

ESTIMATION OF LAND SURFACE TEMPERATURE (LST) FROM THERMAL BAND OF LANDSAT 5 SATELLITE

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"B"

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INTRODUCTION:

Land Surface Temperature (LST):

The Land Surface Temperature (LST) is the radiative skin temperature of the land surface, as measured in the direction of the remote sensor.

Study Area:

Area selected for this study is **CHARSADDA**.

Objectives of the Study:

1. Extraction of Area of Interest (AOI).
2. NDVI estimation
3. TOA Spectral Radiance.
4. Brightness Temperature.
5. Land Surface Emissivity (LSE).
6. Land Surface Temperature.

Material:

- Landsat 5 Image
- ArcGIS Software

Tools:

- Clipping Tool
- Raster Calculator

Formulas:

- $NDVI = NIR - RED / NIR + RE$
- $(TOA) L\lambda = ML Q_{cal} + AL$
- $T = k_2 / \ln(k_1/L\lambda + 1)$
- $PV = (NDVI + NDVI_{min} / NDVI_{max} - NDVI_{min})^2$
- Land Surface Emissivity (LSE) = $0.004 (PV) + 0.986$ (values are constant)
- $LST = (BT/1 + W * (BT/P) * \ln(e))$

PROBLEM STATEMENT

- To overcome the difficulty of LAND SURFACE TEMPERATURE (LST)

METHODOLOGY

Untitled - ArcMap

File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

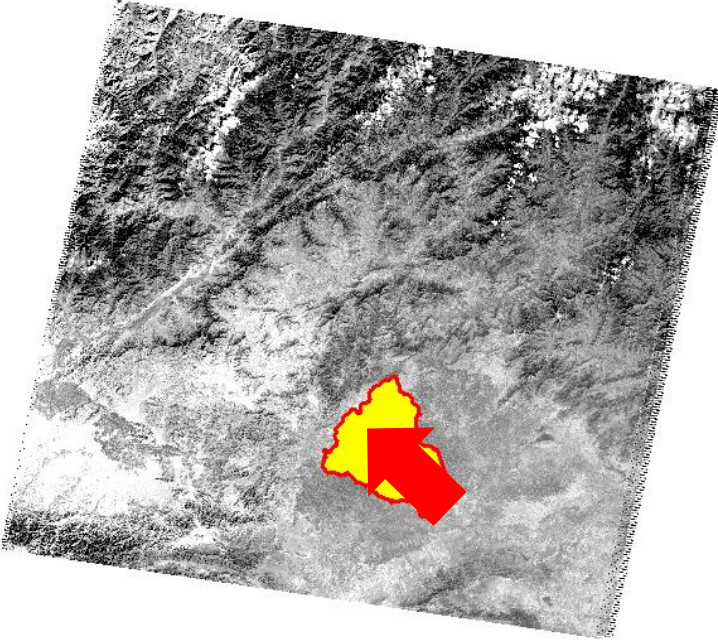
1:1,547,602 Classification LT05_L1TP_151036_200810

Georeferencing LT05_L1TP_151036_20081025

Editor

Table Of Contents

- Layers
 - G:\LST
 - charsadda
 - G:\LST\LT05_L1TP_151036_20081025
 - LT05_L1TP_151036_20081025 Value High: 79 Low: 12
 - LT05_L1TP_151036_20081025 Value High: 92 Low: 11
 - LT05_L1TP_151036_20081025 Value High: 161 Low: 102



Search

Local Search

ALL Maps Data Tools Images

Any Extent

Catalog Search

715189.147 3899091.618 Meters

10:09 AM

Clipping of AOI

The screenshot displays the ArcMap interface with the following components:

- Table Of Contents:** Lists three layers under the 'G:\LST' folder:
 - LT05_charsadda_clip_B: Value range High: 96, Low: 23.
 - LT05_charsadda_clip_B: Value range High: 94, Low: 17.
 - LT05_charsadda_clip_B: Value range High: 159, Low: 124.
- Map View:** Shows a grayscale map with a white, irregularly shaped polygon representing the clipped area of interest (AOI).
- Search Panel:** Contains a search bar with the text 'clip' and a list of 18 search results. The first three results are:
 - Clip (Coverage) (Tool):** Uses the outside polygon boundary...
 - Clip (Analysis) (Tool):** Extracts input features that overlay...
 - Clip (Data Management) (Tool):** Cuts out a portion of a raster datas...
- Status Bar:** Displays coordinates: 742577.794 3807977.088 Meters.

