11)

Table.1. Top of Atmospheric Spectral Radiance

Rescaling Factor	Band 10	Band 11
ML	0.000342	0.000342
AL	0.1	0.1

3. Retrieval of Satellite Brightness Temperature (BT)

After the digital numbers (DNs) are converted to reflection, the thermal band’s spectral radiance must be converted to brightness temperature (BT) (*How Jin Aik et al., 2020*). This is commonly accomplished using the thermal constants provided in the metadata file. The following equation is used in the tool’s algorithm to convert reflectance to BT:

$$TB = K2/Ln(K1/\ L\lambda +1) - 273.15$$

Where,

K1 and K2 are constant band-specific thermal conversions from the metadata (Table.2). However, this result must be converted to Celsius. The radiant temperature is revised by adding absolute zero (-273.15ºC).

Table.2. Band-specific thermal conversions factor

Thermal Constant	Band 10	Band11
K1	774.89	480.89
K2	1321.08	1201.14

4. Emissivity Estimation Using the NDVI Technique

Landsat red and near-infrared bands (4 and 5) were used for calculating the Normal Difference Vegetation Index (NDVI). The basic premise of calculating the NDVI is essential because the amount of vegetation present is an essential factor, and the NDVI can be used to understand the general vegetation condition. The calculation of the NDVI is essential because, subsequently, the proportion of the vegetation (Pv) should be premeditated, which is closely related to the NDVI. In addition, emissivity (ε)) should be calculated, which is related to the Pv:

$$NDVI = \frac{NIR - R}{NIR + R}$$

Where,

NIR = near-infrared band;

Red = red band.

Landsat 8 data used Bands 5 (infrared) and 4 (red) used to calculate the NDVI values. From the NDVI values obtained, the next step in acquiring Land Surface Emissivity (ε), namely the calculation of the proportion of vegetation (Pv), was performed.

5. Proportion of Vegetation (Pv)

The proportion of vegetation (Pv) is calculated according to the equation below (*Walawender et al., 2012*):

$$Pv = \left[\frac{(NDVI - NDVI_{min})}{(NDVI_{max} - NDVI_{max})}\right]^2$$

6. Surface Emissivity (ε) Retrieval

$$\varepsilon = a * Pv + b$$

land surface emissivity (ε) values are obtained using equation

In this study,

we used a= 0.004 and b = 0.986.

PV is the proportion of vegetation extracted from the equation.

7. Land Surface Temperature (LST)

The land surface temperature (LST) is the radiative temperature which is calculated using top of atmosphere brightness.

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$$LST = \left(\frac{BT}{1}\right) + W * \left(\frac{BT}{14380}\right) * Ln\,(\varepsilon)$$

Where,
BT – Top of atmosphere brightness temperature
W – Wavelength
ε – Land Surface Emissivity

Table 3. Band Wavelength

Satellite	Band	Wavelength (Micro meter) - Average
Landsat – 8	10	10.9
Landsat – 8	11	12.0

Table 4. The ranges and descriptions of LST classifications

Type	Range (°C)	Description (LST area)
Lower	1.9 – 8.9	Very low
Low	8.9 – 15.9	Low
Middle	15.9 – 22.9	Normal
High	22.9 – 29.9	High
Higher	29.9 – 36.9	Very high
Highest	36.9 – 43.9	Extremely high

RESULT AND DISCUSSION

NDVI map derived from landsat-8 map, this map shows most of the land are Agriculture land and followed by Forest land, waste land and water bodies.

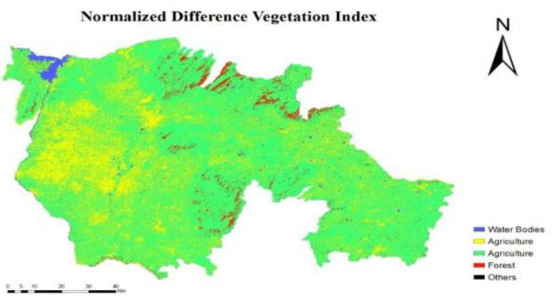

Figure 2. Normalized Difference Vegetation Index

The NDVI ranges between classified on 0 to 1, most of the place's show (Figure.2) 0.2 to 0.4 ranges. In the NDVI map clearly shows that 0.2 to 0.4 (yellow) it was shown by ready for harvesting at the eastern part of study area, because these areas. 0.4 to 0.6 (green) good vegetation condition of western part of Salem and Perambalur district of Tamil Nadu. Northern part of Study area highly covered by forest so, the vegetation around the area will occurred; the NDVI value > 0.6 shown on figure 2. Water bodies 0 or no vegetation (blue) was shown by eastern part of water flowing area and ponds.

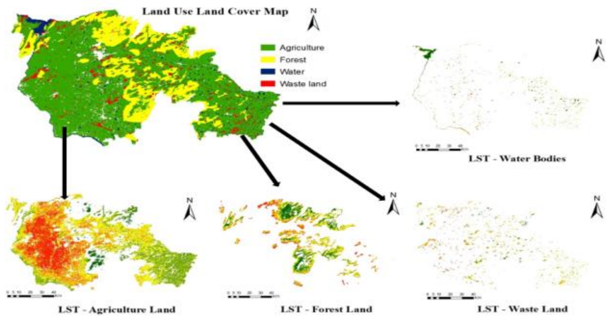

Figure 3. LST at different type of Classified Lands

LST of an area changed into decided primarily based on its brightness temperature. On this look at, OLI and TIR bands of Landsat eight had been used. The look truly revealed that because the district had extra vegetative cover in agriculture cropping regions the LST in the northern part changed into low and the northern plains with barren lands, uncultivable land regions skilled high LST. Comparatively Perambalur district being a drought susceptible district the vicinity below vegetation turned into much less and it's far limited to plantation cropping areas in the western part of study area.

LST maps derived from different classification Agriculture land are mostly covered in study areas; this value ranged from 16.7 to 41.8. Most of the lands are covered by the 34.5 to 41.8 range, because this time crop harvesting time, that's only the highest temperature recorded and Zhang 2017 stated its under very high (29.9 – 36.9) and extremely high (36.9 - 43.9) LST

CONCLUSION

The study investigates the effect of change in Agriculture, forestry and barren over LST of the study area of approximately 10365 km^2 Perambalur, Salem and Namakkal District of Tamil Nadu. The temperature of the study area significantly varied in land type (Agriculture, Forest and Water bodies). In addition, the classification of NDVI and geographic information (Land Use Land Cover) of these districts have a significant impact on the LST prediction of the study area.

Finally, the predicted LST values show that the changes in climate and Agriculture area will affect the LST changes of these districts in feature. Moreover, this technique can be used to assess and expect the LST of different regions from satellite images.

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