iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 8 **Issue:** IV **Month of publication:** April 2020

DOI:

www.ijraset.com

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

Forest Cover Density & Land Surface Temperature Retrieval from Landsat 8 using Q GIS

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***Abstract:** An essential tool for sustainable management of natural resources is monitoring of forest cover. Identification of forest gaps and their subsequent refiling gave a better idea about the woody green cover of the forest. Canopy openings can be analyzed by Forest canopy density (FCD) mapping, which is the most useful criterion considered for the planning, implementation of afforestation and restoration programmed. Forest canopy density along with Land surface temperature is incorporated and analyzed from Landsat 8 (Operational Land Imager and the Thermal Infrared Sensor) using Q GIS.The study enables a prior analysis of Puruliya district, West Bengal to show the existing canopy density present there. The FCD was classified into four categories: high dense Forest (HDF; FCD < 70%) with low land surface temperature, moderate dense Forest (MDF; FCD 70% – 40%), low dense forest (LDF; FCD 40% - 05%) and non-forest (NF; FCD >05%) with High Land Surface Temperature. In this paper a recapitulation of assorted remote sensing Techniques are used to evaluate forest canopy cover are presented and stated an inverse relationship between LST and FCD with help of Free data and Software.*
***Keywords:** FCD, LST, Q GIS, Remote Sensing.*

I. INTRODUCTION

Remote sensing is the science of obtaining information regarding objects from a distance without any substantial communication with them, utilizing various wavelength areas of electromagnetic spectrum to delineate the management of forest resource (Kairu 1982; Fussell and Rundquist 1986).

Recently the application of Remote Sensing technique is to estimate the forest canopy cover and Land Surface temperature, has become a significant factor for countability of forest reserve, for conservation and maintenance of forest ecosystem (Wittmann et al. 2002; van Leeuwen and Nieuwenhuis 2010).

The proportion of the forest floor covered by the vertical projection of the tree summits is known as Forest Canopy Cover, also known as canopy coverage or crown cover (Jennings 1999). Portraying the forest area are definitive and up to date information on the picture of deforestation and forest degradation is unfavorable in understanding whether forests in tropical regions are being sustainably managed(Mon et al. 2012).

The assessible patterns of land surface temperature(LST) measure the energy balance process verification , which is an approximation of the surface radiometric temperature initiated on the ejection of thermal infrared flux encapsulated instantaneously by a sensor at a specific measuring angle (Asgarian et al. 2015).The variant information captured at spatio-temporal scales obtained by satellite platforms produce benefits regarding temporal and spatial variability for the quantification of LST .The consolidated information descends from the satellite data sets oblige in evolution of relevant action plans for starting sustainable development(Maikhuri et al. 1996). Calculating indices fluctuate according to the sensors as in case for Landsat OLI/TI data formula for the calculation of various indices is diversifies (Huang et al. 2002).

II. STUDY AREA

The study area, Purulia district (Fig. 1), located in the utmost west of the state of West Bengal in India. The district incorporates between 22.702950N to 23.713350N latitude and 85.820070E to 86.875080E longitude, in capturing a total area of 6259 km2. The forest area under this division geographically lay between 22.430 to 23.420 North latitude and 85.490 to 86.540 East longitude and envelopes an area of forest land of 62,000 hectares approximately. The areas are surrounded by Ranchi and Hazaribagh districts of Jharkhand in West and Singhbhum district of Jharkhand in South and Bokaro & Hazaribagh Districts of Jharkhand North respectively. Purulia District, has been 6 administrative Blocks of namely – Jhalda-I, Jhalda-II, Balarampur, Arsha, Bagmundi, & Joypur.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

III. MATERIAL AND METHODS

To estimate the FCD and LST, images from the OLI/TIRS sensor/Landsat-8 satellite from January, 2020 (https://earthexplorer.usgs.gov/), B2 (0.45 to 0.52 µm), B3 (0.52 to 0.60 µm), B4 (0.63 to 0.67 µm), B5 (0.85 to 0.90 µm), B6 (1.55 to 1.65 µm), and B10 (10.60 to 11.19 µm) all with 30 m res, path 139 and row 44, measured at approximately 10:00 local time, with a revisit of 16 days, were used software QGIS 3.10 (https://qgis.org/en/site/).