NDVI = float(NIR-R)/float(NIR+R)

The screenshot displays the ArcMap interface with the Raster Calculator dialog box open. The dialog box contains a Map Algebra expression for calculating NDVI, which is highlighted with a red rectangle:

$$\text{Float}(\text{LT05_charsadda_clip_B4.TIF} - \text{LT05_charsadda_clip_B3.TIF}) / \text{Float}(\text{LT05_charsadda_clip_B4.TIF} + \text{LT05_charsadda_clip_B3.TIF})$$

The background shows the ArcMap workspace with a map of a region and a Table of Contents on the left. The Table of Contents lists several layers:

- LT05_charsadda_NDVI: Value range from -0.26087 to 0.517241.
- LT05_charsadda_clip_B: Value range from 23 to 96.
- LT05_charsadda_clip_B: Value range from 17 to 94.
- LT05_charsadda_clip_B: Value range from 124 to 159.

The Raster Calculator dialog box also shows a list of layers and variables on the left and a keypad for entering the expression. The expression is: `Float('LT05_charsadda_clip_B4.TIF' - 'LT05_charsadda_clip_B3.TIF')/Float('LT05_charsadda_clip_B4.TIF' + 'LT05_charsadda_clip_B3.TIF')`

Top of the Atmosphere (TOA):

Formula TOA Radiance is:

$$L_{\lambda} = ML Q_{cal} + AL$$

- L_{λ} = TOA spectral radiance.
- $ML = \text{RADIANCE_MULTI_BAND_6}$.
- $AL = \text{RADIANCE_ADD_BAND_6}$
- Q_{cal} = is the specific thermal band
- The output of this formula is TOA

