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Calculation of Land Surface Temperature Neighboring Thermal Power Plant, NTPC-Singrauli, Using Geo-Spatial Techniques

Sachin Saurabh Pandey[1], Dr Virendra Kumar[2], Dr Sudhakar Shukla[3]

[1]M.Tech Scholar, School of Geoinformatics, RSAC-UP, Lucknow, Uttar Pradesh, India
[2]Head, Land Use and Urban Survey Division, RSAC-UP, Lucknow, Uttar Pradesh, India
[3]Head, School of Geoinformatics, RSAC-UP, Lucknow, Uttar Pradesh, India

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Abstract – Power generation by the fossil fuels particularly by coal. The burning of coal result in more temperature rise and earth average surface temperature. LST plays critical role in assessing the global temperature rise with the help of Remote Sensing and GIS which have wide application in surface temperature analysis and climate change. India's energy capital—Singrauli, has conglomerations of different thermal power plant and functional coal mine shafts. Prior, the region was thickly forested, rich in biodiversity and home to different ancestral networks. In the last decade, there has been extreme exploitation by the private sector for setting up huge scope power generation plants. Land surface temperature (LST) has been studied for the National Thermal Power Plant. For the analysis of the LST LANDSAT (4-5) and LANDSAT 8 satellite data has been used. The analysis is done for year 1988 and year 2020. The calculation of LST is done with ArcGIS Software for Singrauli area NTPC power plant. By analyzing various parameters, we can easily identify spectral reflectance and Emissivity of surface Temperature. Various tools and techniques are used for enhancing the value of LST. Spectral reflectance has been estimated using TIR and emissivity has been calculated by NDVI value. Finally LST for NTPC Singrauli region has been studied and statistics are represented which define the change in temperature in the study area which is around 10 ^{0}C.

Key Words: Remote sensing (RS) ,Land surface temperature (LST), Normalised Dfifferernce Vegetataion Index(NDVI) ,Climate change

1. INTRODUCTION

The Land Surface Temperature (LST) is also known as the earth surface temperature, as measured using the remote sensor. It is estimated from Top-of-Atmosphere brightness temperatures from the infrared spectral channels of a constellation of geostationary satellites. Its estimation further depends on the albedo, which is the percentage of solar radiation that is absorbed by the land surface, the vegetation cover and the soil moisture.

LST includes vegetation and bare soil temperatures. Because both react rapidly to changes in incoming solar radiation due to cloud cover and aerosol load modifications and diurnal variation of illumination, the LST displays quick variations too. In turn, the LST influences the partition of energy between ground and vegetation, and determines the surface air temperature Land surface temperature (LST) is a critical parameter in land surface cycles, not just going about as a key indicator of environmental change, yet in addition because of its control of the upward terrestrial radiation, and therefore, the control of the energy balance at the outside of the Earth LST is the temperature discharged by the outside of the Earth and mesured in Kelvin. The increasing concentration of the green house gases in the atmosphere affects the LST greatly. As the temperature rises, it brings about the liquefying of the glacial masses and ice sheets in the polar districts driving to flood and ocean level ascent. Expansion in LST likewise influences the climatic state of the rainstorm nations like India leading to flighty examples of precipitation. In this study the change in Land Surface Temperature is analyzed between (January 1988 and January 2020). Data of Landsat (4-5) Thematic mapper and Landsat 8 operational land imager (OLI) and Thermal Infrared Sensor (TIRS) are used for study . Landsat (4-5) Band 6 is thermal band and Landsat 8 Band 10 is used for the calculation of the Land Surface Temperature.

In this manner, Remote Sensing detecting is a significant marker to examine thermal varieties in metropolitan biological system and its relationship with vegetation cover . The motivation behind this paper isn't to emphasize the grounded connection among LST and NDVI, yet rather to delineate how once thickly forested, biodiversity rich and hostage coal save Singrauli has been utilized by the private area for setting up of enormous scope influence plants, which thus has prompted huge changes in the LST of the study region.

2. STUDY AREA

The study area lies in some part of Sonbhadra district of Uttar Pradesh and Singrauli district of Madhya Pradesh. It ranges from latitude 23°50’ and 24°30’ N and longitude 82°30’ and 83°10’ E. The area for the study is National Thermal Power Plant of Singrauli District of (M.P) State in India . On 24 May 2008, Madhya Pradesh government proclaimed Singrauli as its 50th region by isolating from Sidhi with 3 tehsils, Singrauli, Chitrangi and Deosar. On 1 April 2012 two new Tehsils were added, Mada and Sarai. Population of the study area is 2.2 lakhs from (2011census survey) . Today , it is coming for thasone of the energy hubs of India and would soon be the India’s new energy capital .All thermal power plant s at Singrauli together have an installed capacity of around 10% of India’ s total installed capacity .The locals also call it as ‘Urjanchal’ i.e. the land of energy.

