



Understanding an image

Using SAGA

Tutorial ID: IGET_RS_002



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Understanding an Image

Objective: To understand basic characteristics of a satellite image.

Software: SAGA GIS (6.4.0)

Level: Beginner

Time required: 1 Hour

Prerequisites and Geospatial Skills

1. SAGA GIS should be installed on the computer
2. Basic knowledge about the SAGA interface
3. Should have completed Exercise ID: IGET_RS_001

Reading

1. Digital image, <http://www.crisp.nus.edu.sg/~research/tutorial/image.htm>
2. Landsat bands, http://landsat.usgs.gov/band_designations_landsat_satellites.php,
http://landsat.usgs.gov/best_spectral_bands_to_use.php

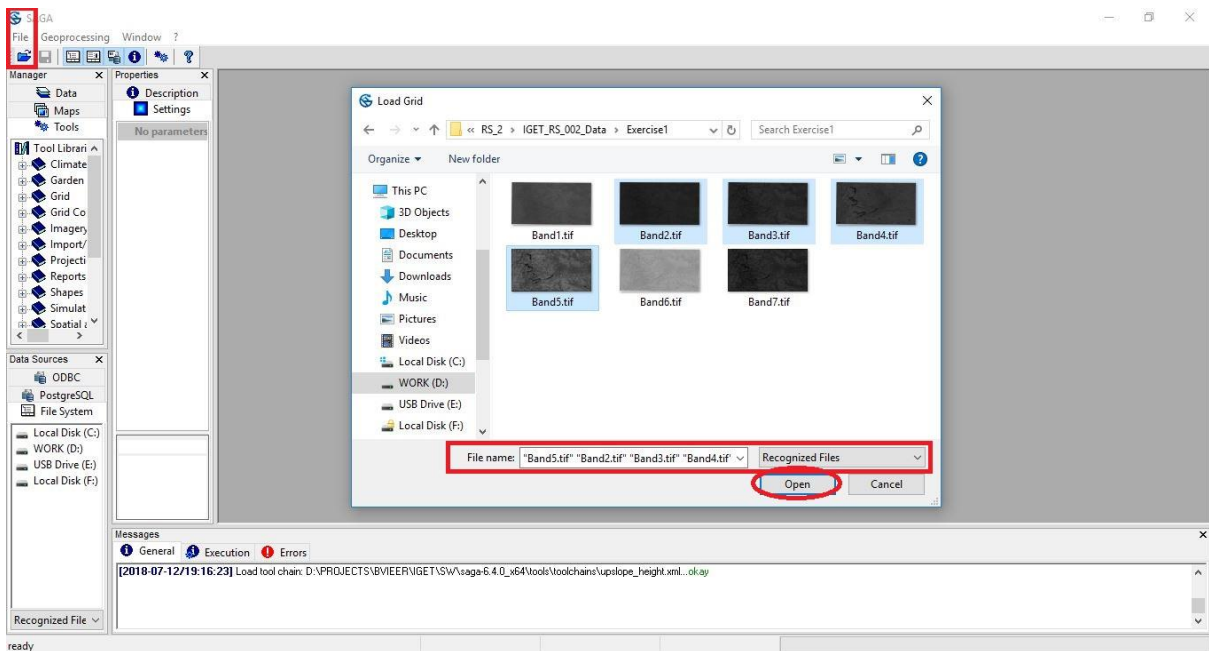
Tutorial dataset: http://dst-iget.in/tutorials/IGET_RS_02/IGET_RS_002_Data.zip