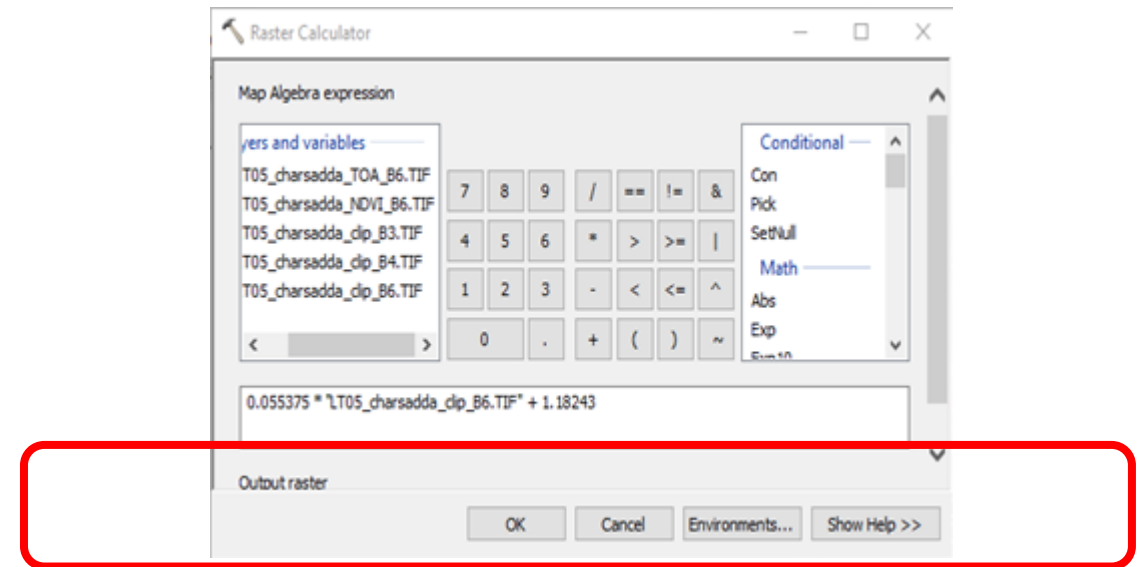
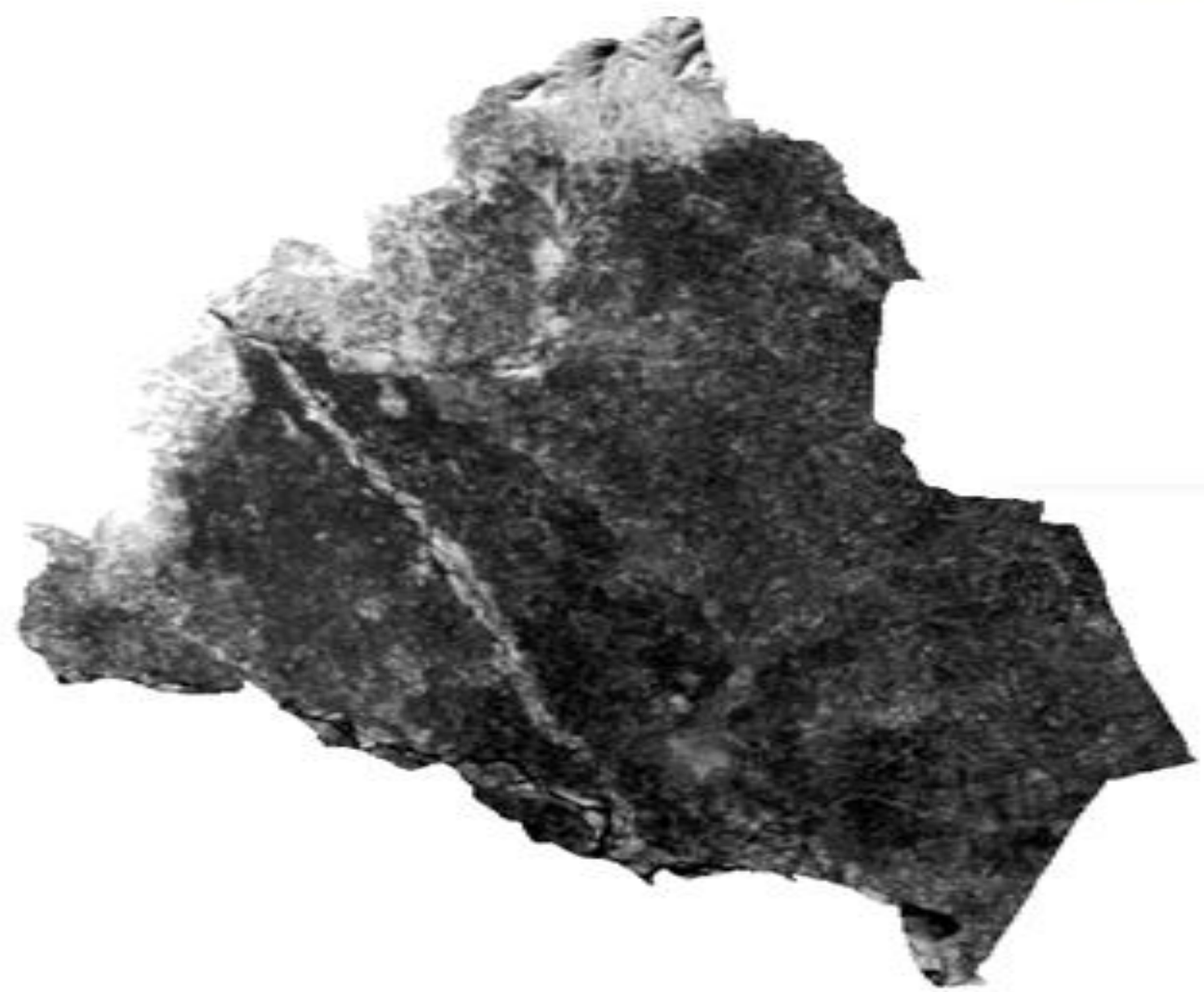


Table Of Contents

Layers

- G:\LST\
- LT05_charsadda_TOA_B6.T
Value
High : 9.98705
Low : 8.04893
- LT05_charsadda_NDVI_B6.T
Value
High : 0.517241
Low : -0.26087
- LT05_charsadda_clip_B3.T1
Value
High : 96
Low : 23
- LT05_charsadda_clip_B4.T1
Value
High : 94
Low : 17
- LT05_charsadda_clip_B6.T1



Brightness Temperature (BT):

Formula for Brightness Temperature:

$$T = k2 / \text{Ln.} (k1/L\lambda + 1)$$

- K1= Thermal constant values present in meta data
- K2= Thermal constant values present in metadata

For converting the kelvin temperature to degree centigrade, subtract -272.15 from the formula.

