Calculating Brightness Temperature using Landsat-8

Using SAGA GIS

Tutorial ID: IGET_SA_004

Calculating Brightness temperature using Landsat-8

Objective: To create a brightness temperate map of the Dangs district in Gujarat using Landsat-8 thermal bands.

Software: SAGA GIS

Level: Beginner

Time required: 1 Hour

Prerequisites and Geospatial Skills:

1. SAGA GIS should be installed on the computer
2. All The basic GIS and Remote Sensing tutosrial from IGET portal must be completed
3. Should have completed Exercise ID: IGET_CT_003

Reading: Using Landsat-8 data product, http://landsat.usgs.gov/Landsat8_Using_Product.php

Data credit: Landsat data credit goes to EROS data center, USGS, Sioux Falls, US.

Introduction

The thermal remote sensing is based on the fact that, there exists a very high positive correlation between the amounts of radiant flux radiated by an object and the true kinetic temperature of the object. Thus the radiant temperature of an object can be easily measured from distantly placed radiometers. A series of satellite and airborne sensors have been developed to collect thermal Infra-Red (TIR) data from the earth surface viz., Landsat TM/ETM+, HCMM, AVHRR, MODIS, ASTER, and TIMS etc. In this tutorial, we will use Landsat-8 thermal bands i.e., Band 10 and Band 11 to calculate the brightness temperature over the Dangs district in the state of Gujarat dated 12-Dec-2013.

1. Open SAGA GIS and load '***L8_Dang_12DEC2013_Band10.TIF***' and '***L8_Dang_12DEC2013_Band11.TIF***' via, '*Geoprocessing → File → GDAL/OGR → GDAL: Import raster*'.
2. To calculate brightness temperature from Landsat thermal bands, at first we need to convert Landsat thermal band DN values to spectral radiance. The formula for converting DN to Top atmosphere spectral radiance is