Introduction

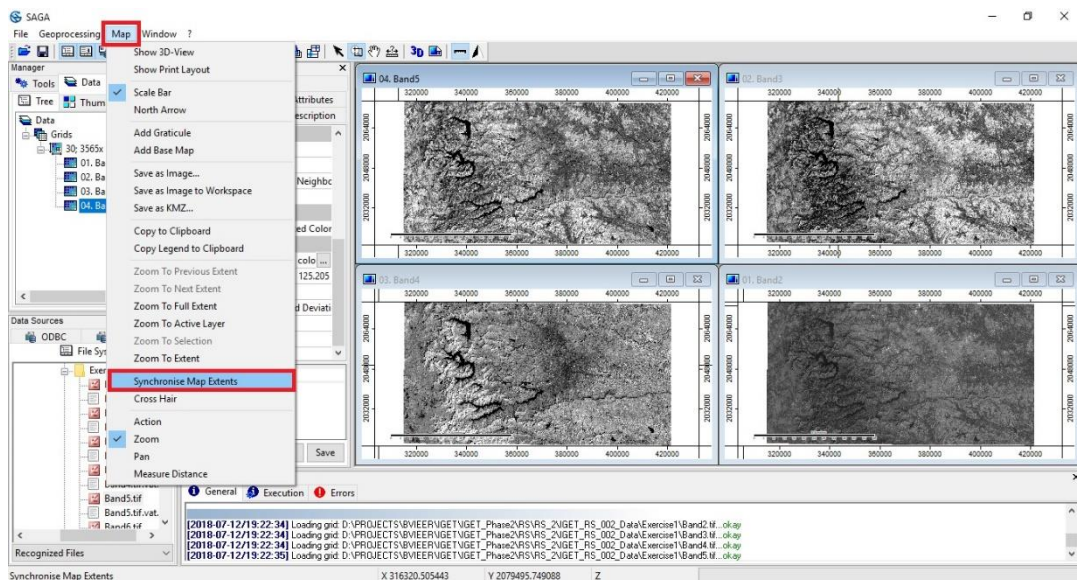
Satellite or airborne digital images are composed of a two-dimensional array of discrete picture elements, known as pixels. Generally, the pixels in remote sensing images are in square shape. The corresponding length of a side of the pixel on earth surface is known as ground sampling distance or simply 'spatial resolution'. Each pixel is associated with a spectral brightness value (also, *known as Digital Number, simply 'DN'*) of corresponding ground feature. These DN values are a quantized spectral radiance¹ of a specific wavelength received at the sensor. The value range of Digital numbers in an image is determined by the radiometric resolution. For example a sensor with 8-bit radiometric resolution permits maximum 2^8 i.e., 256 DN values (brightness values or gray scale levels) ranging from 0–255. A pixel with high DN value represents that the sensor received high spectral radiance from the corresponding ground area of the pixel and vice versa. In order to acquire sufficient spectral information of an objects on the earth surface, a set of sampling wavelengths in the electromagnetic spectrum are used. The sensor will record the DN values which are specific to these sampling wave lengths. Therefore, each sampling wavelength will result an array of pixels and is known as a *band of satellite image*. If a sensor uses one wider wavelength range (i.e, $\approx 0.4 \mu\text{m}$ to $0.7 \mu\text{m}$) to measure the spectral response characteristics of an area, then it records all the information into one single image band, such sensors are known as '*panchromatic sensors*' and the satellite image is known a '*panchromatic satellite image*'. A *multispectral sensor* collects the spectral information using few number of sampling wavelengths in electromagnetic spectrum, hence it is a multi-layer (multi band) image. For example, Landsat-8 sensor records the spectral information in eleven image bands, for more information please refer http://landsat.usgs.gov/band_designations_landsat_satellites.php. In this tutorial we will use Landsat Thematic mapper sensor data to understand few basic data characteristics of multispectral images.

1. Download the tutorial dataset from [IGET portal](#) and unzip it into a convenient location. The tutorial dataset contains of two folders exercise 1 and 2. The folder of exercise one contains seven spectral bands of '*Landsat thematic mapper*' sensor pertaining to Pune city area. From this dataset, load Band2, Band3, Band4, and Band5 image bands into SAGA GIS.

¹ Spectral radiance is the radiant power emitted or received or reflected by a unit surface per unit solid angle per unit wave length.



2. To view image bands double click on the Image bands under **'Data'** tab in **'Manager'** section. In order to open them in separate viewers, make sure to select option **'New'** in **'Add layer to selected map'** window when it prompts. And change the colour ramp to grey scale (Refer: IGET_RS_001 for help).
3. Before proceeding further, tile the viewers via, **'Windows → Tile Horizontally'**. And synchronize the extents via, **'Map → Synchronise Map Extents'**.