Computation of FCD, per pixel canopy density is based on four different indicators (Hussin and Bijker; Joshi et al. 2006; Mon et al. 2012; Deka et al. 2013; Azadeh et al. 2017). These indices are: (i) advanced vegetation index (AVI), (ii) bare soil index (BI), (iii) canopy shadow index or scaled shadow index (SSI), (iv) thermal index (TI). Forest canopy and FCD components indicates a direct and indirect relationship between them.

A. Advance Vegetation Index (AVI):

The degree of power on NDVI prevails a more sensitive AVI towards forest density and physiognomic vegetation indices. With the increase of vegetation cover AVI also increase which is calculated using this equation (Himayah et al. 2016).

AVI = (B5* (DNmax – B4) * (B5-B4) + 1)1/3 (1)

B. Bare soil Index (BI)

This index enhanced the marked background response of bare soil areas, fallow lands and vegetation. Convenient concept AVI, the bare soil index (BI) is a normalized index of the difference sums of two separate vegetation having variant background viz completely bare, sparse canopy and dense canopy etc. Using this equation BI can be calculated.

BI = ((B4 + B2) - B3 / (B4 + B2) + B3) (2)

C. Canopy Shadow Index (SI)

Canopy shadow index (SI) assess the difference in shadow pattern based on the structure, age, and species distribution etc which at individual time affects the spectral responses. CSI is calculated based on Equation 3

SI = (65536 – B3) * (65536 – B4)1/2 (3)

D. Thermal Index (TI)

The decrease in temperature within a forest, reason accounts for two factors as follows. First the protecting layer of forest canopy, which prevents entering and blocks energy from sun. The other is evaporation from the leaf surface, which mitigates warming. This phenomenon is based on the formulation of the thermal index. The source of thermal information is the thermal infrared band of TIRS data.

E. Forest Canopy Density (FCD)

Transformation for forest canopy density value is combination of Scaled Vegetation Density (VD) and Scaled Shadow Index (SSI). Both parameters are dimensionless and has percentage scale unit of density. By means of corresponding scale and units, it is possible to synthesize. Forest Canopy Density (%) for each pixel is calculated by using the Equation 4
(Rikimaru, 1999).

FCD = $\sqrt{(VD * SSI + 1)} - 1$ (4)

F. Land Surface Temperature (LST)

The combination of systematic and sequential conversion of thermal band's DN value to LST process the algorithm for the estimation of LST. Here LST has been derived from the Planck function which corrects the discharge of a substance in comparison to a Black Body(Mallick et al.; Isaya Ndossi and Avdan 2016). By this method we calculate land Surface Temperature in degree Celsius

$$\mathbf{T_S} = \frac{\mathbf{BT}}{\left(1+\left(\frac{\lambda * \mathbf{BT}}{\rho}\right) * \ln \varepsilon \lambda\right)} - \mathbf{273.15} \quad (5)$$

Where,
Ts = land surface temperature (˚C);
BT = brightness temperature (K),

λ = wavelength of the emitted radiance;
ρ = (h * c/σ) = 1.438 *10-2 mK
ελ= Land surface emissivity
This forest area falls under this division lies in Sub region of North Eastern part of Chotanagpur plateau with a oscillated topography. The highest peaks in the hilly areas depicts an altitude of 677 meters above M.S.L. and cover Ajodhya.

IV. RESULTS

Three type of canopy density has been found from the whole part of analysis viz: high dense Forest (HDF; FCD < 70%), moderate dense Forest (MDF; FCD 70% – 40%), low dense forest (LDF; FCD 40% - 05%) and non-forest (NF; FCD > 05%) (Fig. 3). Western part of the study area Ajodha Hill falls. in high and Moderate forest density class and the outer boundary portion in Non-forest part. High and low forest density class covers approximately 2.00% of total area where low forest density part covers about 6% and non-forest covers about 89% of total area. Several small undulated hillocks have been seen in the South- East and North-East part of the study area where the moderate density of canopy cover found. all layers (AVI, BSI, and SI) have been instigated to create classified canopy density map.
In this study region LST (Fig. 4) lies from 24.94˚C to 18.14˚C, which shows an indirect relationship between FCD and LST. The heist LST, 21.08˚c has been seen in Non- Forest area were as it kept on decreasing. Where as in mean LST in HDF is 19.51˚C, MDF is 20.30˚C and LDF is 20.76˚C. The difference among HDF to LDF is 1.24˚C (Table 1).