The climate of the study area is characterized as tropical monsoonal and the temperature reaches up to 48°C during June, the atmosphere remains humid in rainy season while in January the temperature goesdown. Kalyan, Mayar, Matwani and Baliyanala are the four main seasonal rivers transverse through the Singrauli area. North flowing streams join the Bijul tributary of Son River and south-flowing streams mostly join the Kachan and Mayar tributary of Rihand reservoir.

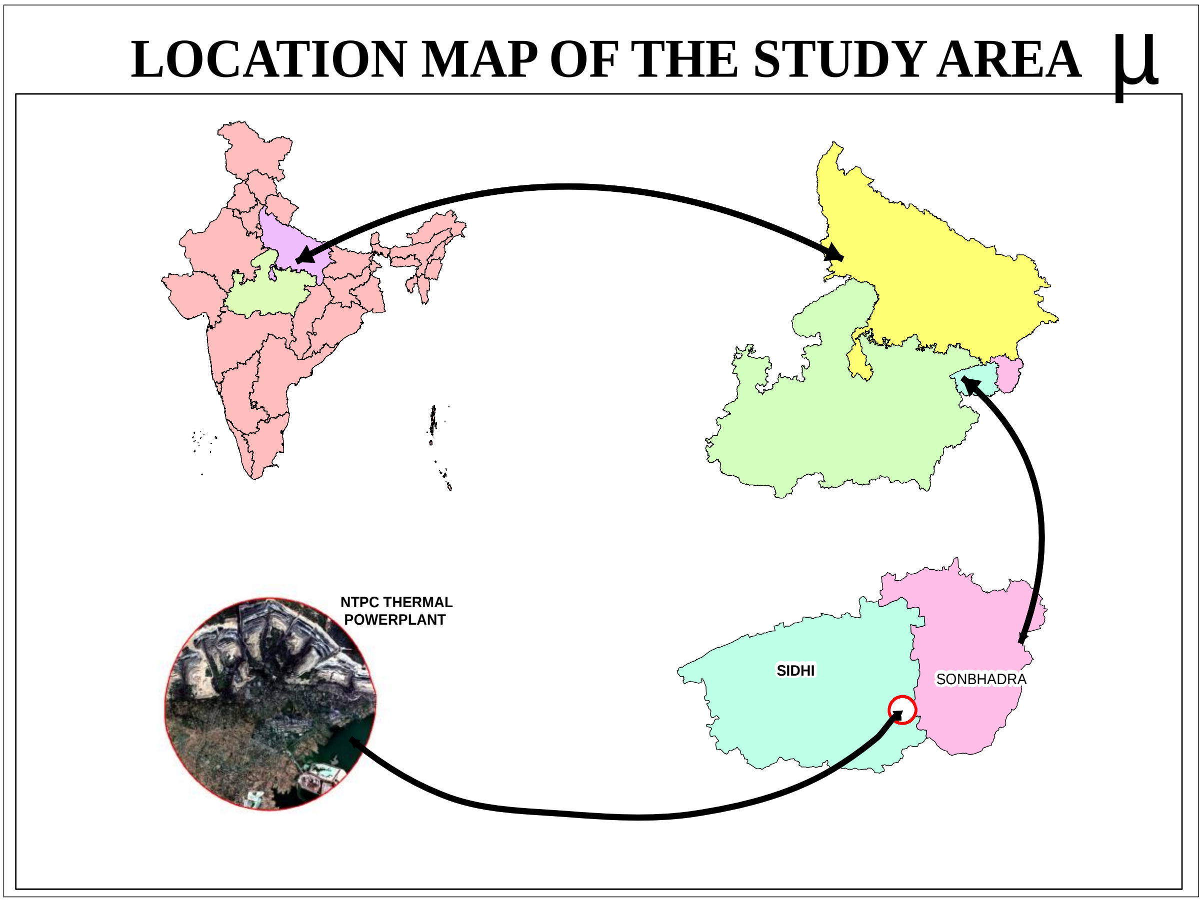

Fig – 1: Study Area

3. METHOD AND DATA USED

Multi temporal satellite imageries of LANDSAT (4,5&8) from (1988 and 2020) is used for finding Land Surface Temperature . For calculation of LST thermal bands of the LANDSAT data is used For LANDSAT (4-5) Band 6 is used , LANDSAT(8) Band 10 is used .