$$T = k2 / \text{Ln.} (k1/L\lambda + 1) - 272.15$$

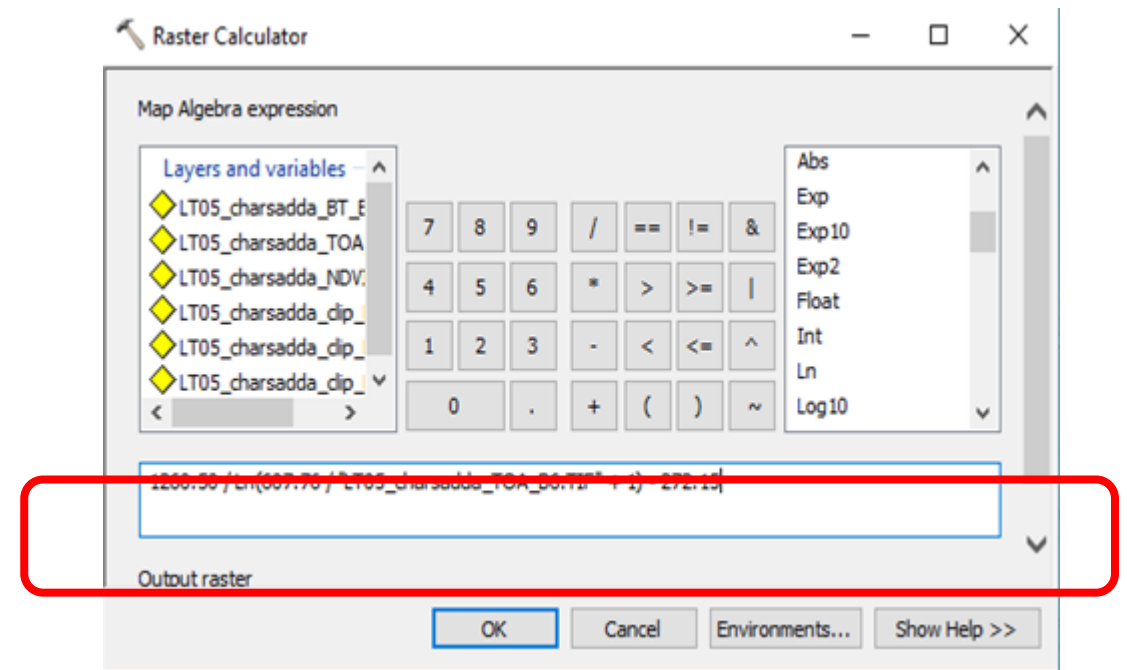
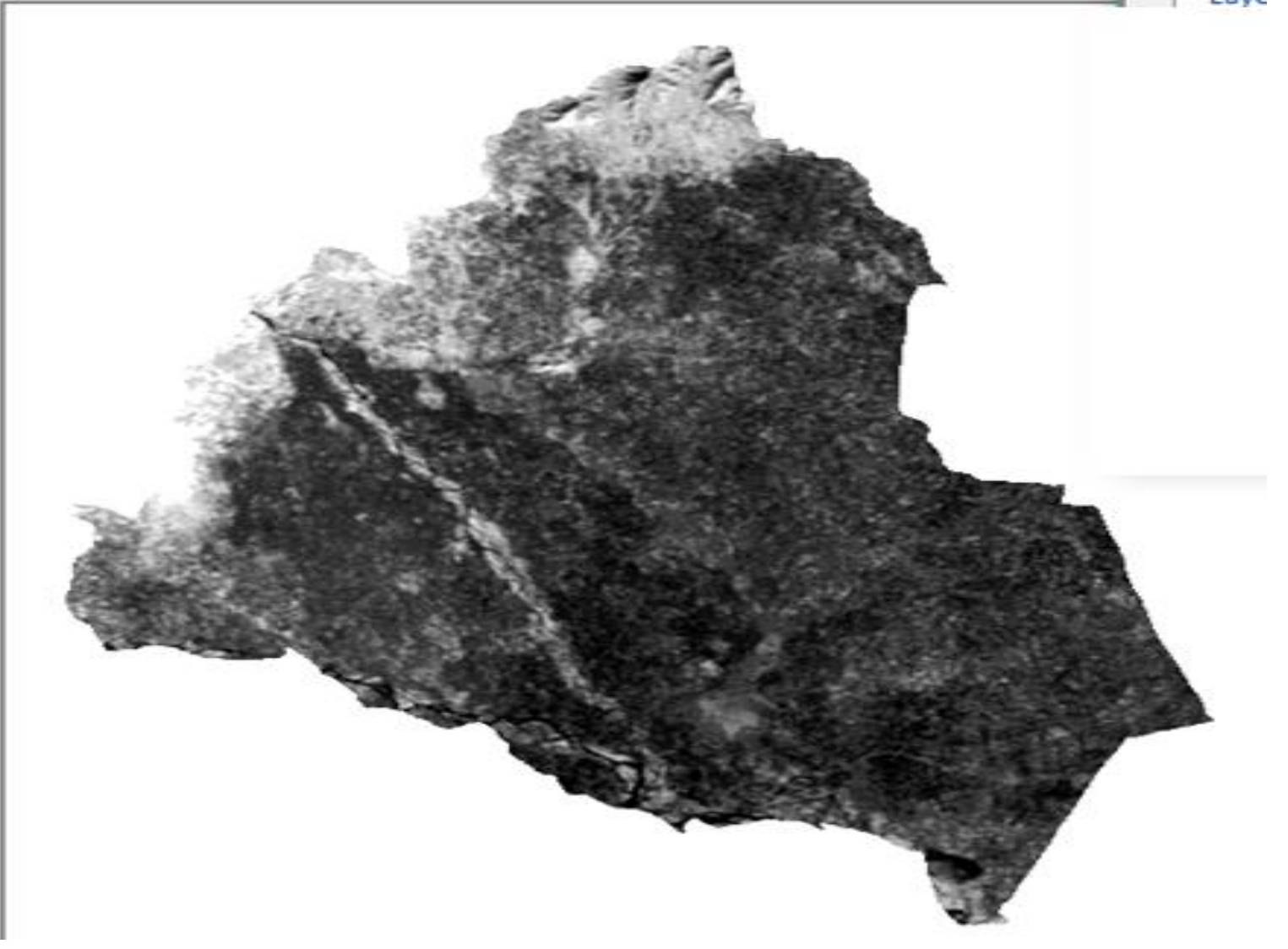