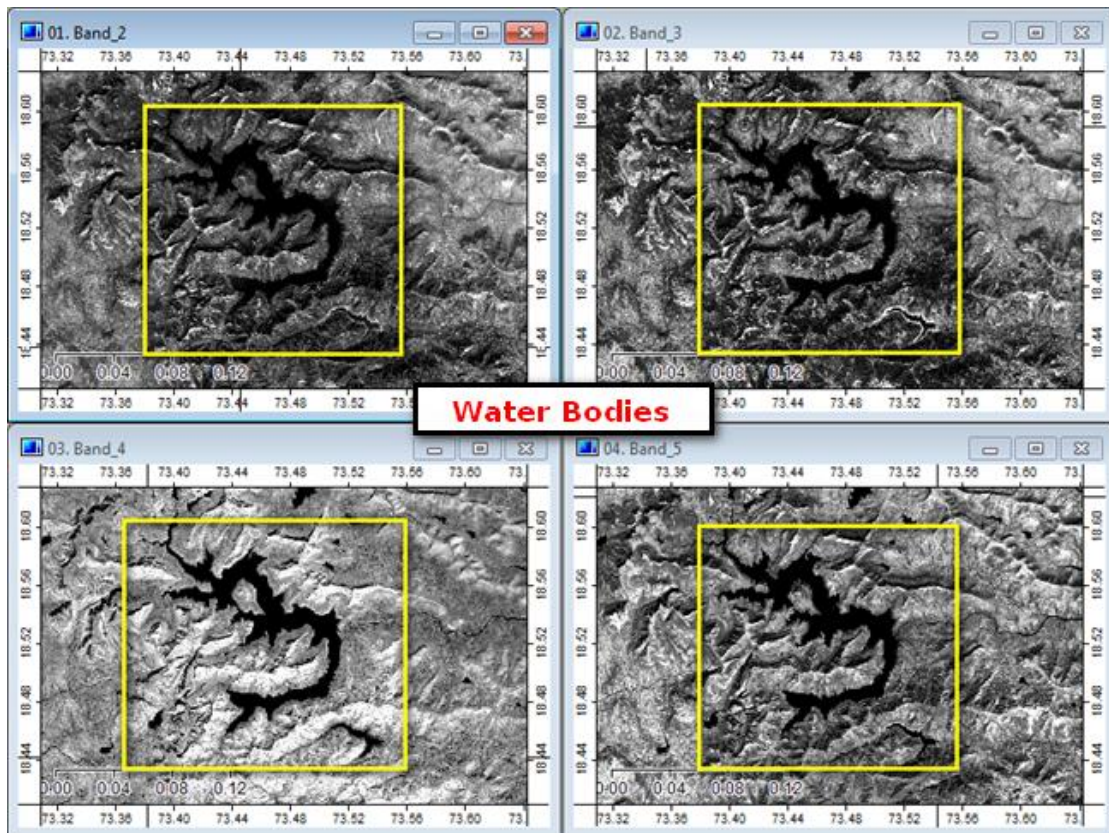


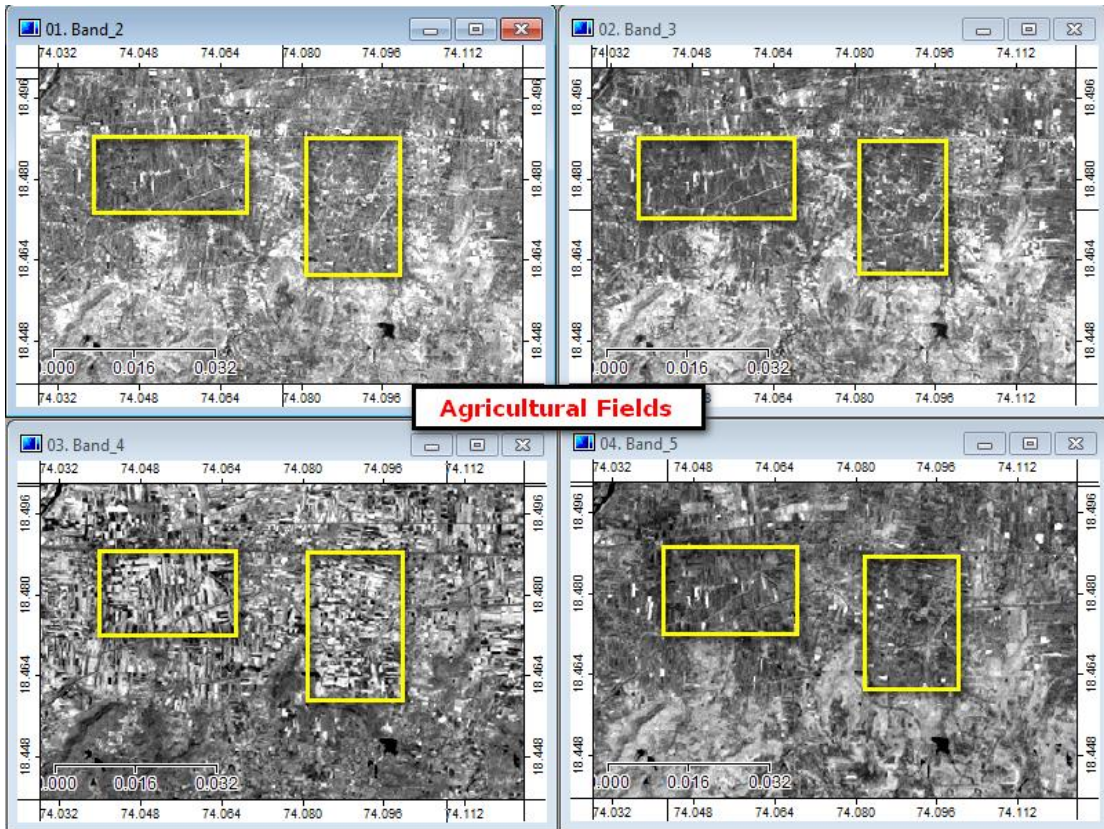
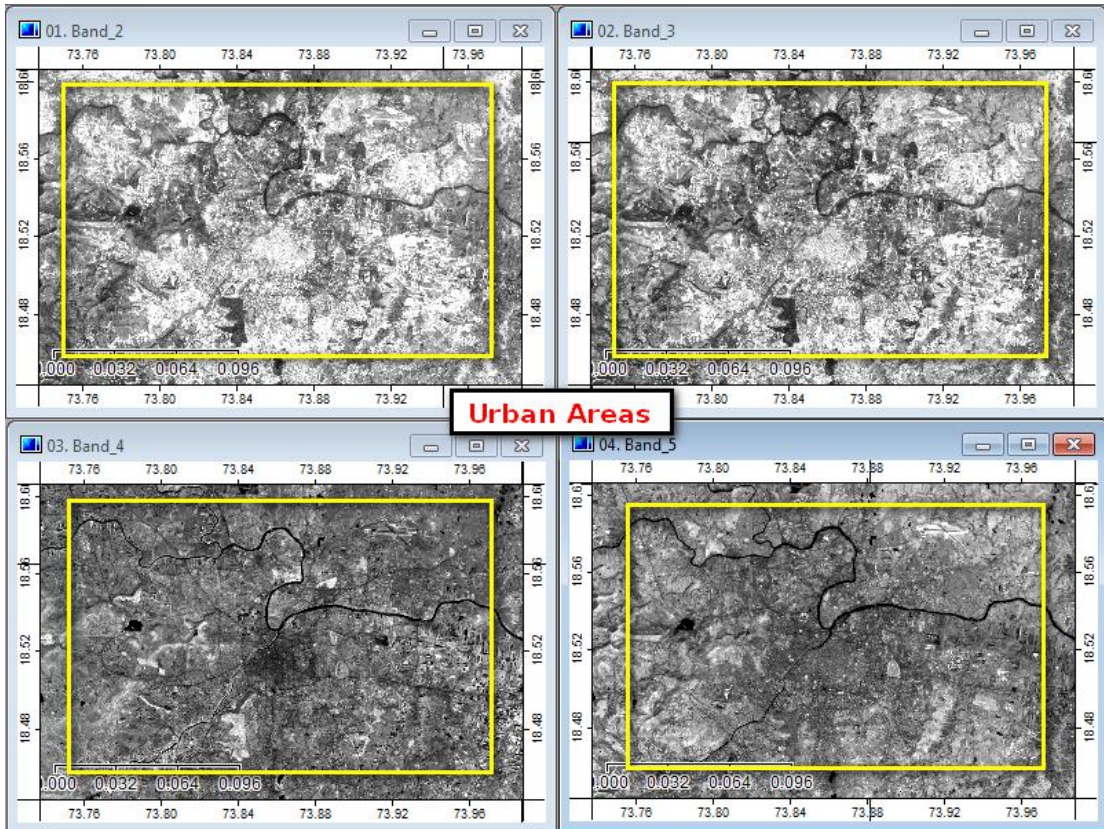
4. The dataset using in this tutorial is pertaining to the same area of [IGET_RS_001](#) tutorial. So we would request you to have a look at IGET_S_001 tutorial before proceeding further.

- If a grey scale (Black to white) colour ramp used to represent the image. Then black colour represents less, grey colour represents medium and white colour represents high spectral returns from the earth surface features. Zoom to various land-cover classes i.e., water, urban areas, and agriculture etc., and try to explore the brightness values (DN) in terms of spectral response of land-cover classes for the individual bands. Write down the relative spectral response as 'low', 'medium' or 'high', for the different land cover classes and spectral bands (For help refer step no: 8 to 17 of IGET_RS_001).

