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# Estimation of Land Surface Temperature of Vidarbha Region, Maharashtra using Lands AT-8 Data

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***Abstract***: ***Remote sensing (RS) and geographical information systems (GIS) can be effectively used for generating such information and hence an attempt has been made to map the areas Vidarbha region of Maharashtra. High density built-up areas in particular area most affected by high surface temperature. Land surface temperature (LST) is an important phenomenon in global climate change. In this study an attempt has been made to estimate land surface temperature over Vidarbha region of Maharashtra using Landsat-8 OLI satellite data.FVC of vegetation height and lowest value 0.24 to-0.59.The findings indication that the mean LST over the year. Mean LST calculated band 10 and 11, band10 minimum value is 0.004-0.007 and maximum value 0.003-0.003.The land surface temperature of band 10 and11 minimum values is 0.9144-0.9617, minimum value 0.9698-0.9701, respectively and stander deviation is 0.0020-0.004 and 0.9730-0.9750, respectively. The knowledge of surface temperature is important to a range of issues and themes in earth sciences central to urban climatology, global environmental change, and human-environment interactions. NDVI of Vidarbha region of Maharashtra, December, 2016 NDVI is varies from 0-0.56 (zero for negative NDVI values using condition).The surface emissivity based on NDVI classes is used to retrieve the final LST. Emissivity was derived with the help of NDVI threshold technique for which OLI bands 2, 3, 4 and 5 were used. It was noted that maximum air temperature was observed in built up areas of the city and minimum temperatures are observed in areas where vegetation cover. However, the cooling effect of green area is also very much depend on the size and type of green area. As the SW algorithm uses both the TIR bands 10 and 11 the LST generated using them were more reliable and accurate***
***Keyword:*** ***RS & GIS, Landsat8, NDVI, FVC, BT, LST***

## I. INTRODUCTION

LST is a key parameter in land surface processes; it is the temperature of the surface which we observe directly contact. It is also referred as skin temperature or radiant temperature of the ground off the surface. LST not only acting as an indicator of climate change, but also its control the upward terrestrial radiation, and consequently, the control the surface sensible and latent heat flux exchange with the atmosphere. Earth surface temperature (LST) is a fundamental physical property relevant to many ecological, hydrological, and atmospheric processes. Earth surface temperature (LST) is related to surface energy and water balance, it widely used in several applications, such as climate change, urban climate, the hydrological cycle, and vegetation monitoring [1–4].It depends on the Albedo, the vegetation cover and the ground moisture. The subject of land surface temperature (LST) has been performed by several Researchers: [5] - [9].Our primary goal in this composition is the mean LST over the year, high density built-up areas in particular area most involved by high surface temperature. However, the cooling effect of green area very also much depends on the size and type of green area.

## II. STUDY AREA.

Vidrabha region lies in between 17°57'-21°46' N Latitude and 75°57'-80°59’ E Longitude and covers an expanse of 98 lakh ha, which is 32% area of Maharashtra. Satpuda hill ranges in the north bound the region, Ajanta hill ranges in the southwest and a series of high hill ranges along the eastern border. It is divided into Godavari and Tapi river basins. The mean annual rainfall ranges from 700 mm at the west to 1700 mm at the east Western Vidarbha soils are derived from trap rock and have varying depth depending upon their physiography. Most of the soils are calcareous, highly base saturated,

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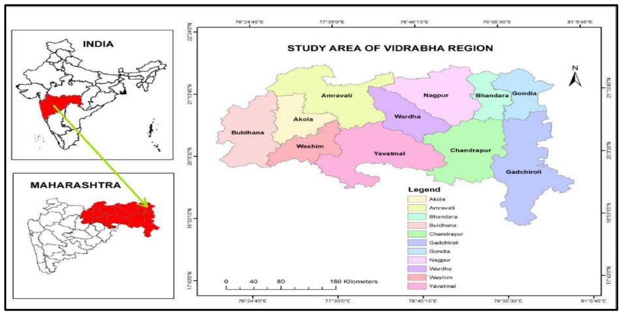


Figure 1.Location of the study area

## III.METHODOLOGY

### *A. Layer Stack*

The layer stack shown in this model is utilized in the Crisp model (among others) where the number of input PC (Principal Component) bands will depend on the number of input bands in the multiband input image, and hence will vary from application to application. Working Process: - Click Raster tab > Spectral > Layer Stack. To view or edit this model, click the View... button in the Layer Cull and Stacking dialog.