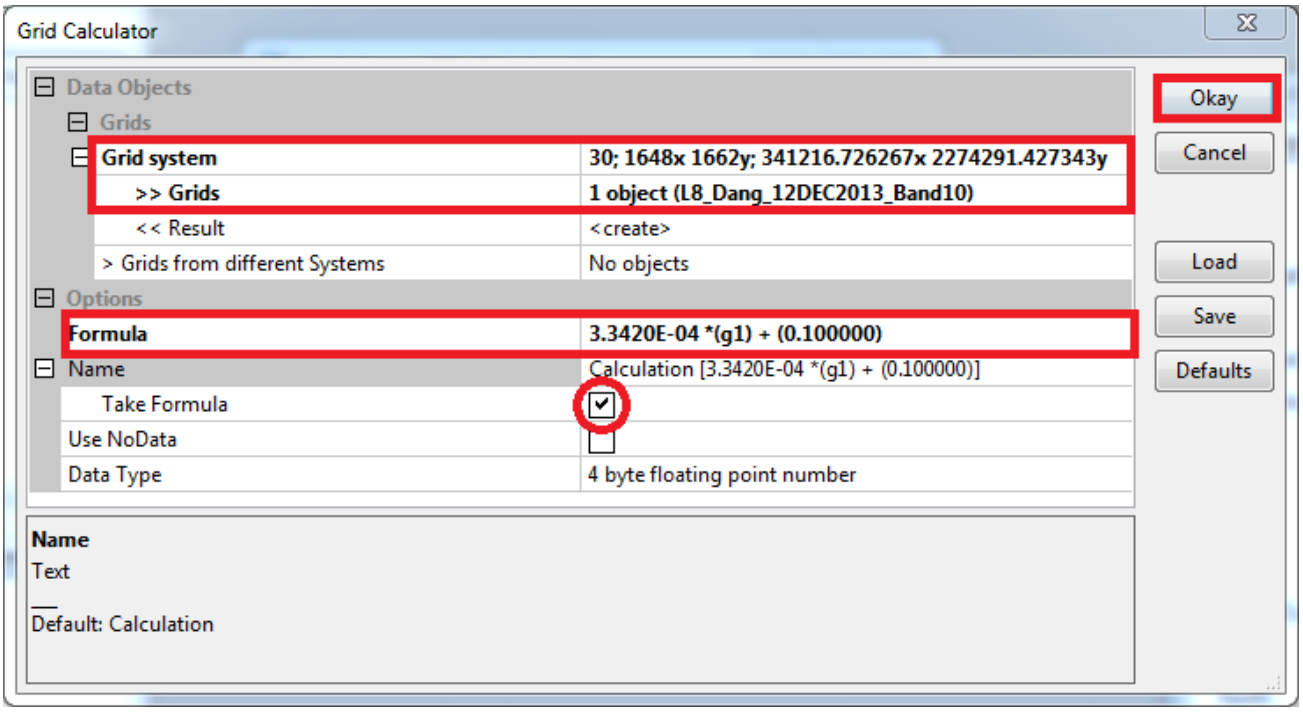
$$L_\lambda = M_L Q_{cal} + A_L;$$

Where
L_λ = TOA spectral radiance (Watts/(m^2*srad*µm))
M_L= Band-Specific Multiplicative rescaling factor from metadata
Q_{cal}= Quantized and calibrated standard product pixel value DN
A_L= Band-Specific additive rescaling factor from metadata

The values of M_L and A_L for band 10 and band 11 for our study area is extracted from the metadata and are presented in the following table.

	Band 10	Band 11
M_L	3.3420E-04	0.100000
A_L	3.3420E-04	0.100000

3. Now we will use grid calculator '*Geoprocessing → Grid → Calculus → Grid Calculator*' to compute *Top of Atmosphere spectral radiance.*
4. In the *Grid calculator* window input the details of '***L8_Dang_12DEC2013_Band10.TIF***' band as shown below snapshot. Make sure to keep '*Results*' as '***<create>***'. Write '***3.3420E-04 *(g1) + (0.100000)***' in '*Formula*' and ensure that '*Take Formula*' is checked in and Click '***Okay***'.



5. After successful execution of *grid calculator* module, you can see '***Calculation [3.3420E-04 *(g1) + (0.100000)]***' grid under *Data Tree* tab of '*Manager*'. Rename it as '***L8_Dang_12DEC2013_Band10 [Radiance]***' using '*Properties*' window.
6. Similarly convert the DN values in '*L8_Dang_12DEC2013_Band11.TIF*' to *Top of Atmosphere spectral radiance* and rename the radiance file to '***L8_Dang_12DEC2013_Band11 [Radiance]***'.
7. The spectral radiance can be converted to brightness temperature in Celsius using following formula,

$$T = \frac{K_2}{\ln\left(\frac{K_1}{L_\lambda}+1\right)} - 273.15$$

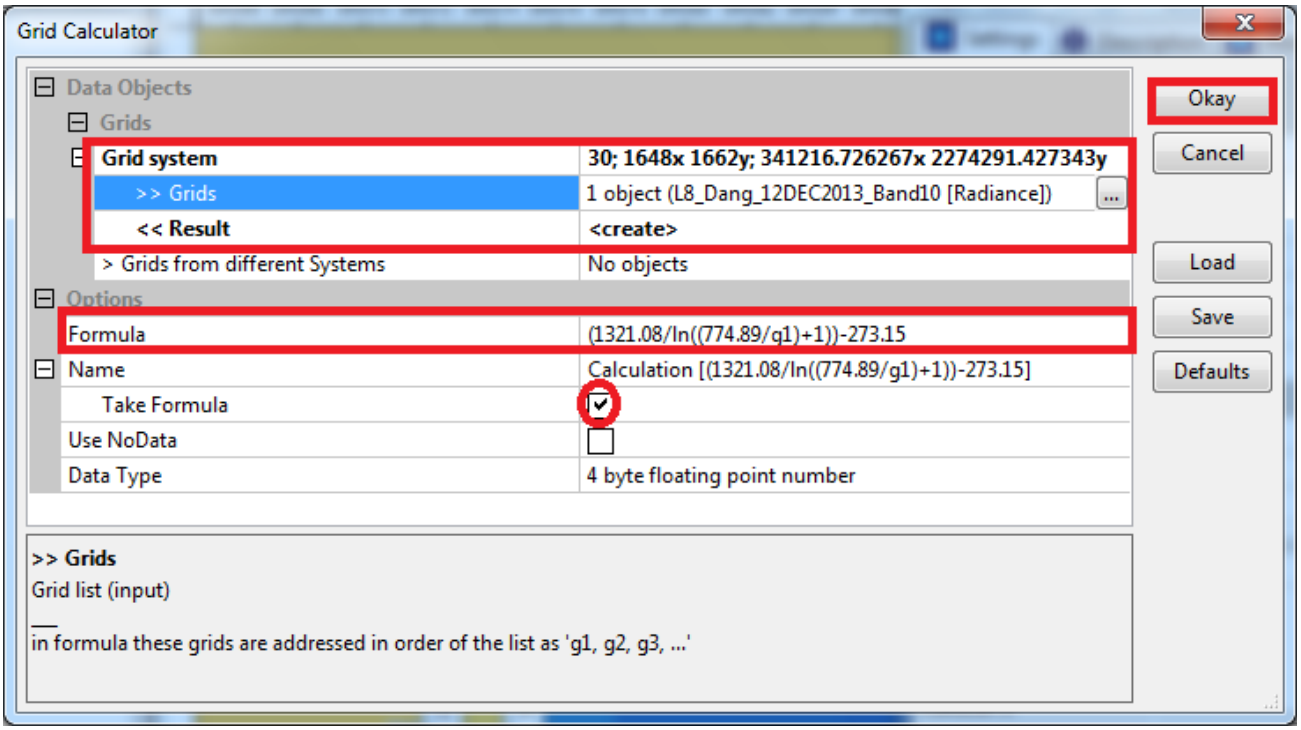
Where,
T = At-satellite brightness temperature in Celsius
L_λ = TOA spectral radiance (Watts/(m2*srad*µm))
K_1 = Calibration constant 1
K_2 = Calibration constant 2