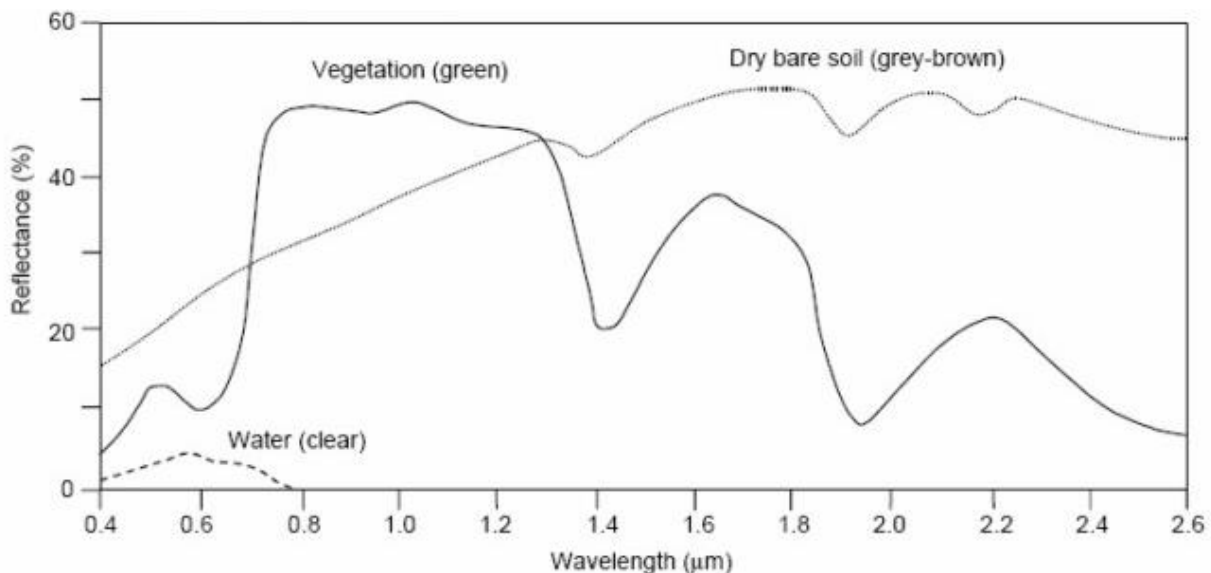
	Water	Urban Areas	Agriculture
BAND 2			
BAND 3			
BAND 4			
BAND 5			

Table 1: Fill in the table with classes: low, medium and high.





You can use spectral reflectance curve to explain the spectral variance of various land cover features on the surface of earth as function of wave length.



Band Statistics

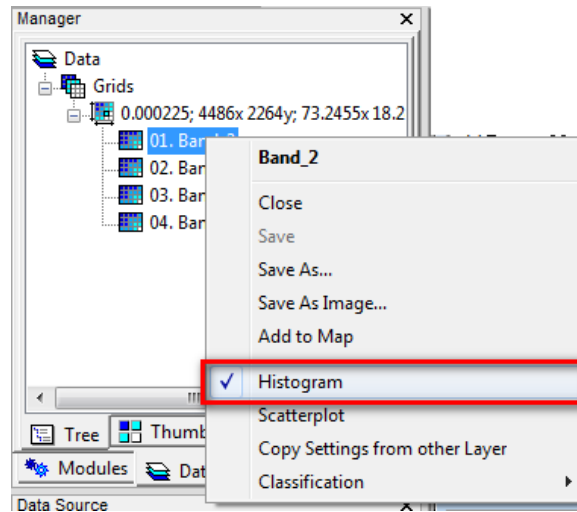
The distribution of brightness values (DN values) in a single band can be represented graphically using a *histogram*. The correlation between two (or more) bands can be assessed graphically by using a *scatter plot*. Large negative values indicate a strong negative correlation where as large positive values indicate strong positive relation and covariance values near to zero indicate no correlation. In this section, we will explore the image band data characteristics by using graphical methods.

