Practical Manual

for

ILWIS Open - Image Processing Software

&

QGIS - GIS Analysis Software

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ILWIS Open

ILWIS

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1. Introduction

Integrated Land and Water Information System (ILWIS) is a geographic information system (GIS) and remote sensing software for both vector and raster processing. The ILWIS software was made commercial with ITC establishing a worldwide distributors network. Since July 1, 2007, ILWIS has been distributed as open source software under GPL license (FOSS4G, 2007). Now the developer of the ILWIS is 52°North ILWIS Community.

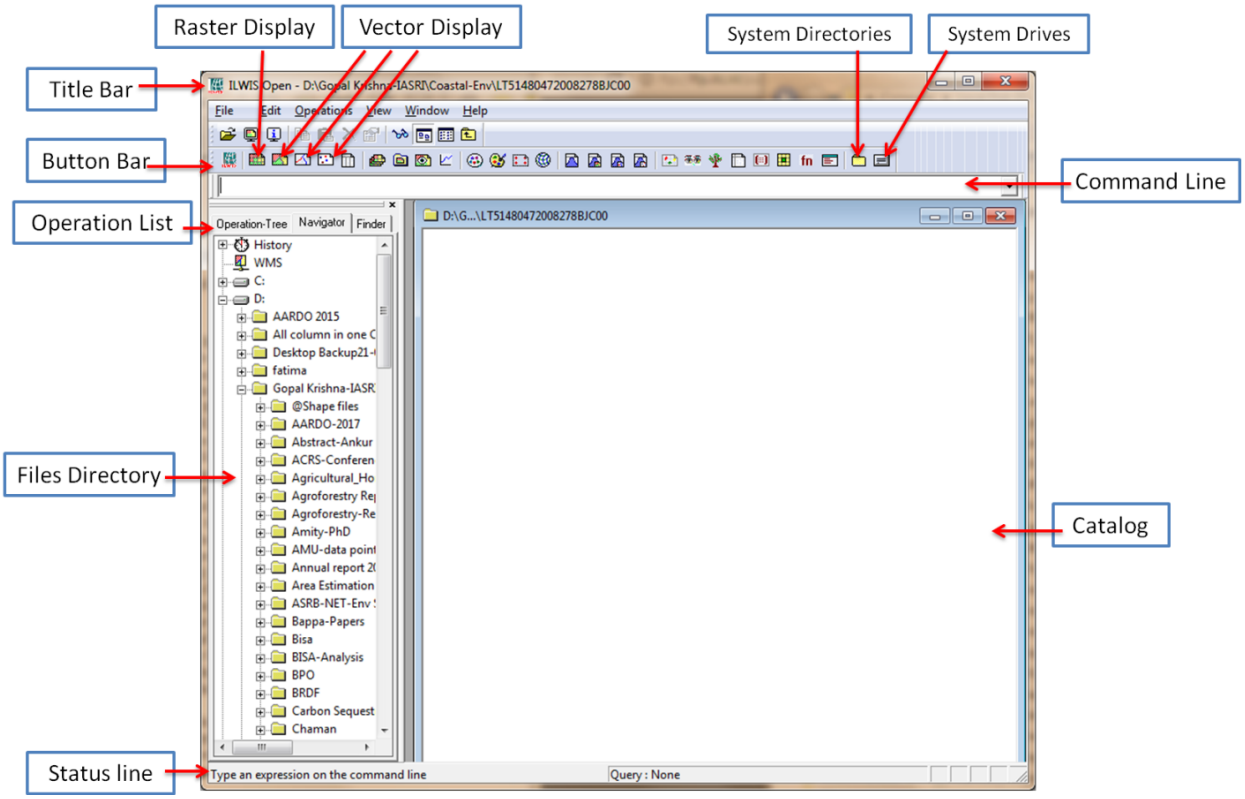
ILWIS combines remotes sensing and GIS capabilities, enabling us to create geospatial data, extract the most information and update our existing GIS data. ILWIS allows processing images and extracting the information. ILWIS simplifies classification, orthorectification, mosaicking, reprojection and image interpretation, while maintaining the integrity of the geospatial data for updating our GIS in multiple formats.

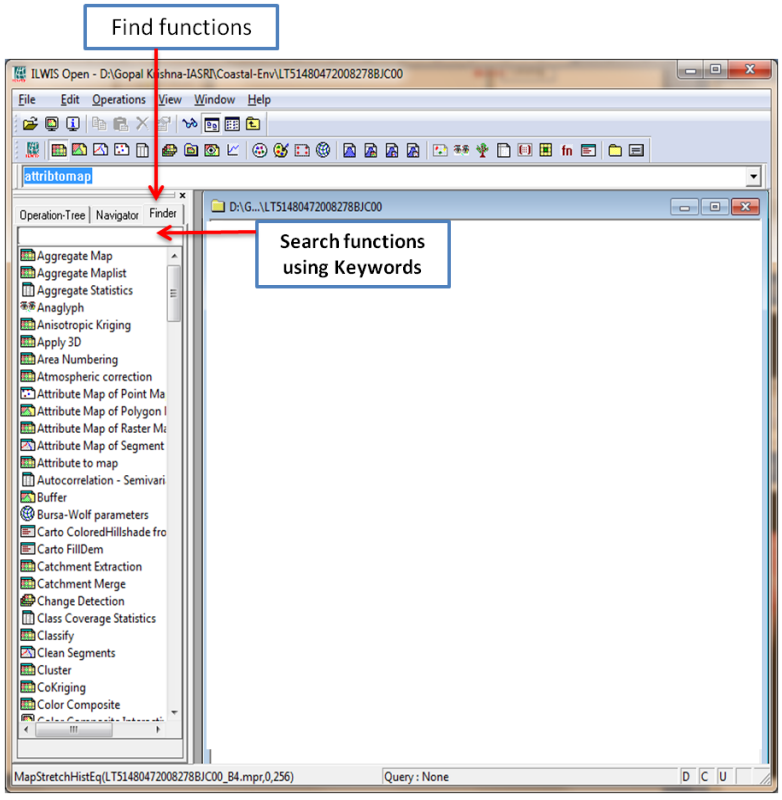
Key features of ILWIS open are-

- Integrated raster and vector design
- Import and export of widely used data formats
- On-screen digitizing
- Comprehensive set of image processing tools
- Orthophoto, image georeferencing, transformation and mosaicing
- Advanced modeling and spatial data analysis
- 3D visualization
- Animation framework (with optional 3D)
- Auto resampling of different spatial geometries
- Extensive tool set for visual analysis
- Rich projection and coordinate system library
- Geo-statisitical analyses, with Kriging for improved interpolation
- Production and visualization of stereo image pairs
- Spatial Multiple Criteria Evaluation
- Web Mapping Service (WMS)
- Web Processing Service (WPS)
- Hydrological modelling
- Surface Energy Balances
  (Source: 52 North community and ITC, The Netherlands)