Table Of Contents

Layers

- G:\LST\
 - LT05_charsadda_BT_B6.TIF
 - Value
 - High : 33.4559
 - Low : 18.4759
 - LT05_charsadda_TOA_B6.TIF
 - Value
 - High : 9.98705
 - Low : 8.04893
 - LT05_charsadda_NDVI_B6.TIF
 - Value
 - High : 0.517241
 - Low : -0.26087
 - LT05_charsadda_clip_B3.TIF
 - Value
 - High : 96
 - Low : 23
 - LT05_charsadda_clip_B4.TIF



(Proportion of Vegetation) $PV = \text{square}(\text{NDVI} -$

The screenshot displays the ArcMap interface with a Raster Calculator dialog box open. The dialog box contains the following elements:

- Map Algebra expression:** A text box containing the formula $\text{Square}(\text{LT05_charsadda_NDVI_B6.TIF} * + 0.26087 / 0.517241 + 0.26087)$, which is highlighted with a red border.
- Layers and variables:** A list of layers including LT05_charsadda_PV_E, LT05_charsadda_BT_E, LT05_charsadda_TOA, LT05_charsadda_NDVI, and LT05_charsadda_clip.
- Power:** A dropdown menu with options: RoundDown, RoundUp, Square, SquareRoot, Trigonometric, ACos, and ACosH.
- Output raster:** A field for specifying the output name.
- Buttons:** OK, Cancel, Environments..., and Show Help >>.

The background map shows a grayscale terrain image. The Table of Contents on the left lists several layers with their respective value ranges:

- LT05_charsadda_PV_B6.TIF: Value range 0.254368 to 1.6447.
- LT05_charsadda_BT_B6.TIF: Value range 18.4759 to 33.4559.
- LT05_charsadda_TOA_B6.TIF: Value range 8.04893 to 9.98705.
- LT05_charsadda_NDVI_B6.TIF: Value range -0.26087 to 0.517241.
- LT05_charsadda_clip_B3.TIF: Value range 0 to 96.

The status bar at the bottom indicates the coordinates 757250.735 3810269.735 Meters and the time 10:29 AM.