V. DISCUSSION

Each of classes of every Index has also given the percentage of contributions in the weighted model. The final cumulative map was reclassified into five categories of five forest canopy cover types via; ‘very low’, ‘low’, ‘moderate’, ‘high’, and ‘very high’. Pairwise comparison is a kind of divide-and-conquer problem-solving method. An alternative is to divide the problem of assigning weights into two parts: Determine qualitatively which criteria are more important i.e. establish a ranking of the criteria, and assign each criterion a quantitative weight so that the qualitative ranking is satisfied. After studying all the above vegetation index, multi criteria-based weightage analysis has been done to prepared the forest canopy density mapping.

VI. CONCLUSION

Delineating the canopy density map needs various factors like AVI, BSI, and SI etc with the use of Landsat OLI satellite data. By the means of qualitative analysis, FCD model depicts the flourishing circumstances of forest, unregard of conventional qualitative methods. The FCD model is useful for the monitoring and management with less data obtained from examining the ground truth as the accuracy assessment of the methodology enable to confirm the field test. As per our study region the methodology used, and an indirect relationship has been obtained in between FCD and LST and it clearly indicates that the region where vegetation present depicts less temperature hence proving that afforestation is the fact for decrease in temperature on earth.

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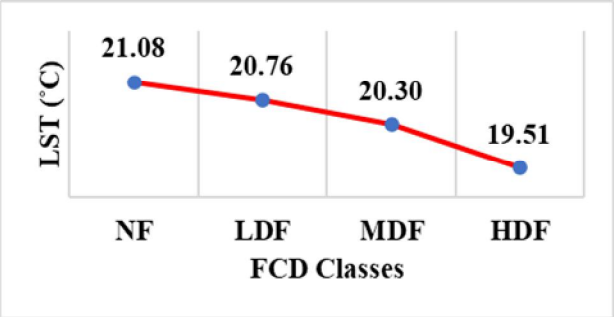
A. *Tables*

Table.1 Correlation between LST with FCD classes



B. *Captions of Figures*

1) Fig.1 Location Map of Study Area using Landsat 8 FCC
2) Fig.2 Flow chart of methodology
3) Fig.3 Forest Canopy Density Map
4) Fig.4 Land Surface Temperature Map