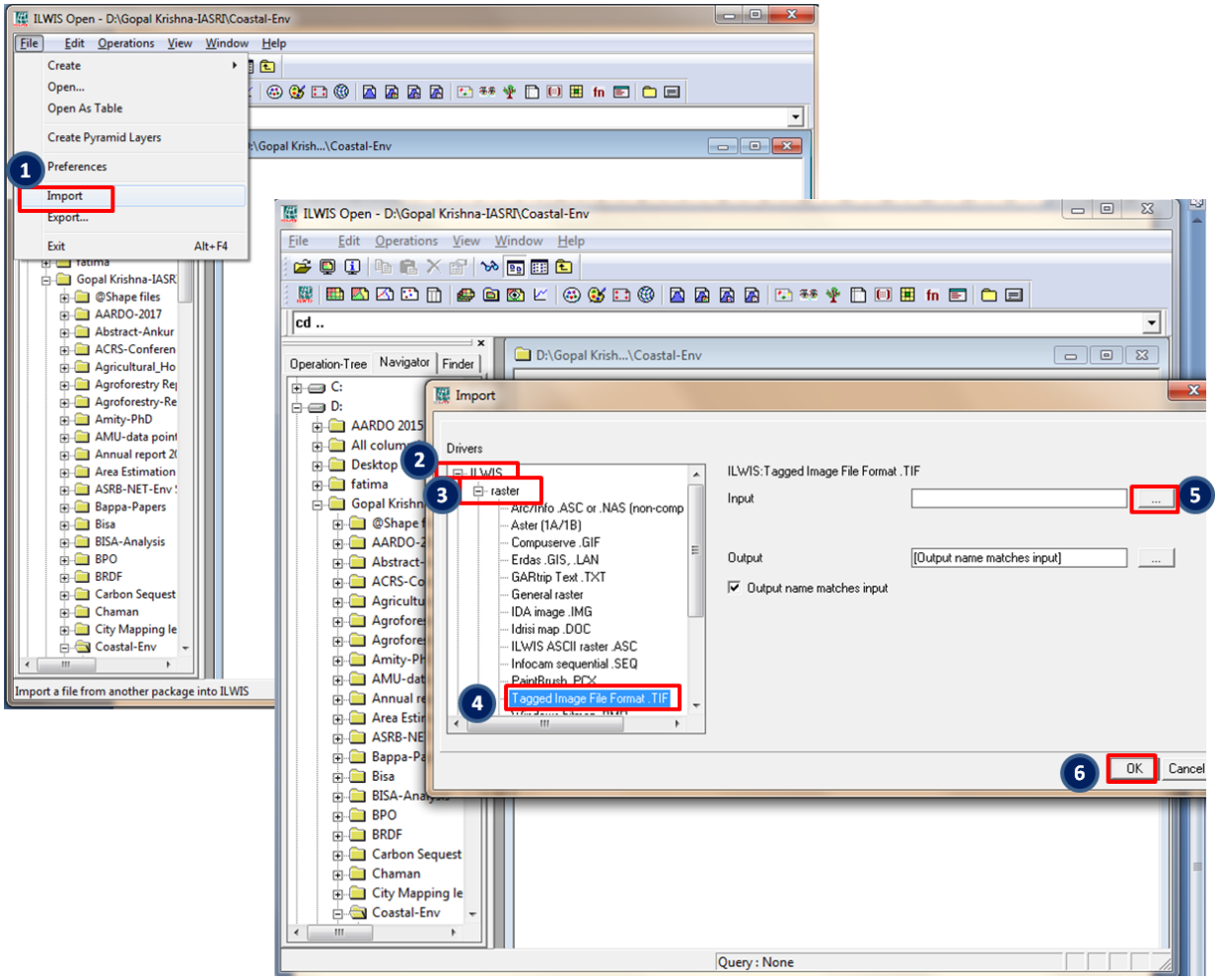
This manual extends image processing and interpretation operations like import of raster data, false colour composite creation, image enhancement techniques, georeferencing, vector layer overlaying on raster, submap/subet creation and image classification.

2. ILWIS Open Image Processing Software - Graphical User Interface





3. Import and Display of Raster Image



Steps:

1. Click on *import* option given in *File* drop down menu
2. In the Import window, click on + button before *ILWIS*
3. Then click on + button before *raster* and
4. Then select *Tagged Image File Format* (TIF)
5. Click on the *Input button* and choose the band of image you want to import
6. Click *ok.*

This will import an imagery band in catalog. The imported band into catalog shows four files-

.mpr – Raster Map (for image band visualization)

.his – Histogram file (for histogram information)