Formula used for calculating Land surface Temperature :

Top Atmospheric spectral Reflectance (TOA):

$L\lambda$=ML+QCAL+AL-Oi

Where , $L\lambda$ = spectral radiance

ML =band specific (here Band 10-for LANDSAT 8

Band 6 – for LANDSAT 4&5)

Mulitplicative rescaling factor =0.000334

QCAL = (band 10 image or band 6 image)

AL =Band specific additive rescaling factor

Oi = Correction for band 10

Conversion of Digital Numbers into reflection

Conversion of spectral radiance to Brightness Temperature (BT)

$$BT = \frac{K2}{\text{Log } [(K1 / L\lambda)]+1}$$

{K1&K2 – band specific thermal conversion constant (from metadata)}

Calculating NDVI

(NDVI = NIR –R / NIR +R)

Calculation of Proportion of Vegetation (Pv)-

Pv ={ (NDVI – NDVI min.) / (NDVI max –NDVI min)}2

Calculate Land surface emissivity ($E\lambda$):

$E\lambda$=$Ev\lambda$ + Pv + $Es\lambda$(1-Pv) + $C\lambda$

C = surface roughness (c=0 for homogeneous flat surface

$Es\lambda$= 0.996(for NDVI values b/w 0-0.2 .it considered that the land is covered with soil and emissivity value of 0.996 is assigned)

$Es\lambda$=0.973 (when NDVI Value greater than 0.5)

$$LST = \frac{BT}{1+[(\lambda\ BT / \rho) \log E\lambda]}$$

λ= wavelength of emitted radiance

$E\lambda$=Emissivity

ρ = h C / σ

σ = Boltzman constant(1.38*10-23 j/k)

h = Plancks Constant (6026*10-34 J/s)

C = velocity of light (3.0*108m/s)