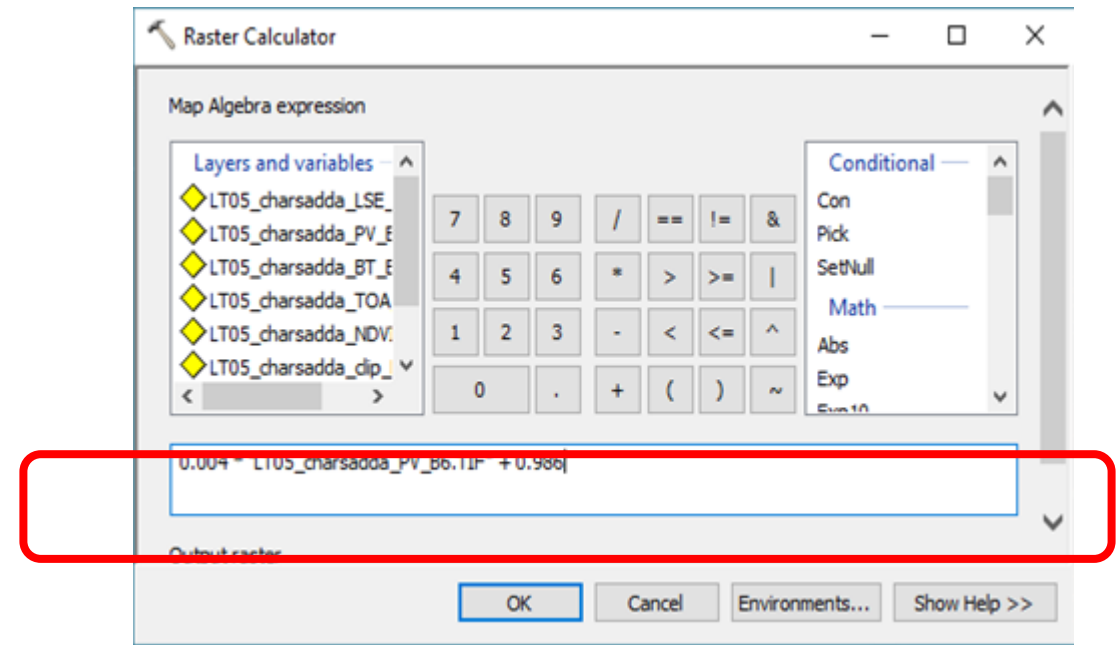
Land Surface Emissivity (LSE):

Formula for LSE:

$$\text{LSE} = 0.004 * \text{PV} + 0.986$$

where the 0.004 and 0.986 is the constant values

While PV is the Proportion Vegetation calculated earlier.