.grf – Georefence information file

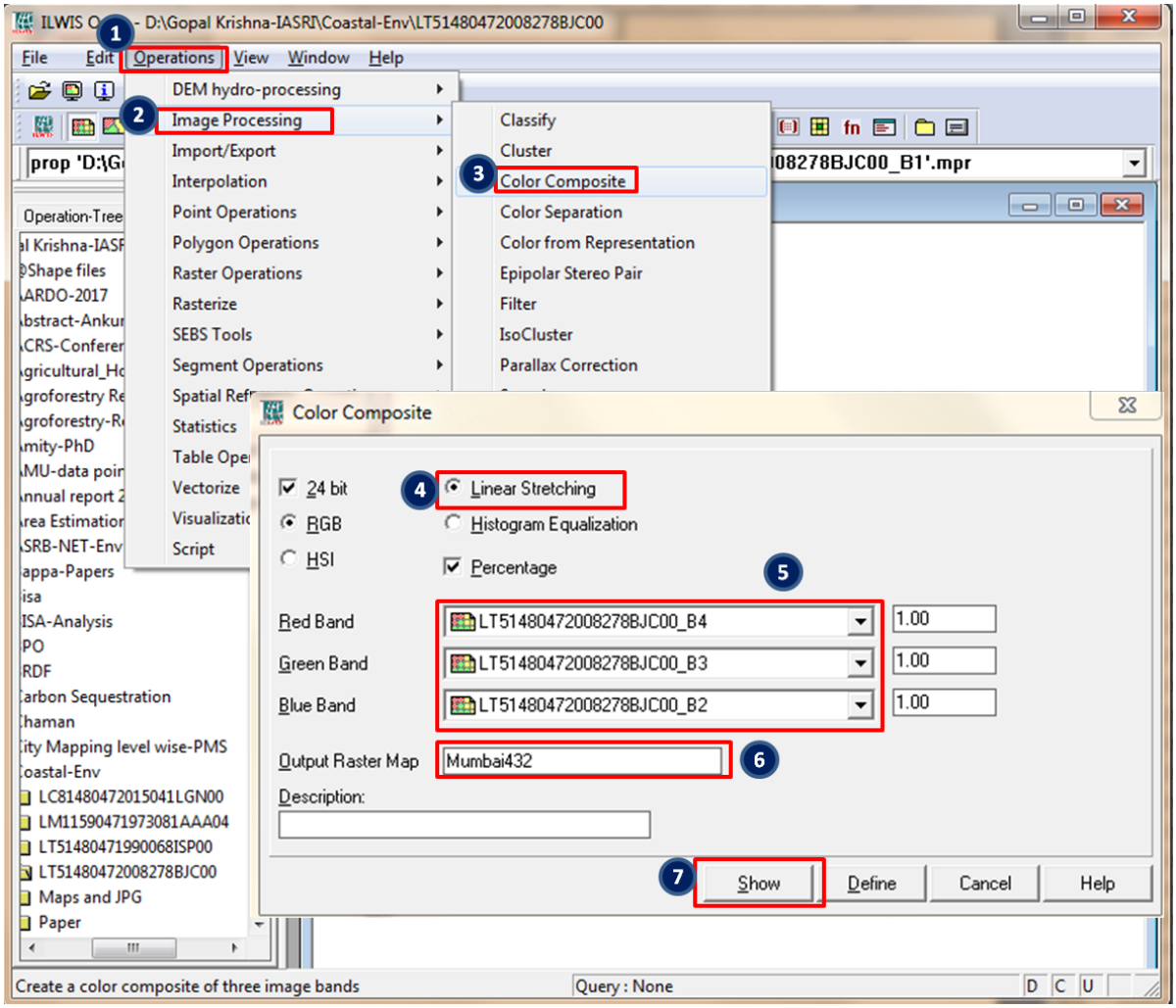
.csy – Coordinate system file (Projection, Datum, Ellipsoid information)

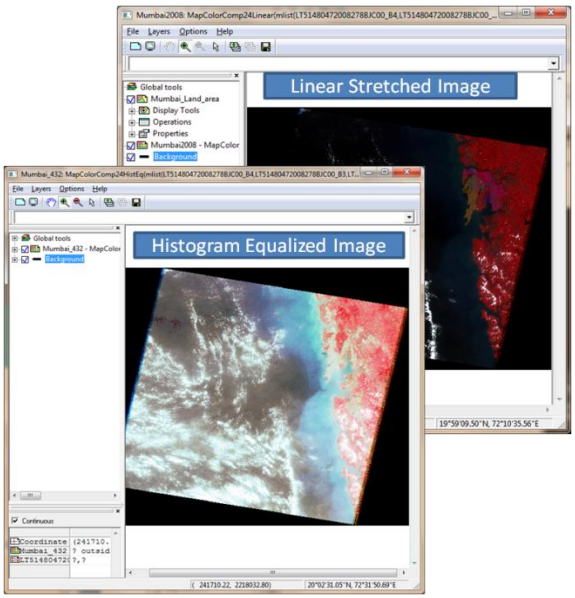
Now click on Raster map button. This is a ***.mpr*** file that has been imported in native format of ILWIS. Right click on this file and choose properties. Here the information about this image band is given. The information contains projection information, number of lines & columns, pixel size and four extreme coordinate values.

Repeat above process for importing Band 4, Band 3, Band 2 and Band 1 of the Landsat data.

