



# Calculating Brightness Temperature using Landsat-8

Using SAGA GIS



Tutorial ID: IGET\_SA\_004

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## 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, <u>http://landsat.usgs.gov/Landsat8\_Using\_Product.php</u>

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  $\rightarrow$  File  $\rightarrow$  GDAL/OGR  $\rightarrow$  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  $L_{\lambda} = \text{TOA spectral radiance}$ (Watts/(m<sup>2</sup>\*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 <sub>L</sub>	3.3420E-04	0.100000	
$A_L$	3.3420E-04	0.100000	

3. Now we will use grid calculator 'Geoprocessing  $\rightarrow$  Grid  $\rightarrow$  Calculus  $\rightarrow$  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'.



Grid	l Calculator		
	Data Objects Grids		Okay
	E Grid system	30; 1648x 1662y; 341216.726267x 2274291.427343y	Cancel
	>> Grids	1 object (L8_Dang_12DEC2013_Band10)	
	<< Result	<create></create>	
	> Grids from different Systems	No objects	Load
Ξ	Options		Save
	Formula	3.3420E-04 *(g1) + (0.100000)	Jave
	Name	Calculation [3.3420E-04 *(g1) + (0.100000)]	Defaults
	Take Formula		
	Use NoData		
	Data Type	4 byte floating point number	
Na Te De	a <b>me</b> xt - fault: Calculation		.d

- 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,

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

Where,

T = At-satellite brightness temperature in Celsius

 $L_{\lambda}$  = 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 <sub>1</sub>	774.89	480.89
<i>K</i> <sub>2</sub>	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*'.

Grid Calculator								
	<ul> <li>Data Objects</li> <li>Grids</li> </ul>							
	E Grid system	30; 1648x 1662y; 341216.726267x 2274291.427343y	Cancel					
	>> Grids	1 object (L8_Dang_12DEC2013_Band10 [Radiance])						
	<< Result	<create></create>						
	> Grids from different Systems	No objects	Load					
	Options		Save					
	Formula	(1321.08/ln((774.89/q1)+1))-273.15	Jave					
	Name	Calculation [(1321.08/ln((774.89/g1)+1))-273.15]	Defaults					
	Take Formula							
	Use NoData							
	Data Type	4 byte floating point number						
>> Gri	>> Grids Grid list (input)							
	in formula these grids are addressed in order of the list as 'g1, g2, g3,'							

- 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.



	07. L8	_Dang_12D	EC2013_Bar	nd11 [B	right Temp]							06. L8 <u>.</u>	_Dang_12D	EC2013_	Band10	(Bright Temp	<b>)</b> ]			- 0	8
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	07. L8	_Dang_12D	EC2013_Bar	nd11 [B	right Temp]					٦İ	<b>3</b>	06. L8	_Dang_12D	EC2013_	Band10	[Bright Temp	<b>b</b> ]			- 0	8
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231164	6.90	27.73	3 28	.36	28.79	29.17	29.3	7 29.2	27	231164	231164	7.01	27.52	2	28.13	28.69	29.0	17 29	.20	29.18	231164
11600 2311620	7.07	27.8	9 28	.51	29.02	29.42	29.6	1 29.5	58 -	11600 2311620	11600 2311620	7.11	27.67	7	28.32	28.93	29.3	16 29	.58	29.63	H1600 2311620
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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.

Grid Calculator								
<ul> <li>Data Objects</li> <li>Grids</li> </ul>		Okay						
Grid system	30; 1648x 1662y; 341216.726267x 2274291.427343y	Cancel						
>> Grids	2 objects (L8_Dang_12DEC2013_Band10 [Bright Temp], L8_Dang_12DEC2013_Band11 [Bright Tem;							
<< Result	<create></create>							
> Grids from different Systems	No objects	Load						
Options		Save						
Formula	(g1+g2)/2	Jave						
E Name	Calculation [(g1+g2)/2]	Defaults						
Take Formula								
Use NoData								
Data Type	4 byte floating point number							
Grid system								
Grid system								
Grid system								

#### 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?