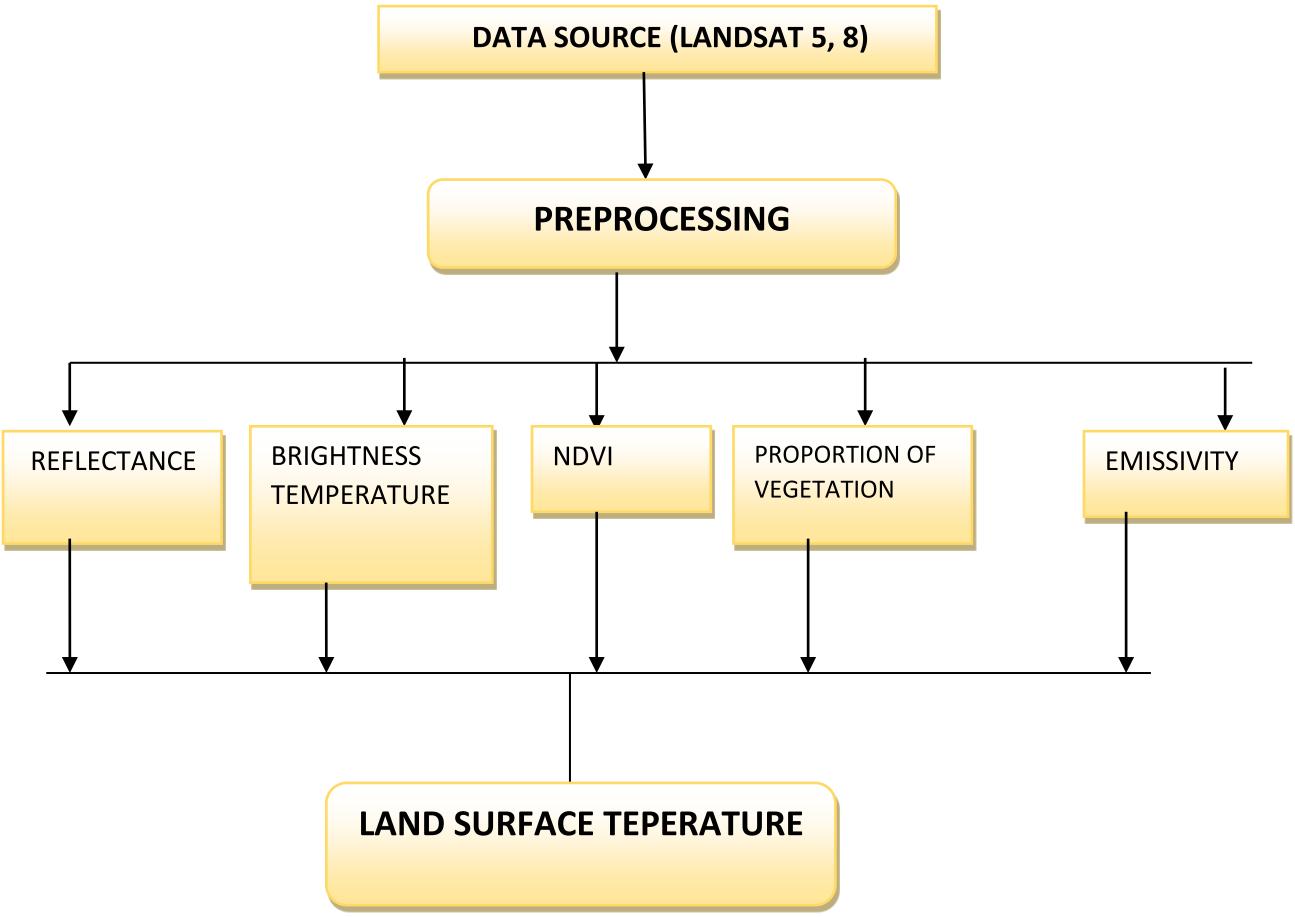

Fig – 2: Flow chart of methodology

4. RESULT & DISCUSSION

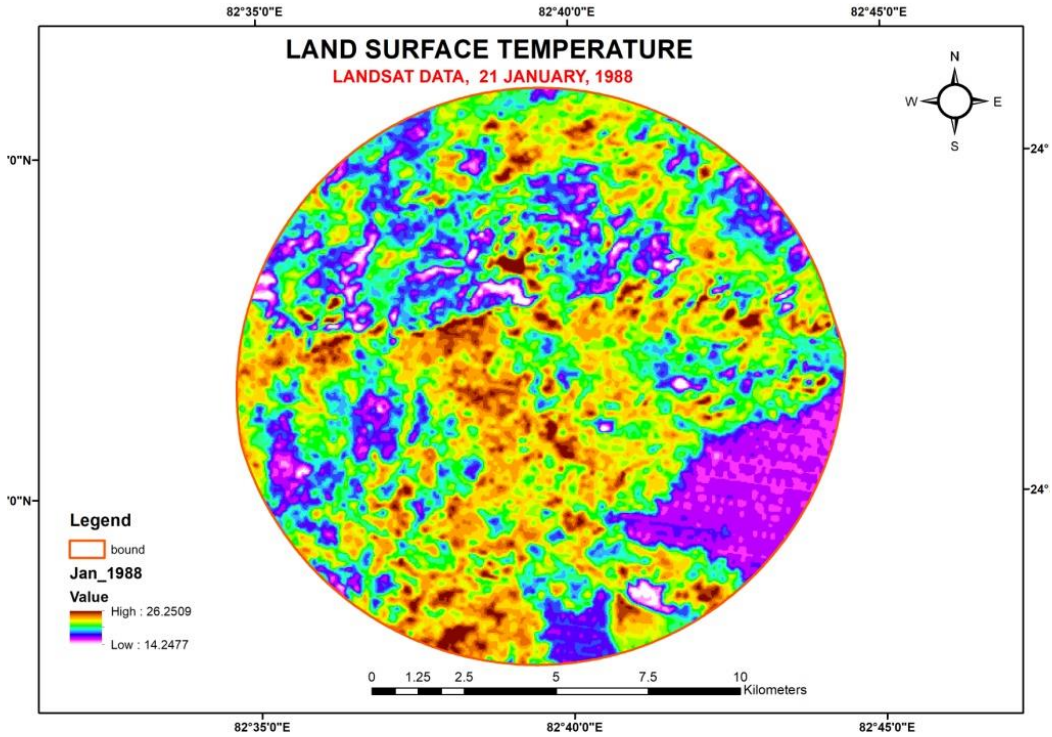

Fig – 3: LST map of JAN 1988

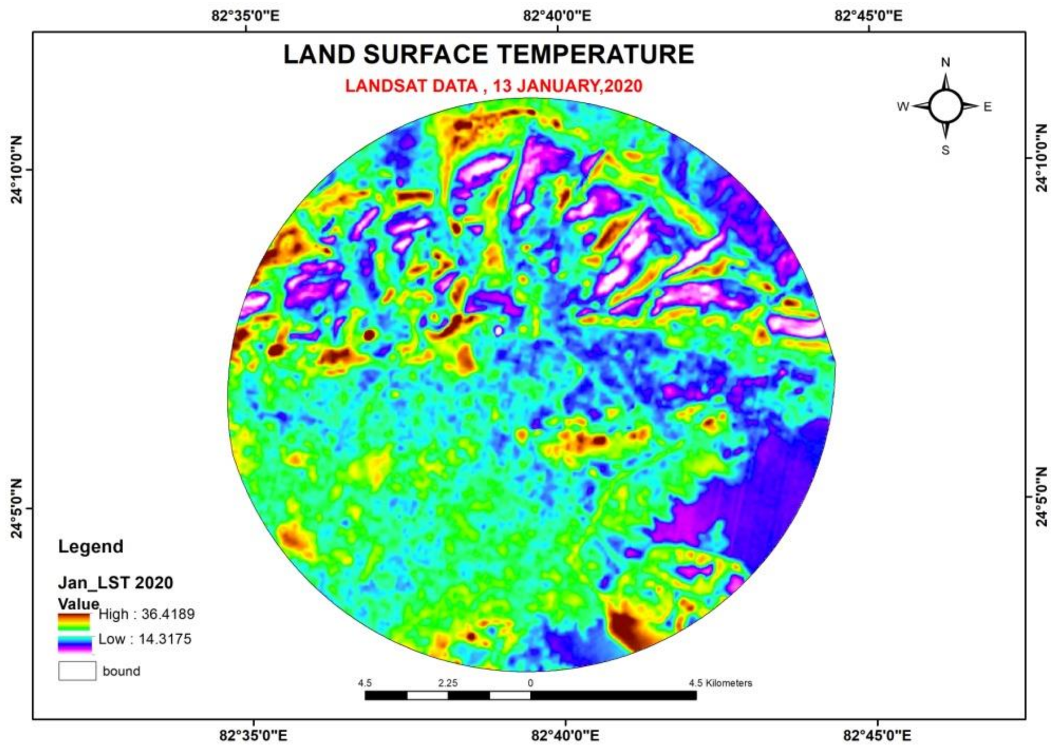

Fig – 4: LST map of JAN 2020

4.1 LST Comparison between January 1988 and January 2020

MONTH (Year)	Maximum value of LST (°C)	Minimum value of LST (°C)
JAN-1988	26.2509	14.2477
JAN-2020	36.4189	14.3175

Table 1: LST value of 1988 & 2020

Chart 1: Graphical representation of LST values

As we can see from the calculation there is difference in maximum temperature of 10.17^{0}c .

This change of temperature in maximum value is because of expansion of capacity of power plant and other activities like excessive mining and construction work.

5. CONCLUSION

Satellite information gives us the benefit of acquiring information spatially and temporally. The land surface temperature is assessed through thermal bands of Landsat 4, 5 and Landsat 8 data. During January 1988, the study area was totally barren with no sort of developement action and the temperature went from 14.2477 0C to 26.25 0C with a mean temperature of 19.07 0C. Later in the year 2020 that is the functional stage experienced temperature varies between 14.32 0C and 36.6 0C with a mean temperature of 27.39 0C. The innovation of the power plant utilizes extremely high temperature and pressure factor for better efficiency and less fuel utilization. Aside from the radiative temperature nearby, the basically high temperature and pressure factor of boiler in the power plant will in general impact the LST around the plant in compared to the area away from the power plant. Generally speaking, the upsurge in the quantity of nuclear energy stations and other related development in the area have brought rise of temperature and increasing urban heat island effect impact. The surface temperature of a space is for the most part affected by the physical and compound properties of land surface and the degree of vegetation cover on Therefore, Remote Sensing technique based on strategies end up being viable in assessing ecological effect on environments.

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14. Artis, D. A., & Carnahan, W. H. (1982). Survey of emissivityvariability in thermography of urban areas. Remote Sensing ofEnvironment, 12(4), 313–329.Table 3 Pearson's co-relation between NDVI and LSTLST Correlation matrix .