3.1 Opening RGB colour composite (FCC) image-

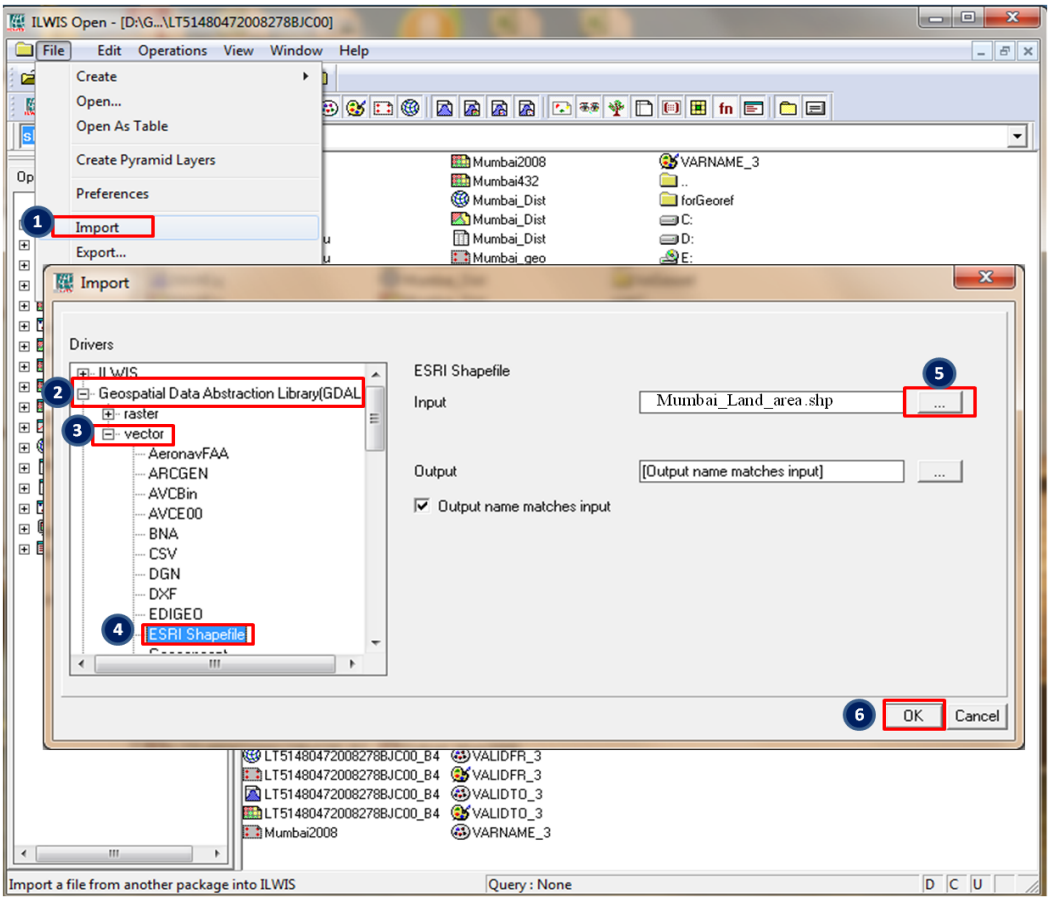
Follow the steps given below-





- Using *Colour Composite* option of *Image Processing* drop down menu, RGB false colour composite (FCC) can be displayed through *Linear Stretching* and *Histogram Equalization* options.

4. Overlaying Vector data (Shapefile) on raster image FCC



Steps:

1. Go to *Import* option of *File* drop down list.

2. In the import window click + button in front of *Geospatial Data Abstraction Library (GDAL)*

3. Click + button before *vector*.

4. Select *ESRI Shapefile*.

5. In front of Input a button is given. Click on that and choose Mumbai_Land_area.shp file.

6. click on *Ok*.

Above process will import shapefile in ILWIS catalog. The imported shapefile into catalog shows three files-

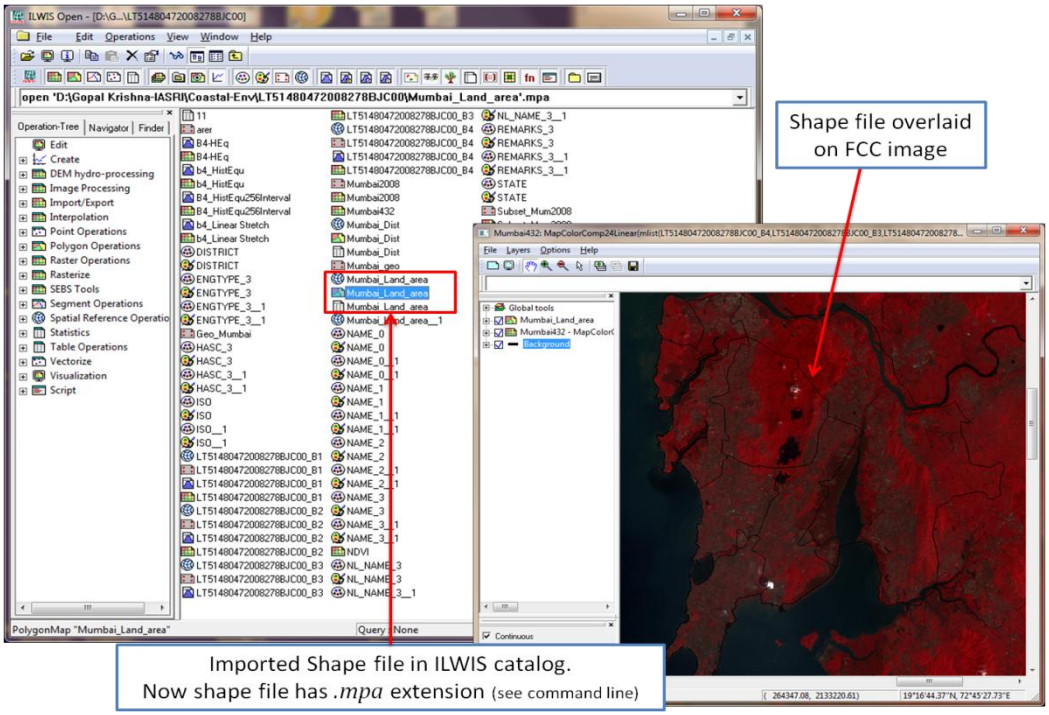
.csy - Coordinate system file (Datum & Ellipsoid information)