The values of K_1 and K_2 for band 10 and band 11 for our study area is extracted from the metadata and are presented in the following table.

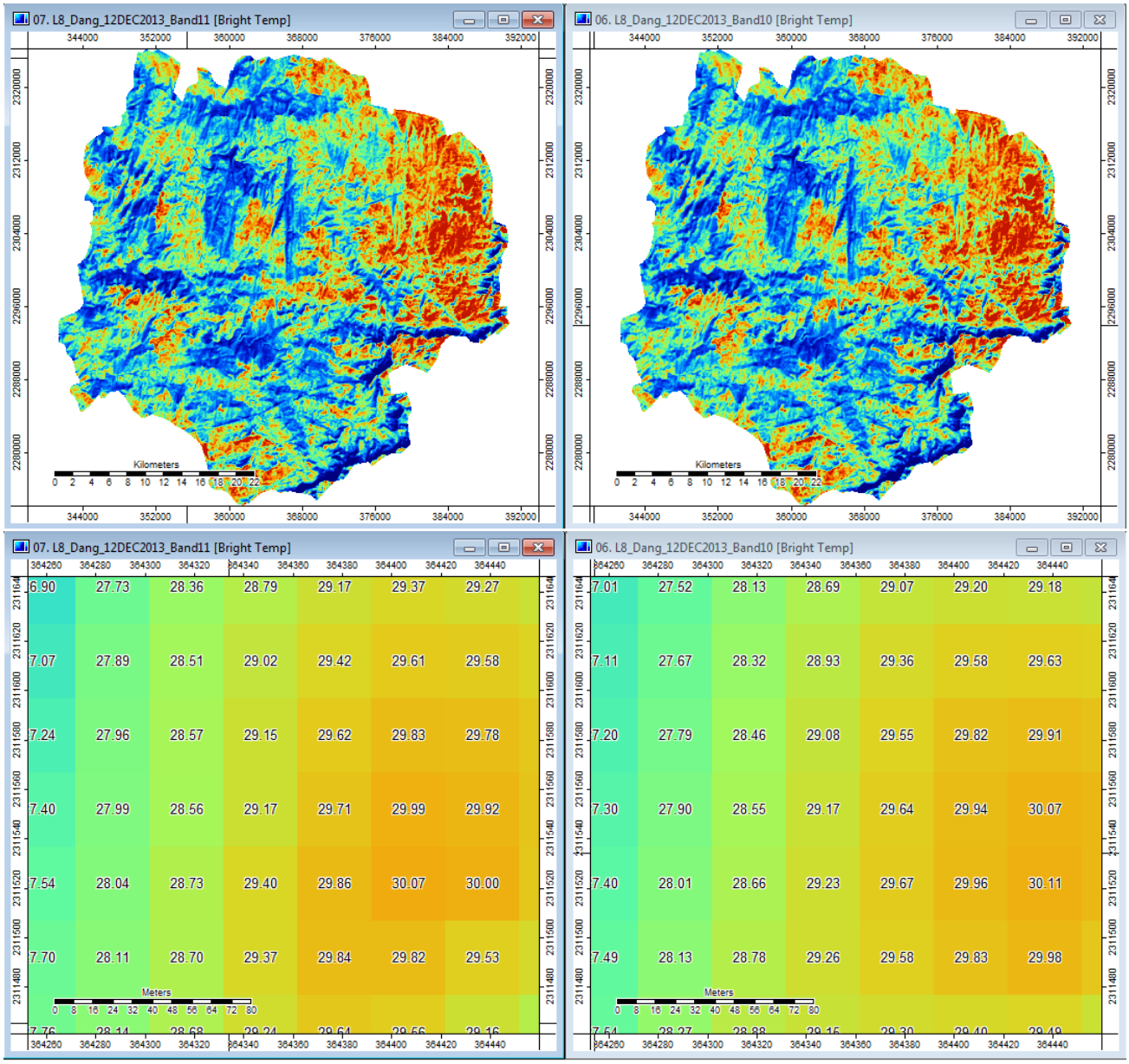
	Band 10	Band 11
K_1	774.89	480.89
K_2	1321.08	1201.14