### *B. Mosaic*

The study area was span several image files. In this case, it is compulsory to amalgamate the images to engender one astronomically immense file. This is called mosaicking. The mosaic process offers the capability to stitch images together so one sizably voluminous, cohesive image of an area can be engendered. Because of the different features of MosaicPro, it is required to smooth these images afore mosaicking them together as well as color balance them, or adjust the histograms of each image in order to present a better immensely colossal picture. It is indispensable for the images to contain map and projection information, but they do not require being in the same projection or having the same cell sizes. The input images must have the same number of layers.

### *C. Subset*

Sub setting refers to breaking out a portion of an astronomically immense file into one or more diminutive files. Often, image files contain areas much more sizably voluminous than a particular study area. In these cases, reduce the size of the image file to include only the area of interest (AOI). This not only eliminates the extraneous data in the file, but it expedites processing due to the more diminutive amount of data to process. This can be consequential when dealing with multiband data

### *D. Top Of Atmospheric Spectral Radiation*

The value of Top of Atmospheric (TOA) spectral radiance (Lλ) was tenacious by multiplying multiplicative rescaling factor (0.000342) of TIR bands with its corresponding TIR band and integrating additive rescaling factor (0.1) with it.

$L\lambda = ML*Qcal + AL$

Where,

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

ML-Band concrete multiplicative rescaling factor (radiance_mult_band_10/11) Qcal-Band 10/ 11 image.

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

Flowchart of the algorithm to be perform during LST estimation utilizing TIRS Band 10 and 11 and OLI sensor Band 2-5 are shown in Fig 3.

### *E. Esimation of Brightness Temperature (Bt).*

Effulgence Temperature is the electromagnetic radiation peregrinating upward from the top of the Earth's atmosphere. Thermal calibration process done by converting thermal DN values of raw thermal bands of TIR sensor into TOA Spectral Radiance and Effulgence Temperature (TB) band as shown in Fig 4. Effulgence Temperature can be calculated by following equation. K2

$BT = \log(1 + K1L\lambda)$

Where,

K1 and K2 – Thermal constant of Bands from metadata image file Lλ – Top of Atmospheric Spectral Radiance layer

 

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### *F. Normalized Difference vegetation Index (NDVI)*

NDVI is given the information of germane vegetation features by utilizing felicitous band amalgamations, accommodating to distinguish among different feature of vegetation. It optimizes the amount of vegetation data present in the entire image, which is due to the spectral replication of vegetation to concrete band accumulation. Moreover, the output varies from season to season as per the reflectance of signature to categorical band coalescence hence; the stages of magnification and phenology of heterogeneous species could be studied facilely. The Normalized Difference Vegetation Index (NDVI), which is cognate to the proportion of photo synthetically absorbed radiation, is calculated from atmospherically redressed reflectance's from the visible and near infrared AVHRR channels as:

(CH2 - CH1) / (CH2 + CH1)

Where CH1 is the reflectance in the visible wavelengths (0.58-0.68 um) and CH2 is the reflectance in the reflective infrared wavelengths (0.725-1.1µm). The principle abaft this is that Channel 1 is in a component of the spectrum where chlorophyll causes considerable absorption of incoming radiation, and the Channel 2 is in a spectral region where spongy mesophyll leaf structure leads to considerable reflectance (Tucker, 1979; Jackson et. al., 1983; Tucker et. al., 1991).The normalized difference vegetation index (NDVI) is a simple graphical designator that can be acclimated to analyze remote sensing quantifications, typically but not obligatorily from a space platform, and assess whether the target being observed contains live green vegetation or not. A vegetation index is a be speaker that describes the greenness-the relative density and health of vegetation-for each picture element, or pixel, in a satellite image. Albeit there are several vegetation indices, one of the most widely used is the Normalized Difference Vegetation Index (NDVI). Normalized Difference Vegetation Index (NDVI) utilizes the NIR and red channels to quantify salubrious vegetation. Estimation of Normalized Difference Vegetation Index (NDVI) utilizing OLI sensor optical Band after layer stacking of Band 2,3,4,5 utilizing following equation.