File Edit View Bookmarks Insert Selection Geoprocessing Customize Windows Help

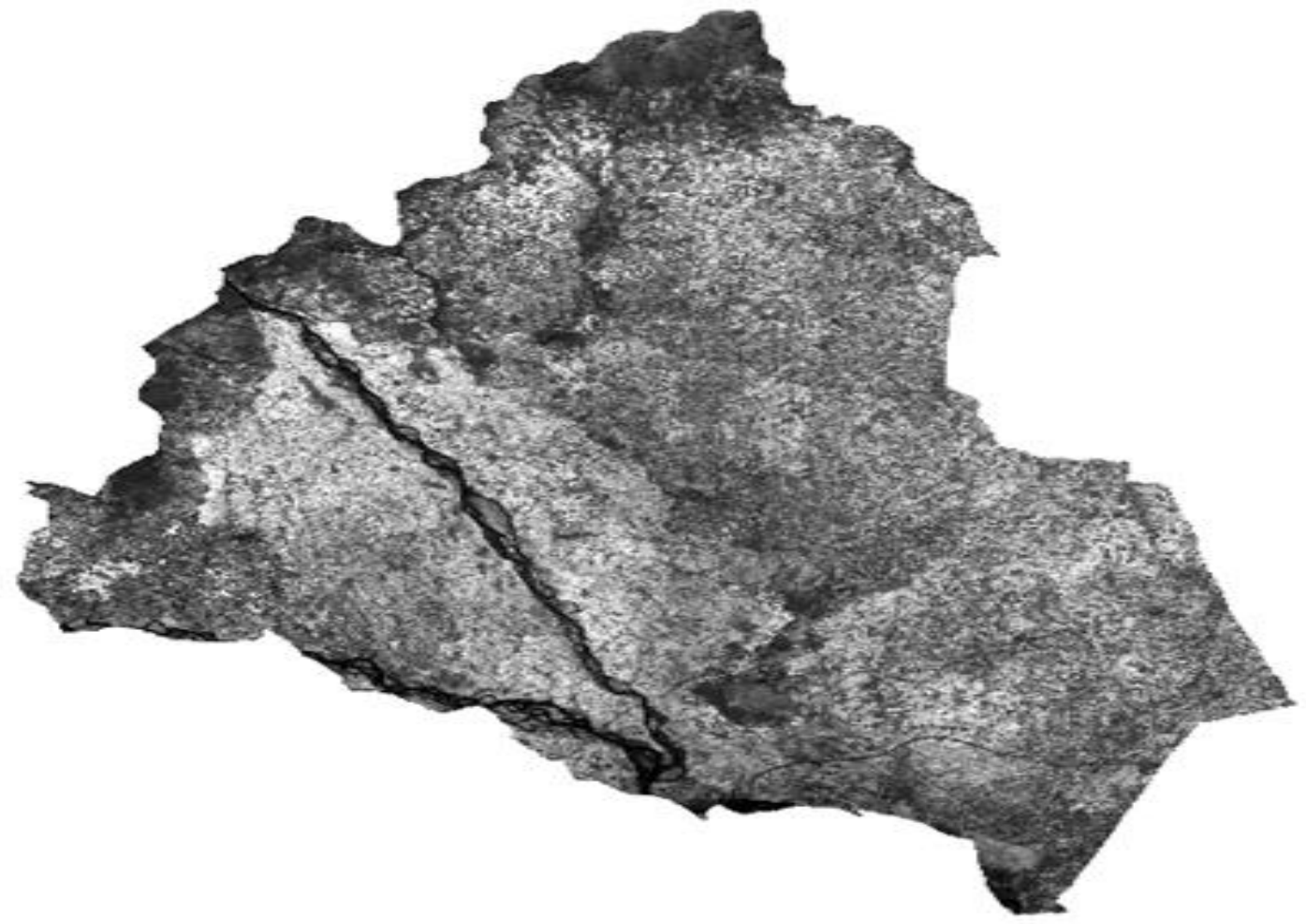
1:346,604

Georeferencing Editor

Table of Contents

Layers

- G:\LST\
- LT05_charsadda_LSE_B6.TIF
Value
High : 0.992579
Low : 0.987017
- LT05_charsadda_PV_B6.TIF
Value
High : 1.6447
Low : 0.254368
- LT05_charsadda_BT_B6.TIF
Value
High : 33.4559
Low : 18.4759
- LT05_charsadda_TOA_B6.T
Value
High : 9.98705
Low : 8.04893
- LT05_charsadda_NDVI_B6.
Value



Land Surface Temperature (LST):

$$LST = (BT / (1 + W * (BT / P) * \ln(e)))$$

- BT= Satellite brightness temperature
- W= Wavelength of emitted radiance
- $P = h * c / s$ ---- equation (1)
- h= Planck's constant having value $(6.626 * 10^{-23} \text{ joule})$
- S= Boltzmann constant $(1.38 * 10^{-16} \text{ m}^2/\text{s}^2/\text{K})$
- C= velocity of light $(2.998 * 10^8 \text{ m/s})$
- Putting the values in Eq. 1, we get:
 $P = 14380$
- $e = 0.004 (PV) + 0.986$