Graphical Representation

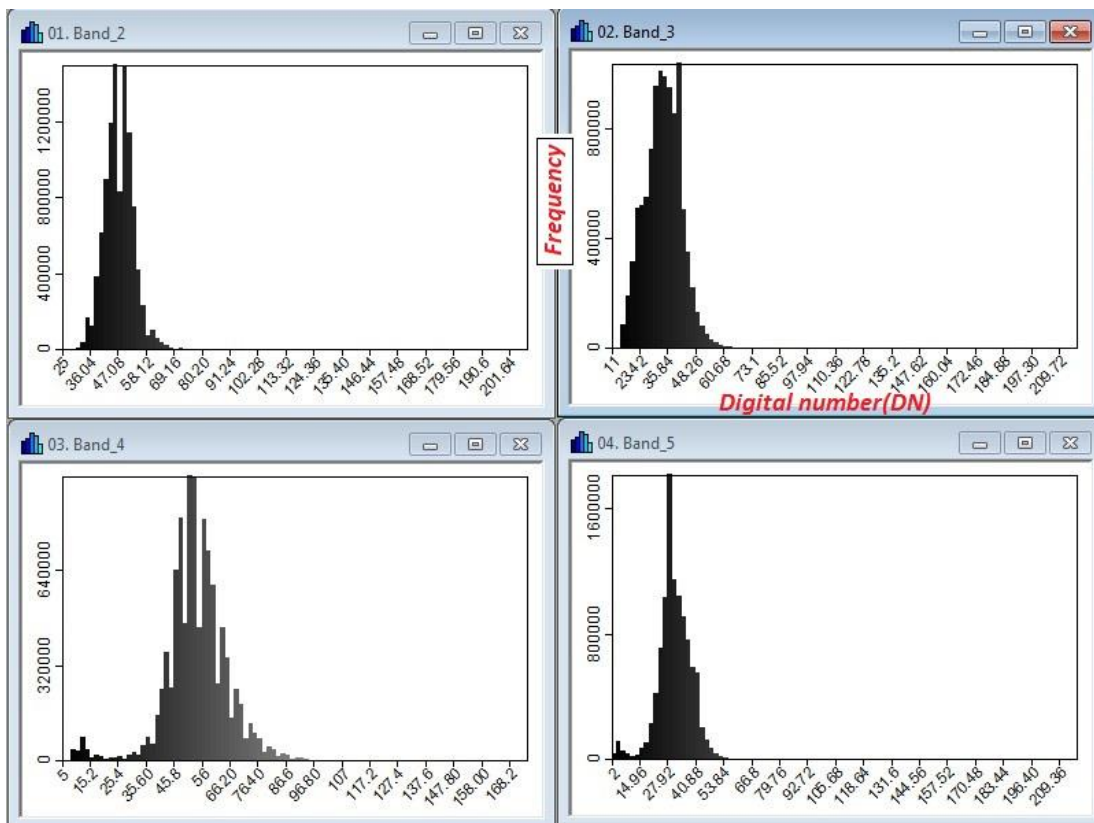
Histogram

The study of histogram provides initial information about the most important parameter of an image, i.e., contrast. Histogram is a frequency distribution function of DN values, which provides the information about number of pixels having a particular Digital Number. It can describe an image just in statistical terms without even explaining its spatial patterns.

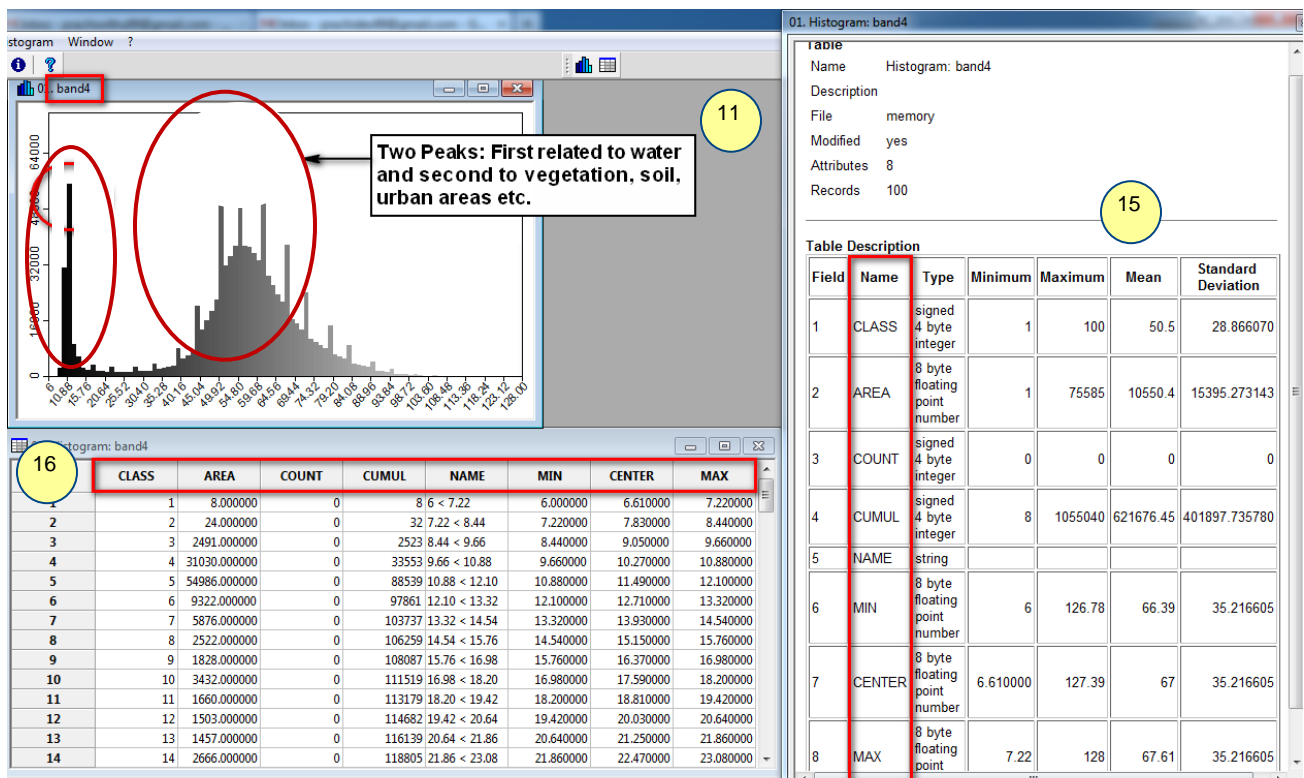
6. Histogram can be calculated for each band by just *right clicking* on the image band under *Data Tab* in *Manager* section, and select '*Histogram*'. A new window will popup showing the histogram of the image band selected.
7. You can zoom in or out of the histogram extent using scroll key of mouse and also by dragging mouse with left data button and reset by right data button of mouse.