.mpa – Polygon map

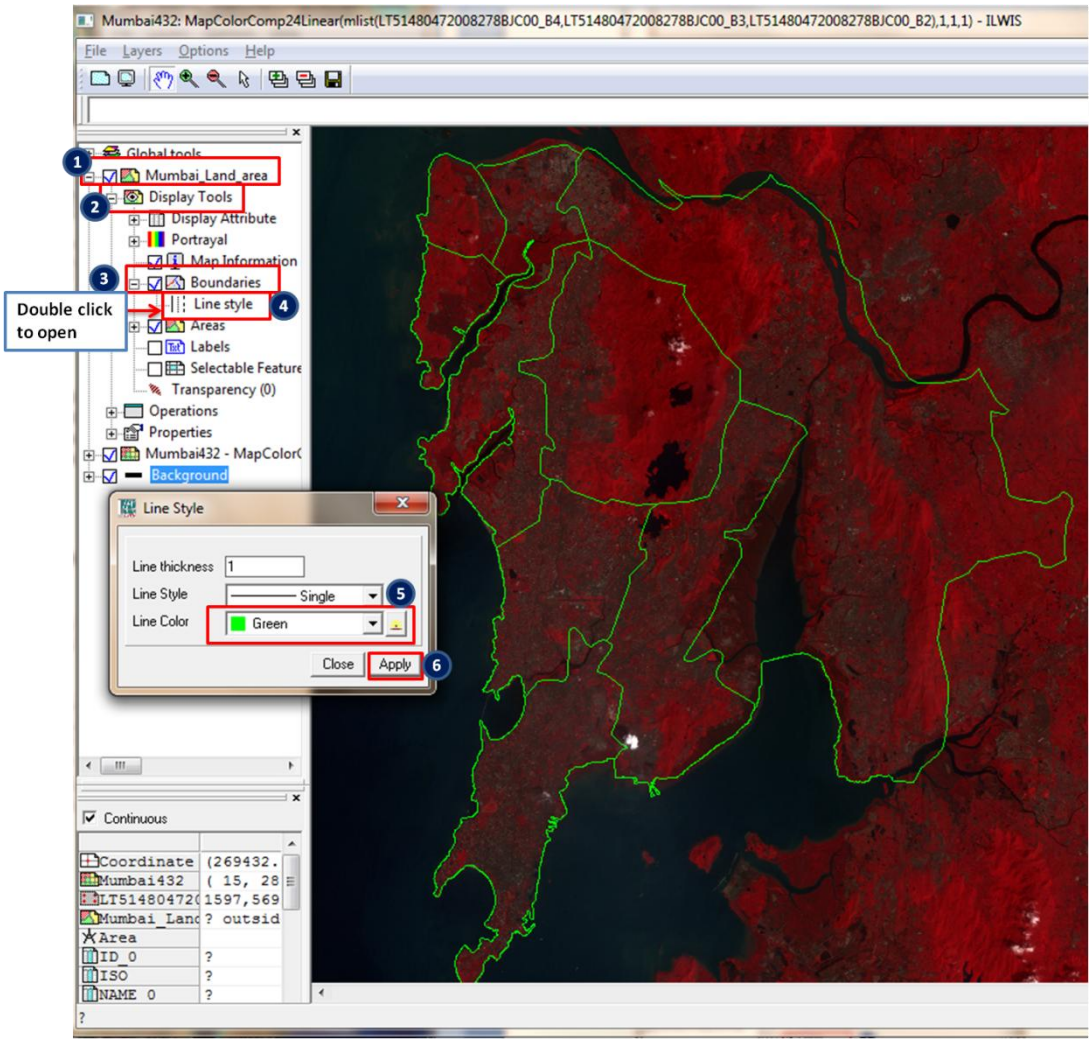
.tbt – Attribute table

In the ILWIS cataolog window, Identify the Mumbai_Land_area fie having  icon and selection of this file will show “Mumbai_Land_area’.mpa written in command line.

Simply drag "Mumbai_Land_area.mpa***" file into the window in which colour composite image "Mumbai432" is already opened.***



5. Steps for changing colour of the shape file polygon for better visualization



Steps:

1- Click the + sign near *Mumbai_Land_area*

2- Click the + sign near *Display Tools*

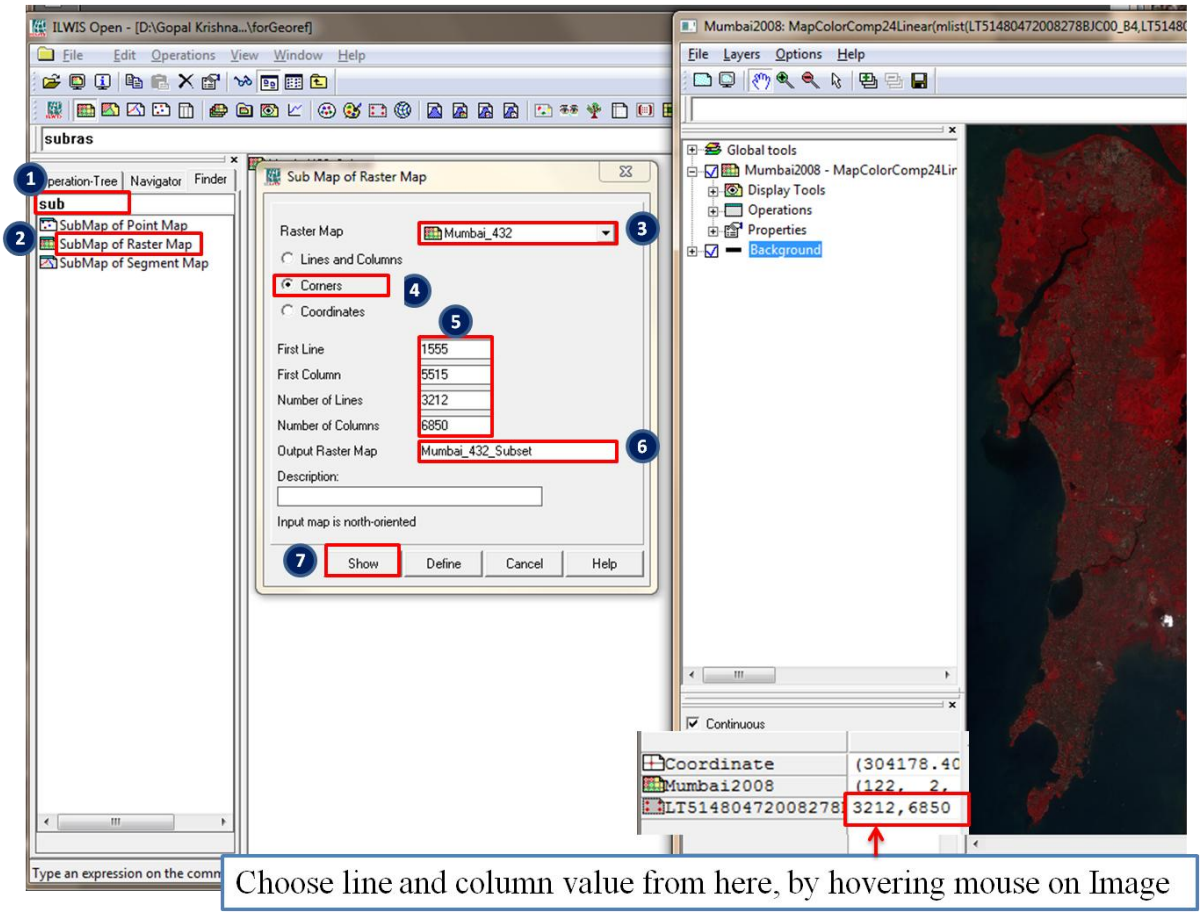
3- Under *Display Tools*, Click the + sign of *Boundaries*. This will open *Line style* option.