NDVI= (NIR- RED) / (NIR+ RED)

Range: -1 < NDVI < + 1

### *G. Fractional Vegetation Cover*

Fractional Vegetation Cover (FVC) for an image is estimated utilizing NDVI image. Fractional Vegetation cover estimates the fraction of area under vegetation. Figure 5 shows the flowchart to perform FVC. Split-Window algorithm utilizes FVC to estimate Land Surface Emissivity (LSE). Utilizing ARC MAP 10 we reclassify the NDVI layer into soil and vegetation and calculate NDVI for Soil and Vegetation. FVC is estimated by utilizing following formula.

NDVI-NDVI (Soil)

FVC= NDVI-NDVI (Soil)

### *H. Land Surface Emissivity (LSE)*

Emissivity is the quantification of an object's facility to emit infrared energy. Emitted energy designates the temperature of the object. Emissivity can have a value from 0 to 1.0 .Most organic, painted, or oxidized surfaces have emissivity values proximate to 0.95.Land Surface Emissivity measures the innate characteristic of earth surface. It measures its faculty to convert thermal or heat energy into radiant energy. LSE estimation required emissivity of soil and vegetation of both Band 10 and 11 are given in Table 5. LSE of Band 10 and 11 are individually calculated utilizing FVC and following equation.

Where, LSE = ∈S* (1-FVC) + ∈V*FVC

Where,

Gs = Emissivity for soil

Gv = Emissivity for vegetation

FVC = Fractional Vegetation Cover

Mean Land Surface Emissivity (m)

Mean Land Surface Emissivity (m) of Band10 and 11 is a component to estimate LST. This can be calculated using following formula.

Mean of LSE = m = (LSE10+LSEu)/2

Difference Land Surface Emissivity (Am)

Difference Land Surface Emissivity (Am) of Band10 and 11 is a component to estimate

*I. This can be calculated using following equation*

Difference of LSE =Am = LSE10 - LSE11

Land Surface Temperature (LST)

Land Surface Temperature (LST) is estimated with following equation.

LST = TB10+C1 (TB10-TB11) +C2 (TB10-TB11)2 + C0 + (C3+C4W) (1-m) + (C5+C6W)Am Where,

TB10 and TB11 - Brightness Temperature of Band 10 and 11 C0-C9 - Split-Window coefficient values m - Mean LSE Am- Difference of LSE W – Atmospheric

## IV. RESULT AND DISCUSSION

### *A. Normalized Difference Vegetation Index(NDVI)*

Figure 6 represent NDVI layer of Vidarbha region of December 2016 derived from band 5 (NIR) and band 4 (RED) of OLI sensor. The range of NDVI is varies from 0-0.56 (zero for negative NDVI values utilizing condition). Increases in NDVI range from 0 to 1 denote for salubrious and green vegetation cover area.

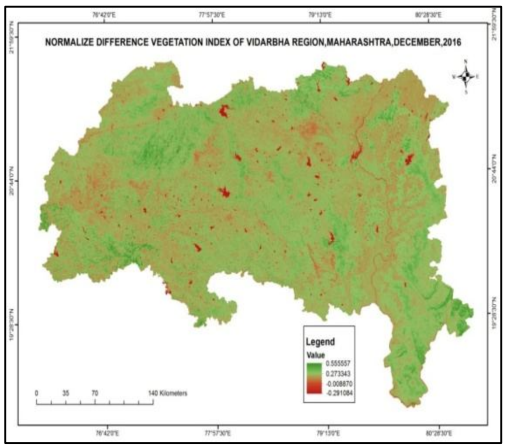


Figure 2: NDVI of Vidarbha region of Maharashtra, December, 2016

### *B. Fractional Vegetation Cover (Fvc)*

Estimated Fractional Vegetation Cover (FVC) for Vidarbha region using NDVI is represented Figure 7. Fractional vegetation cover estimates the fraction of area under vegetation of Vidarbha region December 2016.The highest range of FVC is varied from 0.242 and lowest range is -0.592. The highest value of FVC indicated that health vegetation whereas low value represented water body.