8. Follow similar steps to open up histogram for rest of three bands. Open four windows simultaneously side by side to see the frequency distribution of DN values in each band.
9. All the four image bands cover the same area with same extent. However, you can see different shape and sizes of band histograms. As explained earlier these differences are due to objects ability to respond differently with different spectral wavelengths.



10. Now we will go in detail about, how histogram will help us to analyze an image at pre-processing level? And what information this histogram can provide? To do this, load the 'Band4Clip' image band from the folder of *Exersice2* in tutorial dataset into SAGA GIS. Change the color ramp if necessary. Now repeat step 6 to open the histogram for the *Band4Clip*. Zoom out to get full extent of the histogram.
11. Unlike the previous histograms what mainly will capture your attention in this histogram pattern? It is having two prominent peaks (Refer the figure shown below).
12. This type of histogram pattern is termed as bimodal histograms. Histogram is bi-modal or n-modal depending on two or n-reflective maxima, corresponding to 2 or n groups of objects with similar digital numbers.
13. As explained earlier the DN values are smaller for weaker spectral responses and vice versa. If the digital numbers are represented using grey colour ramp i.e., black to white scale, then black colour represents less, grey colour represents medium and white colour represents high spectral return from the earth surface features. If we consider the histogram for 'Band4Clip' image (As shown below), the first peak represents water bodies because water has very low reflectance in near infrared band(NIR) and the second peak represents the rest of the features which comparatively have higher reflectance in NIR band.



14. Now we will convert this histogram to a table to have a deeper look of data in image band. Goto '**Menu Bar → Histogram → Convert to Table**'. A histogram table would be added to data list. *Double click* on it to open in a viewer.
15. Check out for attributes of the table and what does it imply? You can find more details about this attributes in **Description Tab of Object Property Window**.
16. The table gives the detailed information regarding cumulative frequencies and total area covered by particular pixel classes.
17. Do similar analysis for the image bands provided in folder of *exercise 1* and note down the values of following parameters.

Along with histogram there are other parameters such as Arithmetic mean, mode, Median, variance, Standard Deviation etc. as well; which summarizes the image's grey level / contrast. We will look into some of them

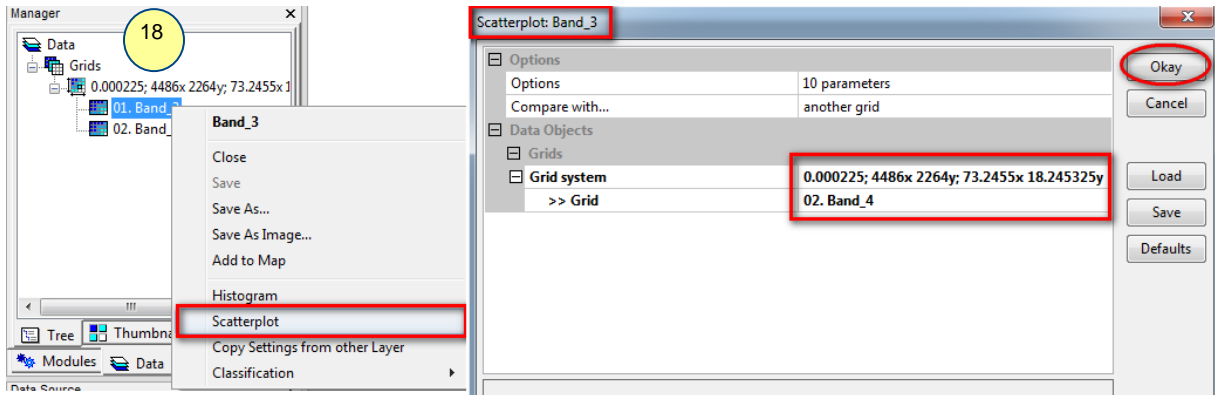
- a. **Arithmetic Mean:** corresponds to the mean brightness of an image band.
- b. **Mode:** It is defined as events occurring most often in a distribution. In the image band histogram mode refers to the pixels with particular DN value which is having higher frequency of occurrence.
- c. **Median:** It refers to the value which is occupying central position.
- d. **Variance:** The variance analysis refers to the variation in spectral radiance levels with respect to mean value in the image band. It is mainly used to find if the image contrast is high or intermediate or low.
- e. **Standard Deviation:** Standard deviation measures the tendency of dispersion of a distribution from the center i.e. it measures how dispersed the distribution is. It is calculated as square root of variance and generally used to measure dispersion of values around the arithmetic mean.