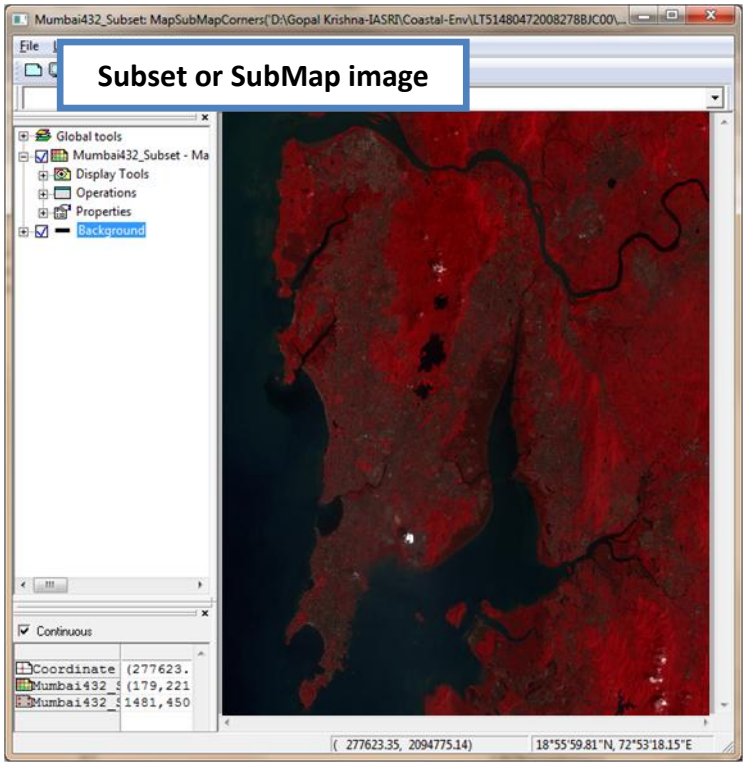
4- Double click on *Line style* and

5- Choose a colour from drop down menu.

6- Click *Apply*.

6. Extracting a SubMap/Subset of image (Area of Interest)

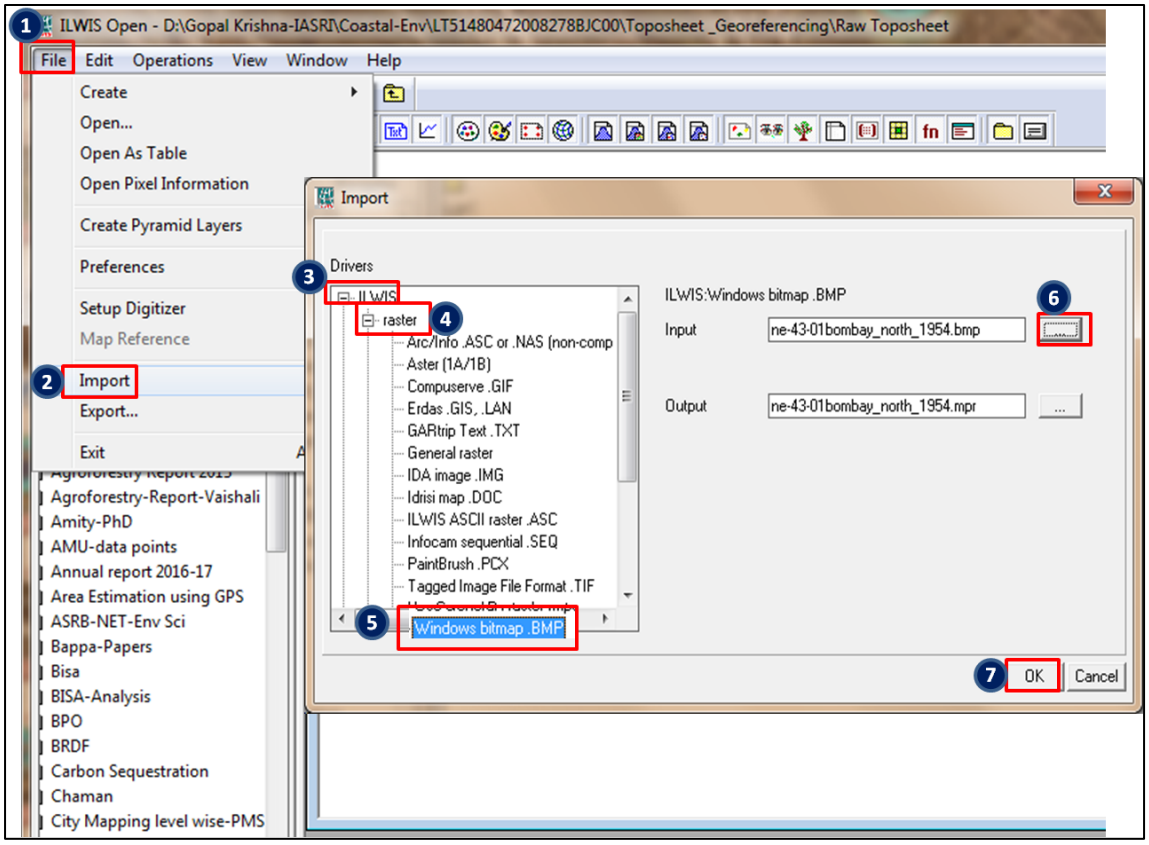




7. Georeferencing

Before starting the georeferencing of a toposheet, we have to reach the folder through *Navigator* of ILWIS where our toposheet named as "ne-43-01bombay_north_1954.bmp" is located.

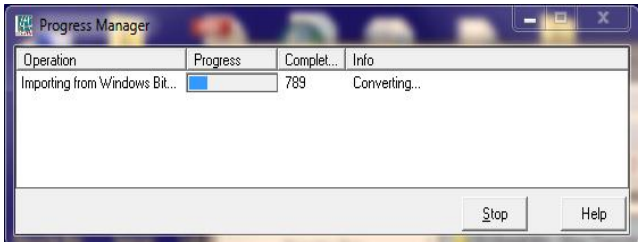
(i) Importing Toposheet (.bmp file) in ILWIS environment-



Steps:

1. Go to *File* option in Main menu.
2. Click on *Import* option
3. In the *Import* window, click + sign near *ILWIS.*
4. Click + sign near *raster* and
5. Select *Windows Bitmap .BMP*
6. Click on the button given in front of *Input* in right pane and choose the "ne-43-01bombay_north_1954.bmp" file. In the *Output* option same name with .mpr extension will be automatically populated as shown in image above.
7. Click *Ok* to import the toposheet BMP file into ILWIS environment.