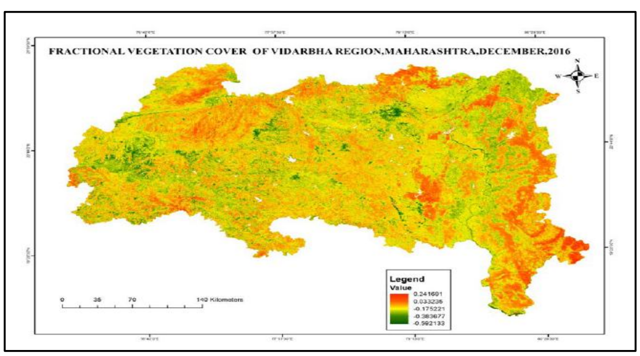


Figure 3: FVC of Vidarbha region of Maharashtra, December, 2016 5.3

### *C. Mean Land Surface Emissivity (M)*

Minimum, maximum mean LSE between band 10 and 11 during 2016 is presented in Figure 9. The minimum mean LSE ranged between 0.00419-0.00774 and the maximum mean LSE ranged between 0.00033-0.00302, respectively.

### *D. Difference Land Surface (ΔM)*

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Minimum, maximum difference LSE between band 10 and 11 during 2016 is presented in Figure 10. The minimum difference LSE ranged between 0.00832-0.01557 and the maximum difference LSE ranged between 0.00067-0.00550, respectively.