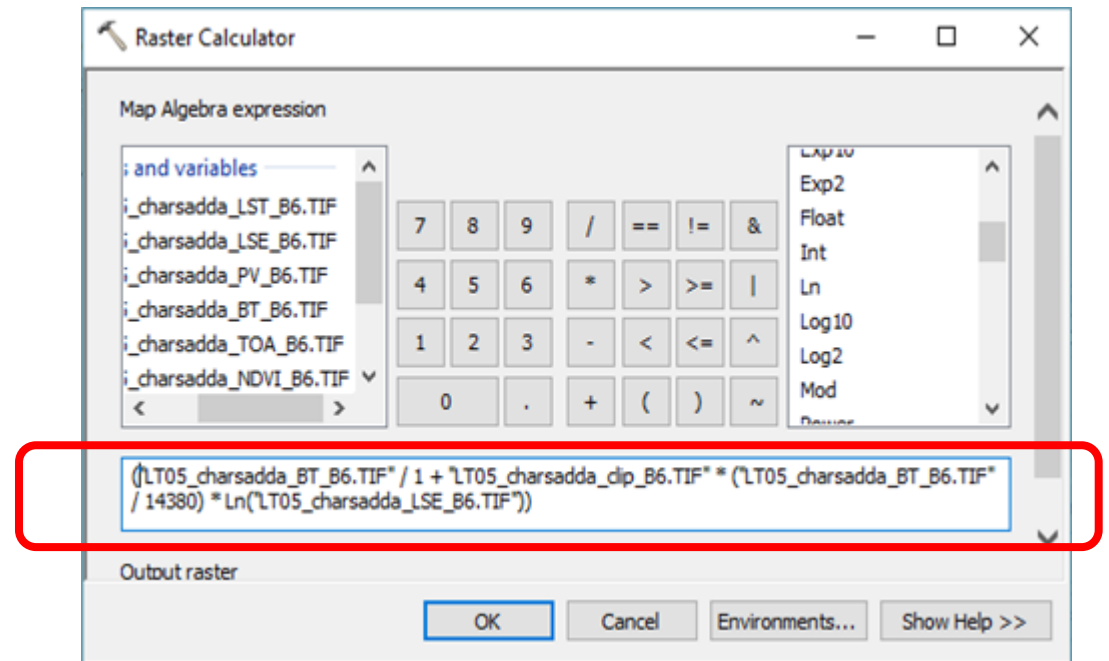
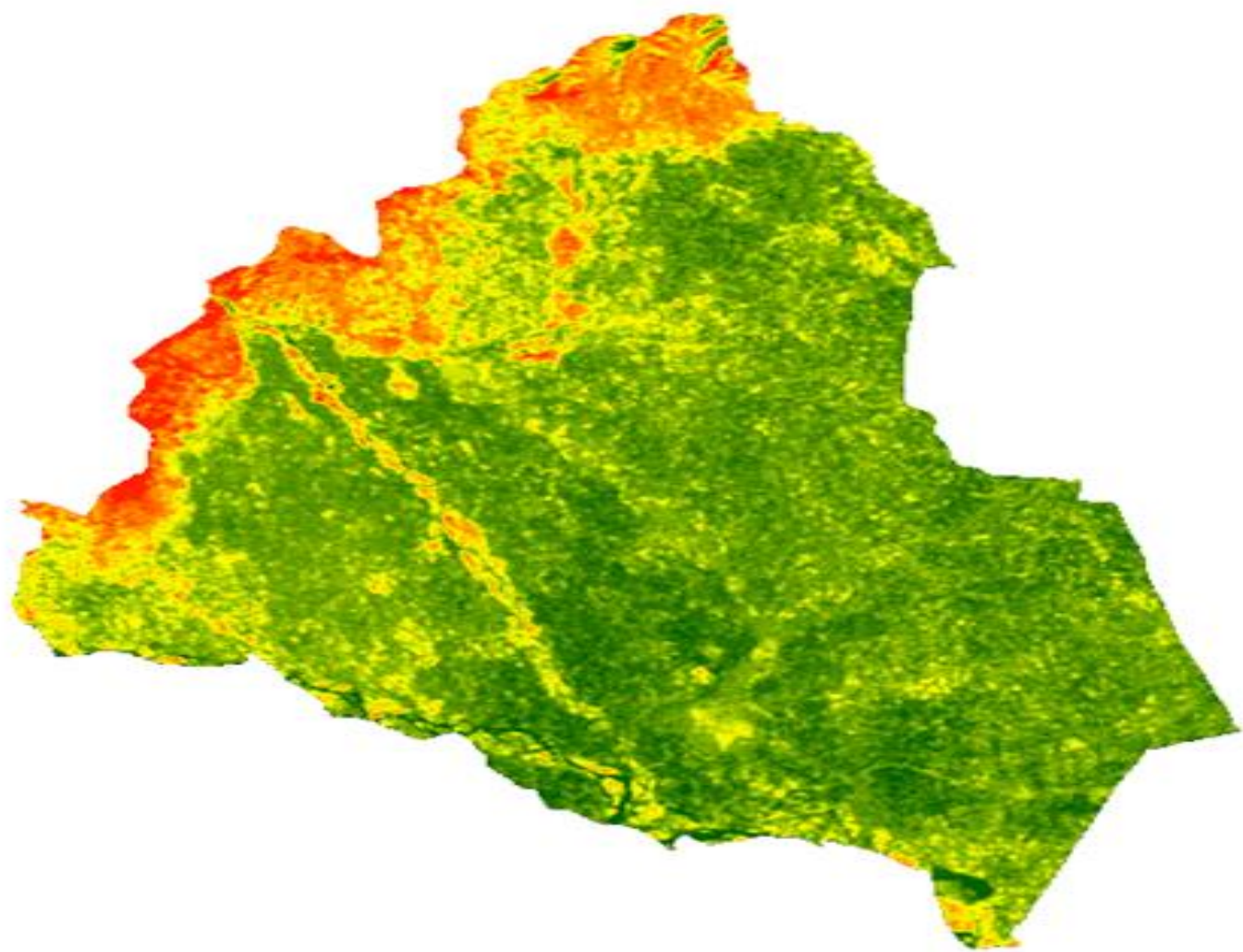


Table Of Contents

Layers

- G:\LST\
 - LT05_charsadda_LST_B6.TIF
 - Value
 - High : 33.4516
 - Low : 18.4738
 - LT05_charsadda_LSE_B6.TIF
 - Value
 - High : 0.992579
 - Low : 0.987017
 - LT05_charsadda_PV_B6.TIF
 - Value
 - High : 1.6447
 - Low : 0.254368
 - LT05_charsadda_BT_B6.TIF
 - Value
 - High : 33.4559
 - Low : 18.4759
 - LT05_charsadda_TOA_B6.TIF
 - Value



Thanks for your Attention