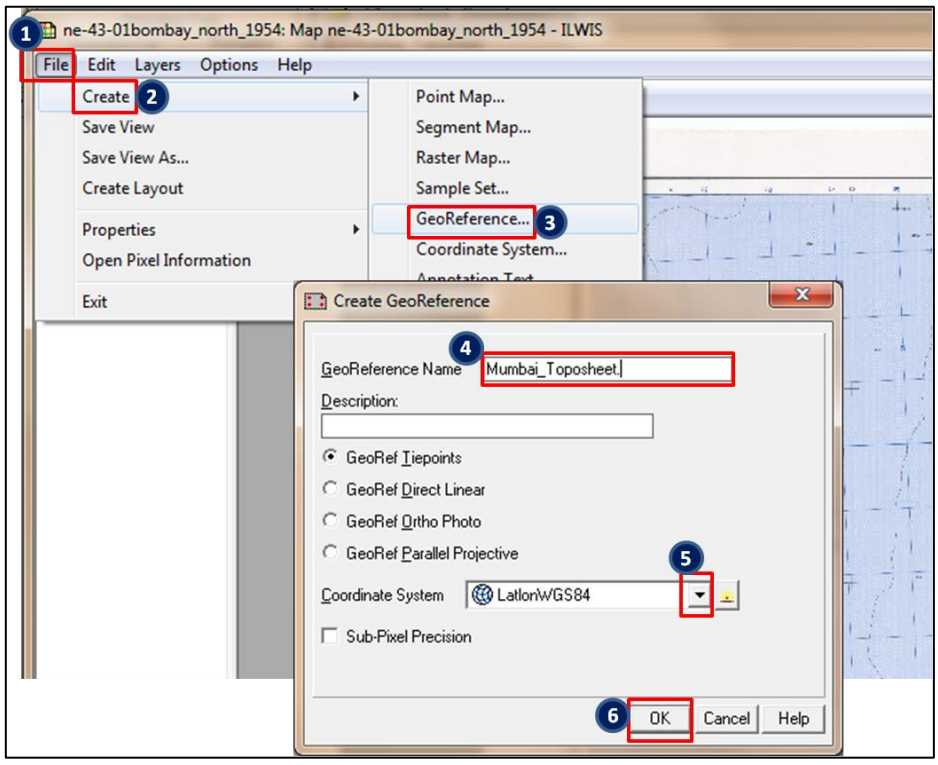
After execution of above shown steps, adjacent progress manager will be appeared-



Now double click to open the file* "ne-43-01bombay_north_1954.mpr" *from catalogue window

(ii) Add Tie points using the Create GeoReference tool

A- <u>Define Coordinate System-</u>



Steps:

1. Click on *File* option in main menu of the window having non georeferenced toposheet in it.
2. Hover mouse on *Create* option
3. Click on *GeoReference* option. It will open a *Create Georeference* dialogue box as shown in image above.
4. In *Create Georeference* dialogue box provide *Georeference Name* as "Mumbai_Toposheet"
5. Choose *Coordinate System* as "LatLongWGS84" from the drop down menu.
6. Click Ok.

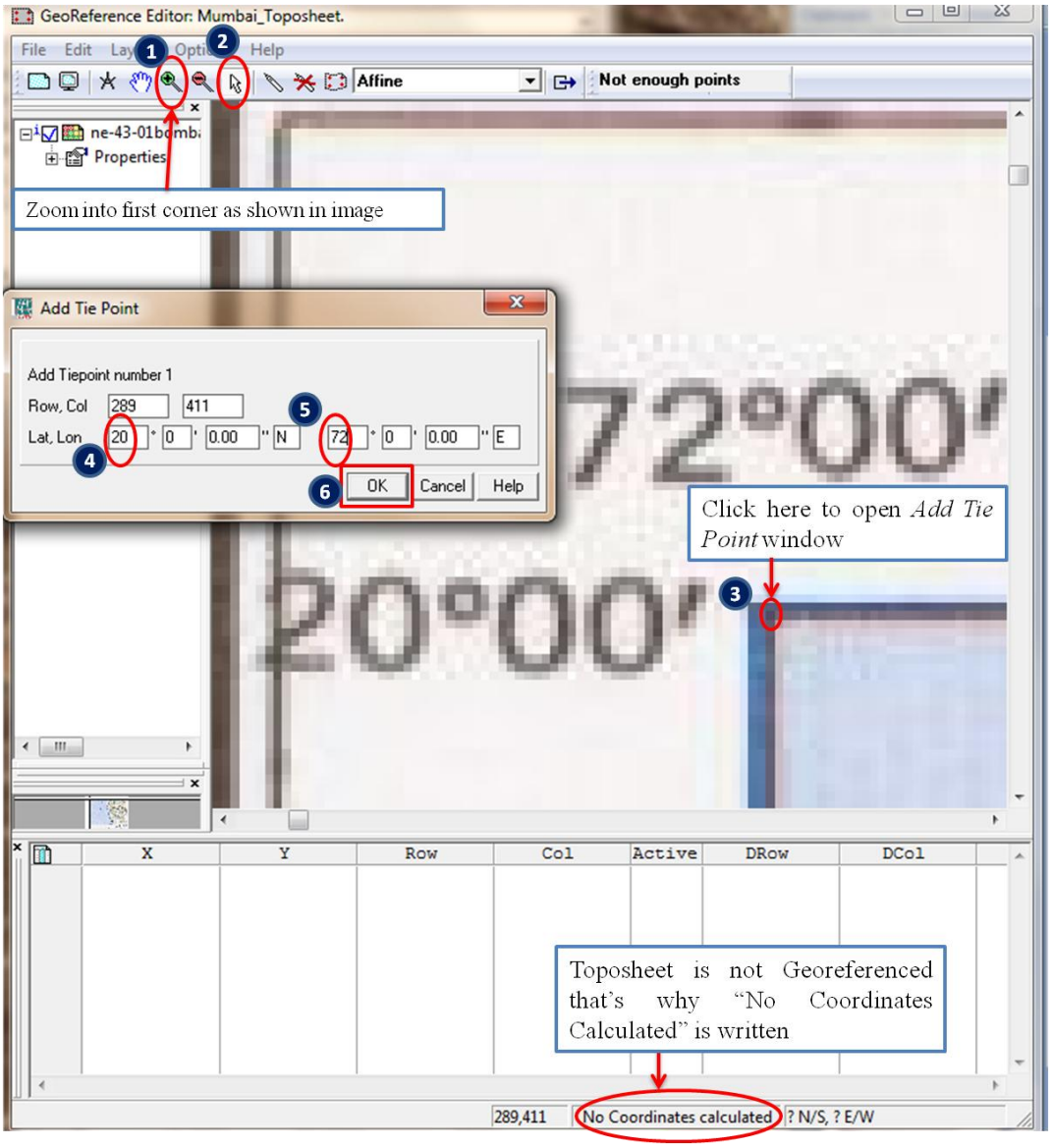
B- <u>Add tie points on appropriate places</u>

Steps:

1- Click on *Zoom in* tool and zoom into one of the corner of images where coordinates are written on toposheet.