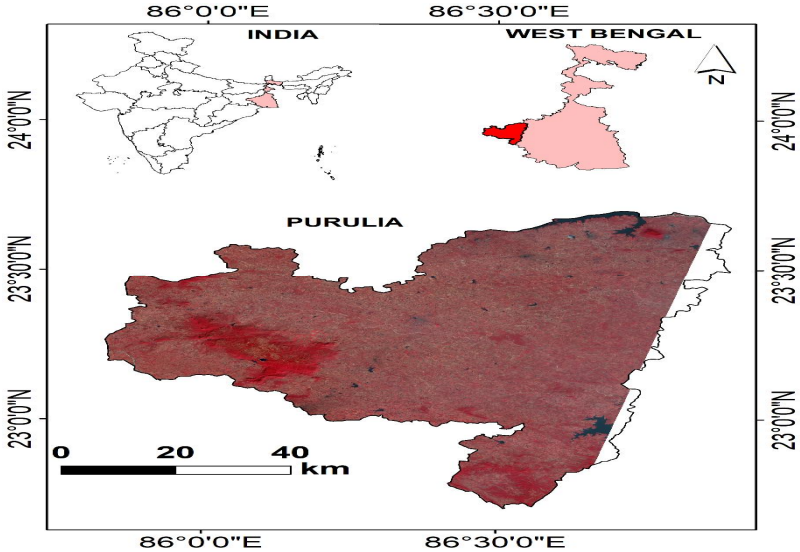


Fig.1 Location Map of Study Area using Landsat 8 FCC

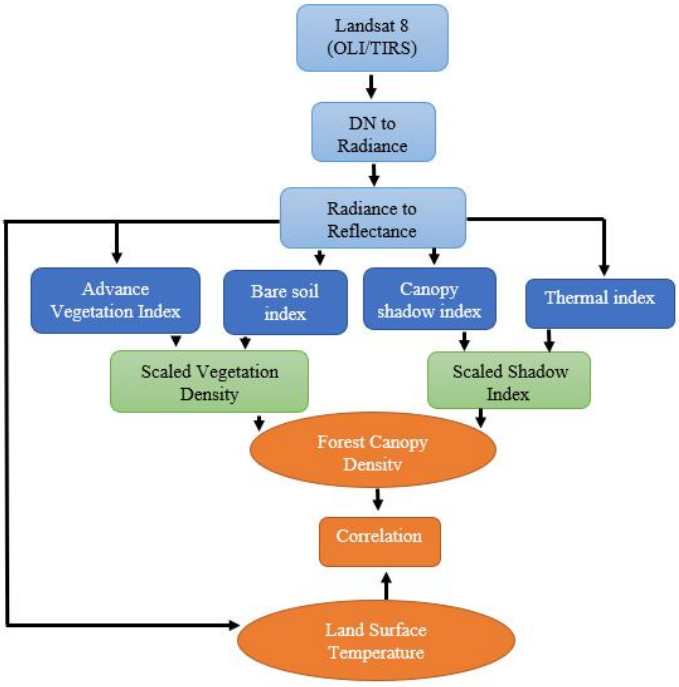


Fig.2 Flow chart of methodology

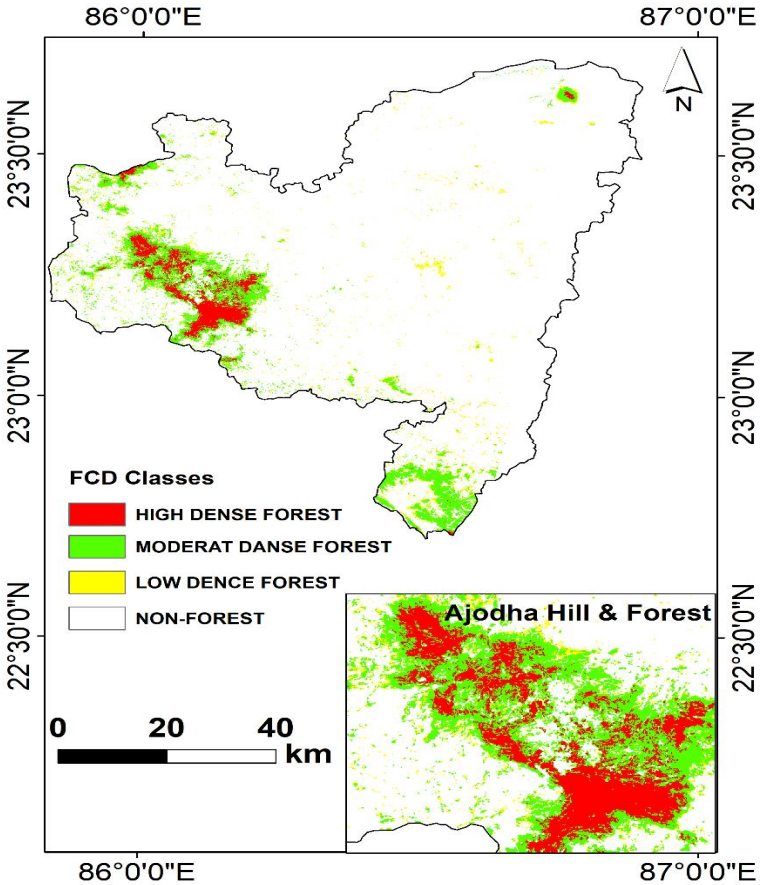


Fig.3 Forest Canopy Density Map

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue IV Apr 2020- Available at www.ijraset.com