1.1.2 Scatterplot

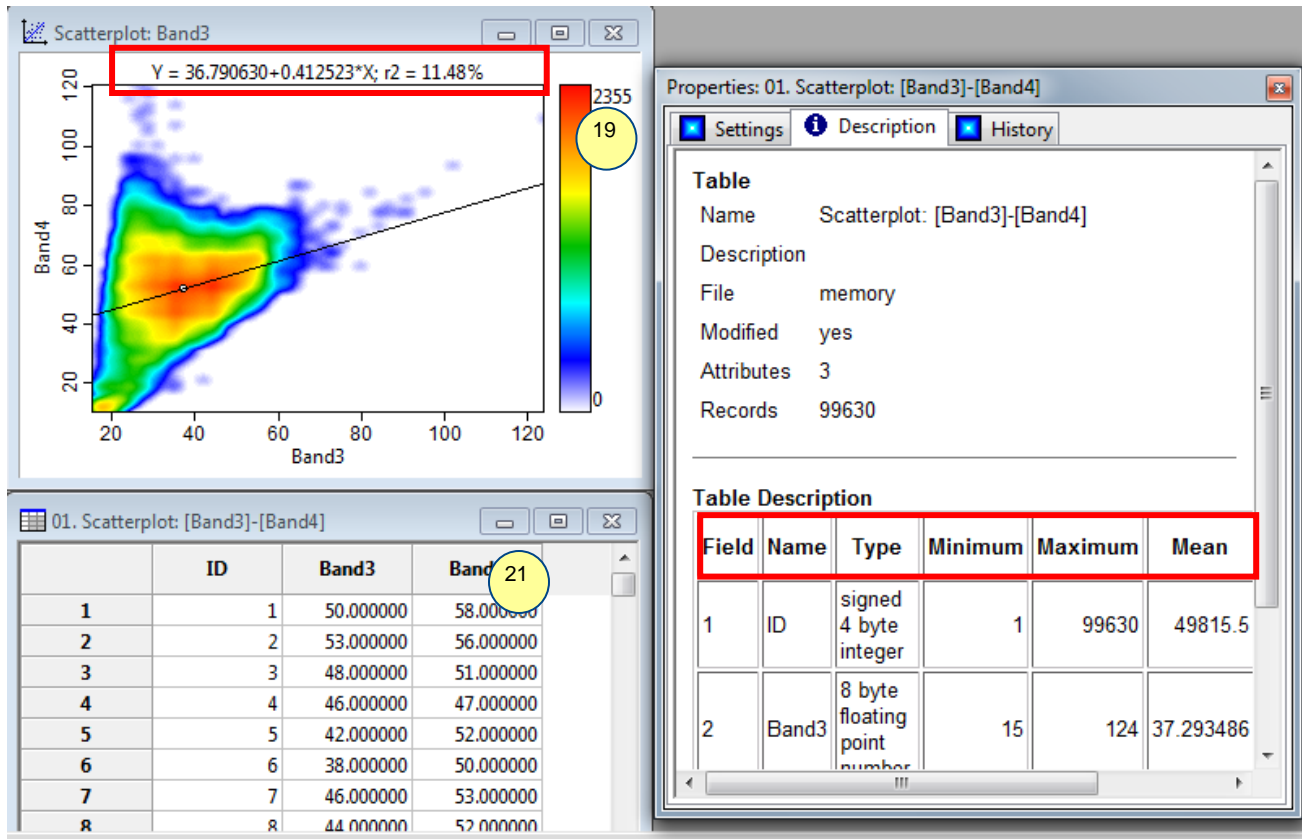
A scatterplot is simply a graph of the DN values of one band plotted against the DN values of another band. If the DN values in the image bands follows normal distribution, then the corresponding feature space of scatterplot will form an ellipse. The feature space in scatter plot is very useful to select the training samples and also helpful to for principal components. In a Bi-dimensional scatterplot, the Cartesian axes (X, Y) represents the Digital Numbers of the

two bands in interest, Z axis represents the frequency of occurrence of certain phenomenon. In this section we will learn how to construct scatterplot.

18. Right click on *Band3* under *Data* tab in *Manager* section and select **Scatterplot**. It will prompt a new window, now select options as shown in below figure and click 'OK' .



19. Now you can see the scatterplot of Band3 vs Band4 in a map layout. The X axis of scatterplot represents Band3 while y-axis represents Band4. It also gives the regression equation between the two bands along with correlation coefficient.



20. As previously done for histogram, we can compute the scatter plot data in form of table. Goto *'Menu bar → Scatterplot → Convert to Table'* and have a look at mean, minimum, maximum, standard deviation values using the description table of object properties window.