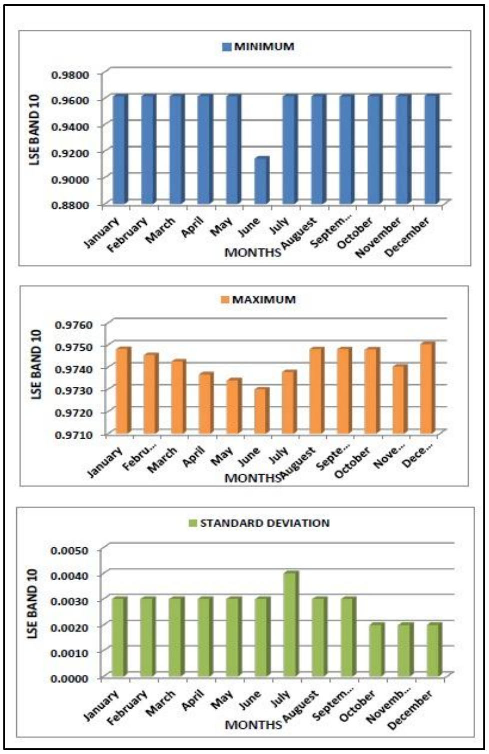


Figure4a: LSE (band 10) of study area

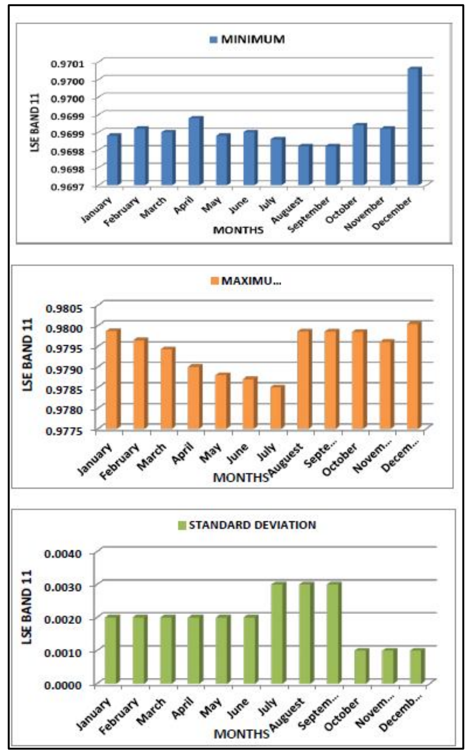


Figure 4b: LSE (band 11) of study area

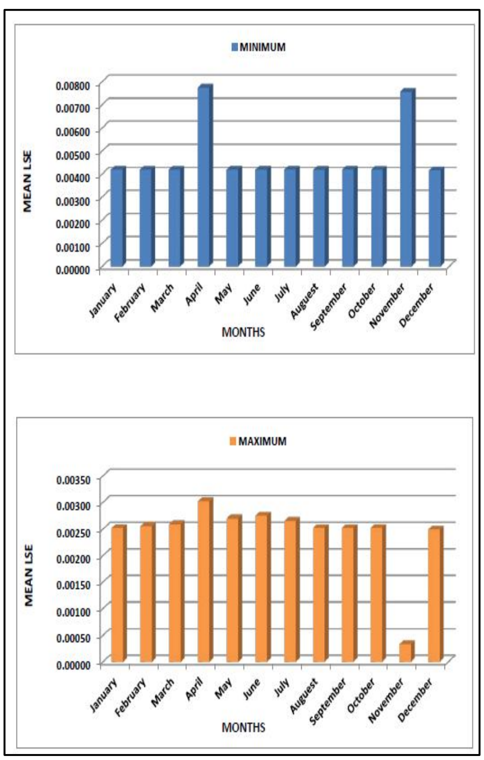


Figure5a: LSE (band 10) of study area

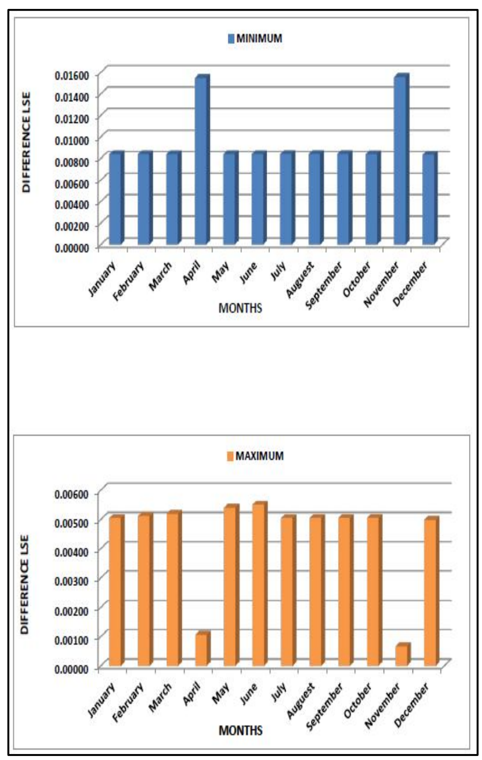


Figure5b:Difference LSE (band 10) of study area

### *E. Brightness temperature.*

The effulgence temperature (BT) of February 2016 of Band 10 and 11 of Vidarbha region is presented in Figure 11a & b. The highest value of BT was found 321.9 K and 315.5 K of band 10 and 11, respectively. This value manly was visually perceived in the highly vegetation, built-up area, forest and agriculture area. The lowest value of BT was found 17.4 K of Band 10 and 11. The lowest value betokened manly dihydrogen monoxide body in the study area. Its betokens that highly vegetation and built-up areas effulgence temperature is high and dihydrogen monoxide body effulgence temperature is low.

### *F. Land Surface Temperature (Lst)*

The monthly land surface temperature (LST) of Vidarbha region during 2016 is depicted in Figure 12a & b. The highest value of LST was ranged from 298-349 K and 296-332 K during February and December, 2016, respectively. The monthly minimum, maximum, mean and standard deviation of LST is presented in Figure 13a-d. The monthly minimum, maximum, mean and standard deviation of LST ranged from 206-225, 333-380, 256-283 and 32.4-51.6 K, respectively.