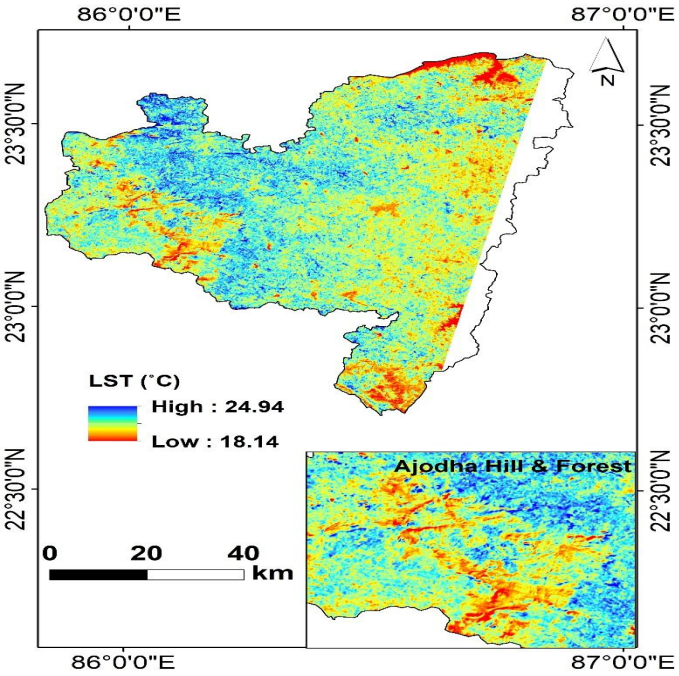
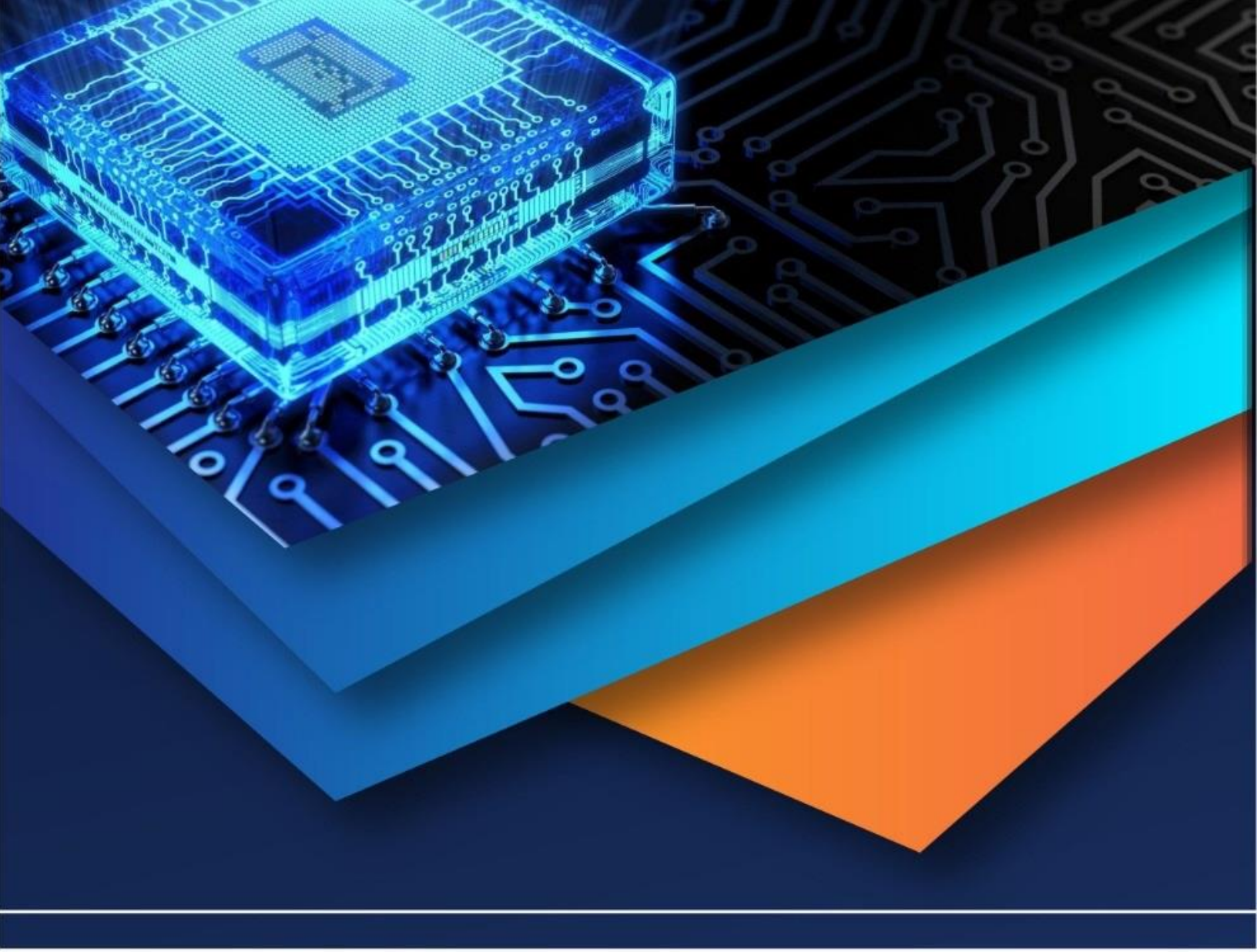


Fig.4 Land Surface Temperature Map



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