8. Again open *Grid calculator* window input the details of as shown below snapshot. This time our input grid is '***L8_Dang_12DEC2013_Band10 [Radiance]***'. Make sure to

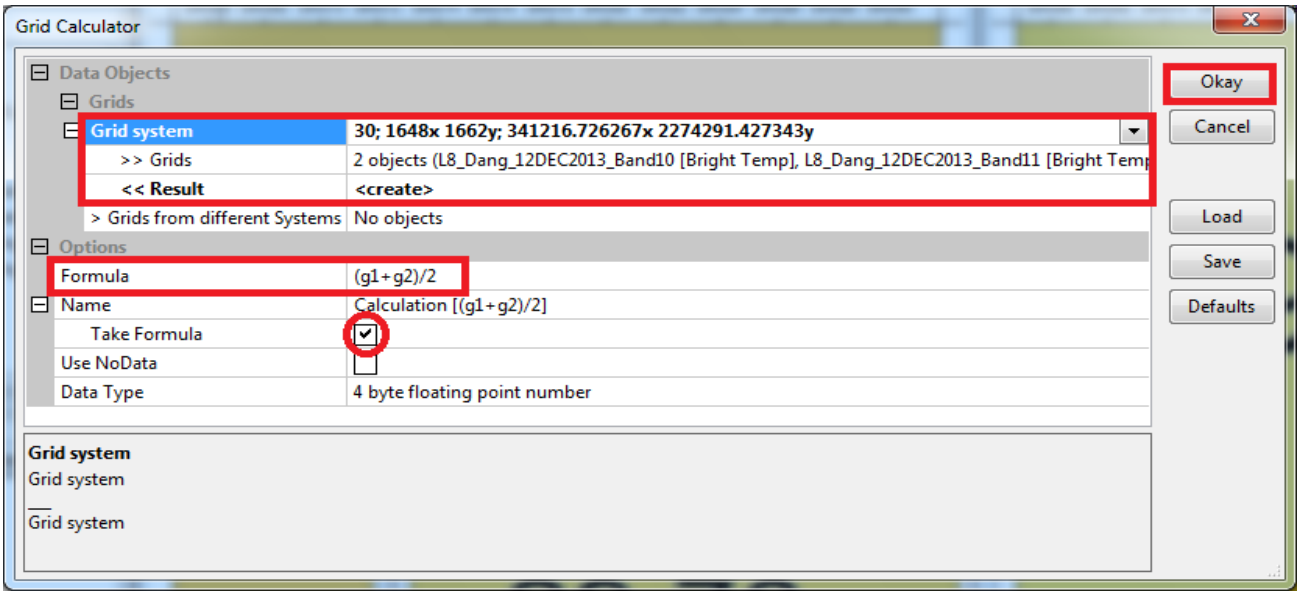
keep '*Results*' as '***<create>***'. Write '***(1321.08/ln((774.89/g1)+1))-273.15***' in '*Formula*' and ensure that '*Take Formula*' is checked in and Click '***Okay***'.



9. Rename the newly calculated grid as '***L8_Dang_12DEC2013_Band10 [Bright Temp]***'.
10. Similarly convert the spectral radiance of '*L8_Dang_12DEC2013_Band11 [Radiance]*' band to brightness temperature using K_1 and K_2 values and formula in step 7. Rename the grid as '***L8_Dang_12DEC2013_Band11 [Bright Temp]***'.
11. Open both brightness temperature images side by side and Zoom in to the pixel level and click on '***show cell values'*** option in *properties* window, to see the temperature difference within the image.



12. Now to get the final brightness temperature of study area, we need to take average of brightness temperatures of band10 and band 11. Once again open *Grid calculator* and select the inputs as shown in below snapshot to calculate the mean brightness temperature. Rename the calculated grid to '***Dangs_Bright_Temp_12Dec2013***' and prepare a map with proper color ramp.



Questions

1. What is the mean temperature recorded in The Dangs district on 2013-12-14?
2. What was the highest and lowest recorded temperature in The Dangs district of Gujarat on 2013-12-14?