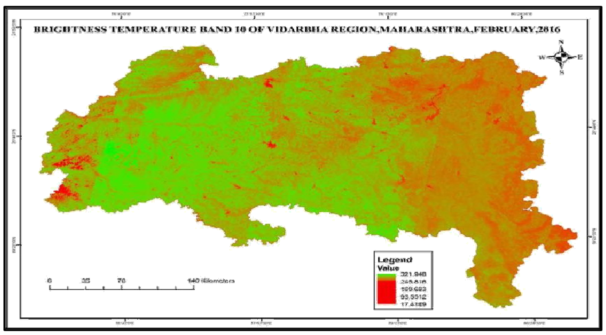


Figure 6a: Brightness Temperature (Band 10) study area, Dec 2016

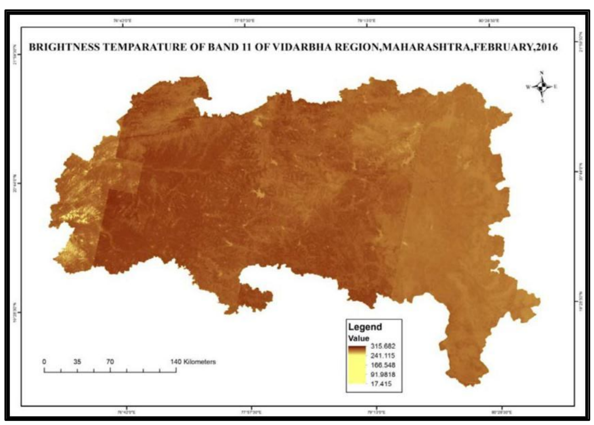


Figure 6b: Brightness Temperature (Band 11) study area, Dec 2016

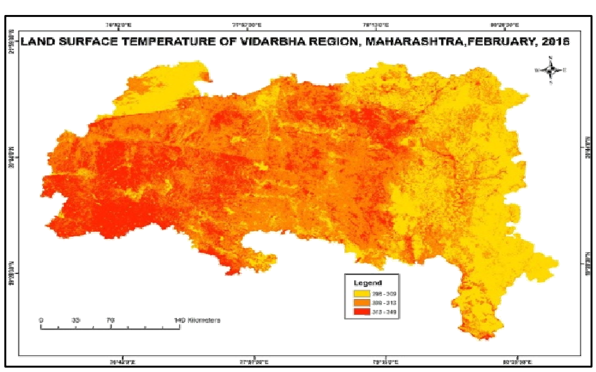


Figure 7a: LST of Vidarbha region, Maharashtra, February 2016

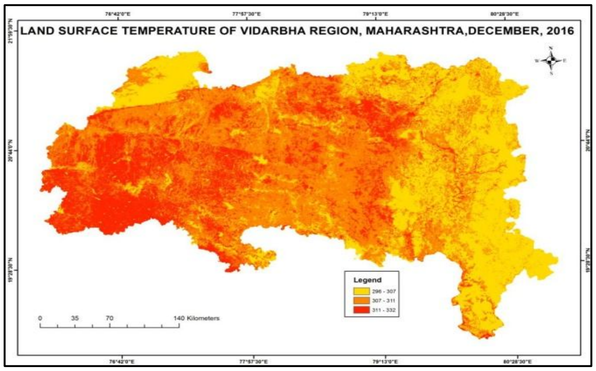


Figure 7b: LST of Vidarbha region, Maharashtra, December 2016

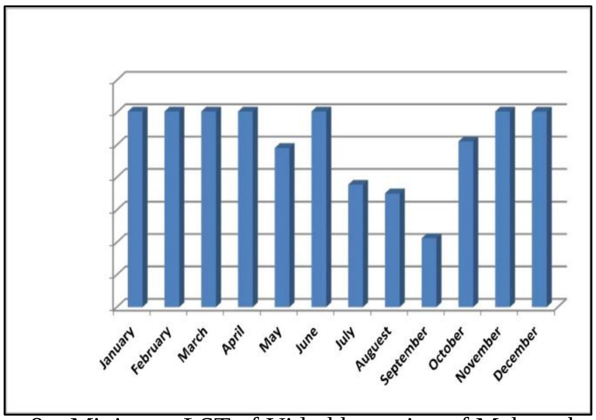


Figure 8a: Minimum LST of Vidarbha region of Maharashtra

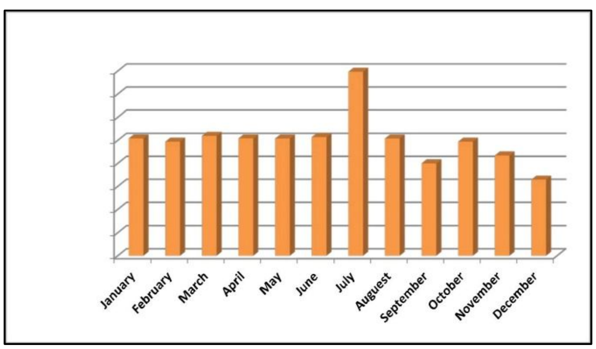


Figure 8b: Maximum ST of Vidarbha region of Maharashtra

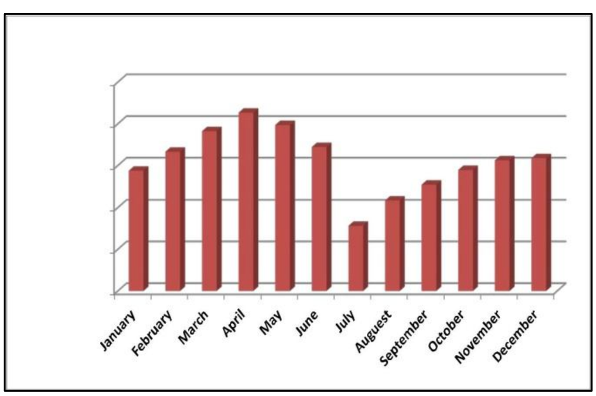


Figure 8c: Mean LST of Vidarbha region of Maharashtra

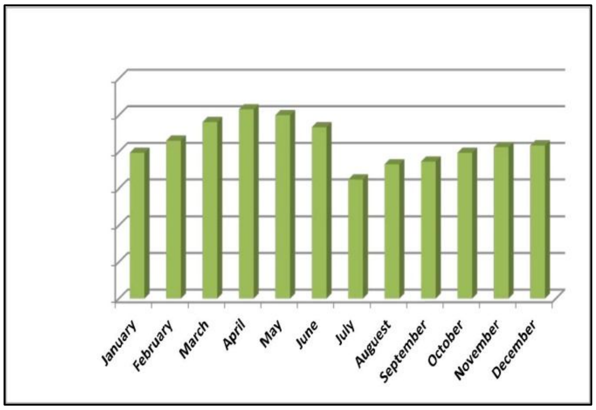


Figure8d: Standard deviation of LST in Vidarbha region

## V. CONCLUSION

Land surface temperature have been identified and estimated through remote sensing and GIS techniques. Split-window algorithm a dynamic mathematical implement provide the Land surface temperature (LST) information utilizing effulgence temperature of thermal bands of TIRS sensor and Land surface emissivity (LSE) factor derived from Fractional vegetation cover (FVC) of optical bands of OLI sensor. NDVI of Vidarbha region of Maharashtra, December, 2016 NDVI is varies from 0-0.56 (zero for negative NDVI values utilizing condition). Increases in NDVI range from 0 to 1 betoken for salubrious and green vegetation cover area. The land surface temperature of band 10 and11 minimum values is 0.9144-0.9617, minimum value 0.9698-0.9701, respectively and stander deviation is 0.0020-0.004 and 0.9730-0.9750, respectively. FVC of vegetation height and lowest value 0.24to-0.59. Mean LST calculated band 10 and 11, band10 minimum value is 0.004-0.007 and maximum value 0.003-0.003. The Effulgence temperature (BT) 11 and 10 we were calculated highest and lowest rang 315.682 to 17.415, band 10 value is 321.00 to 17.4189.The remote sensing data avails in preparing Land surface Temperature (LST) map with constrained field Land set 8 OLI data and GIS avails in analysis of land congruousness with spatial modeling that avails in land surface temperature. This analysis postulates that satellite retrieved LST is an aggregate of the authentic physical temperature of land surface components within the field of view of a Land set 8 OLI data. It withal gives information on circumscription for the crop.

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