2- Click on *Normal* pointer (see screenshot displayed below) and

3- Click on the toposheet at first corner as shown in image below. A new dialogue box named as "Add Tie Point" will be opened. This dialogue box will be populated



with Row and Column numbers because it has taken row and column of the place where you have clicked using *Normal* pointer

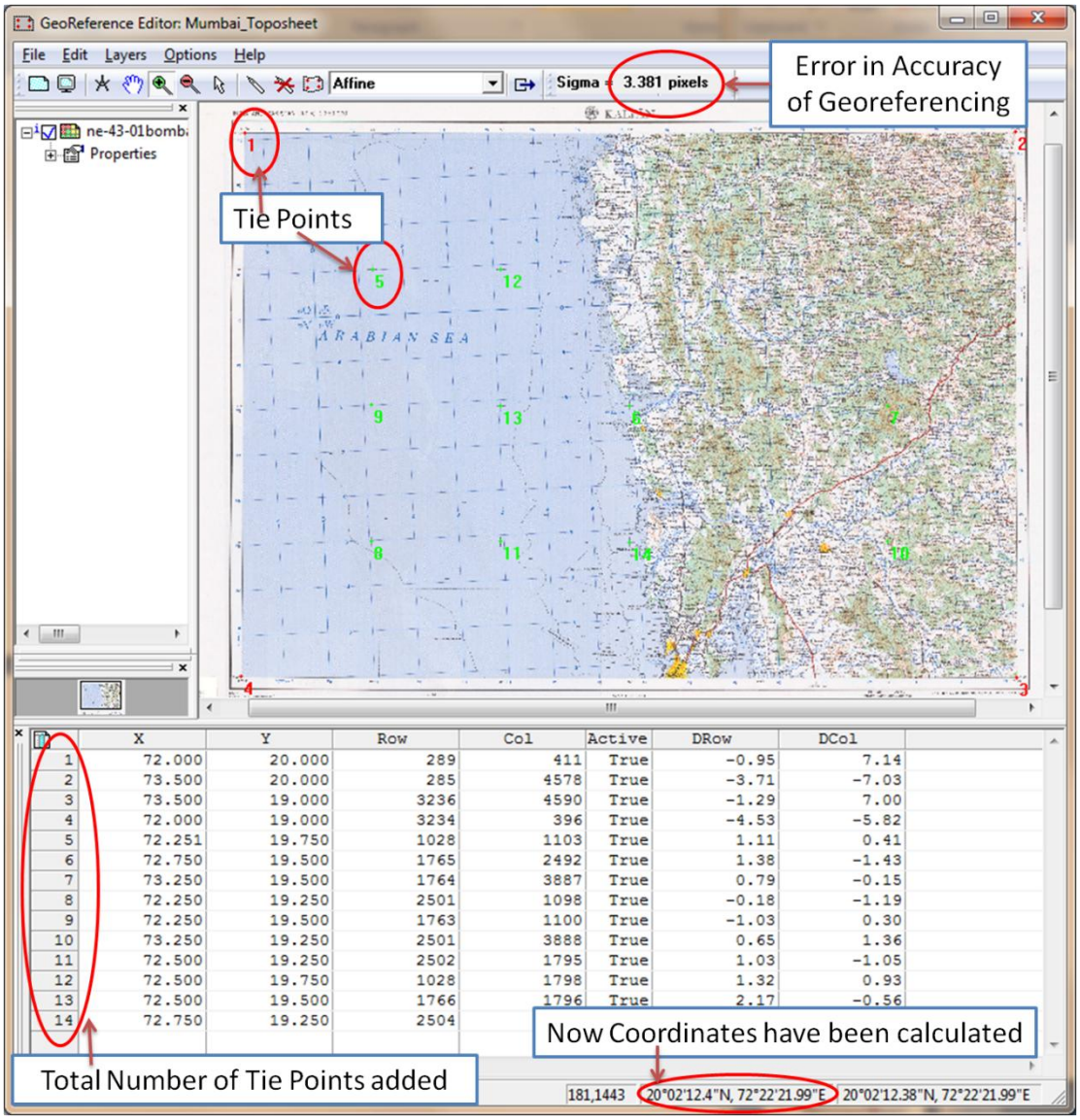
4- Now fill in Latitude value as 20 (as shown in toposheet)

5- Fill in Longitude value as 72 (as shown in toposheet)

6- Click Ok after filling up the Lat Long values.

A new tie point showing X, Y, Row, Col, Active, etc will be added in the table given in the bottom pane of the GeoReference Editor window.

- Follow steps 1 to 6 to add all four Tie points shown in four corners of the toposheet by filling up the Lat Long value of that place. After fourth coordinate onwards, the *Add Tie Point* window will automatically show approximate coordinate value that has been calculated based on previous three coordinate values.
- After that try to put more tie points if the error in accuracy of georeferencing is higher.



	X	Y	Row	Col	Active	DRow	DCol
1	72.000	20.000	289	411	True	-0.95	7.14
2	73.500	20.000	285	4578	True	-3.71	-7.03
3	73.500	19.000	3236	4590	True	-1.29	7.00
4	72.000	19.000	3234	396	True	-4.53	-5.82
5	72.251	19.750	1028	1103	True	1.11	0.41
6	72.750	19.500	1765	2492	True	1.38	-1.43
7	73.250	19.500	1764	3887	True	0.79	-0.15
8	72.250	19.250	2501	1098	True	-0.18	-1.19
9	72.250	19.500	1763	1100	True	-1.03	0.30
10	73.250	19.250	2501	3888	True	0.65	1.36
11	72.500	19.250	2502	1795	True	1.03	-1.05
12	72.500	19.750	1028	1798	True	1.32	0.93
13	72.500	19.500	1766	1796	True	2.17	-0.56
14	72.750	19.250	2504				

Fig: Georeference editor showing location and number of tie points added with error of accuracy in georeferencing.

(iii) Checking the toposheet in ILWIS catalogue

Now close the *GeoReference Editor* window and go to the catalogue of ILWIS where the toposheet was located. You will see that a new file has been added named as "Mumbai_Toposheet". This is a .grf file having georeference information of the toposheet. Double clicking on this file will open it. Now the coordinates have been calculated. Therefore, you will see some coordinates at the place where "No Coordinates Calculated" was written earlier.

8. Image Enhancement Tools

8.1 Contrast Enhancement

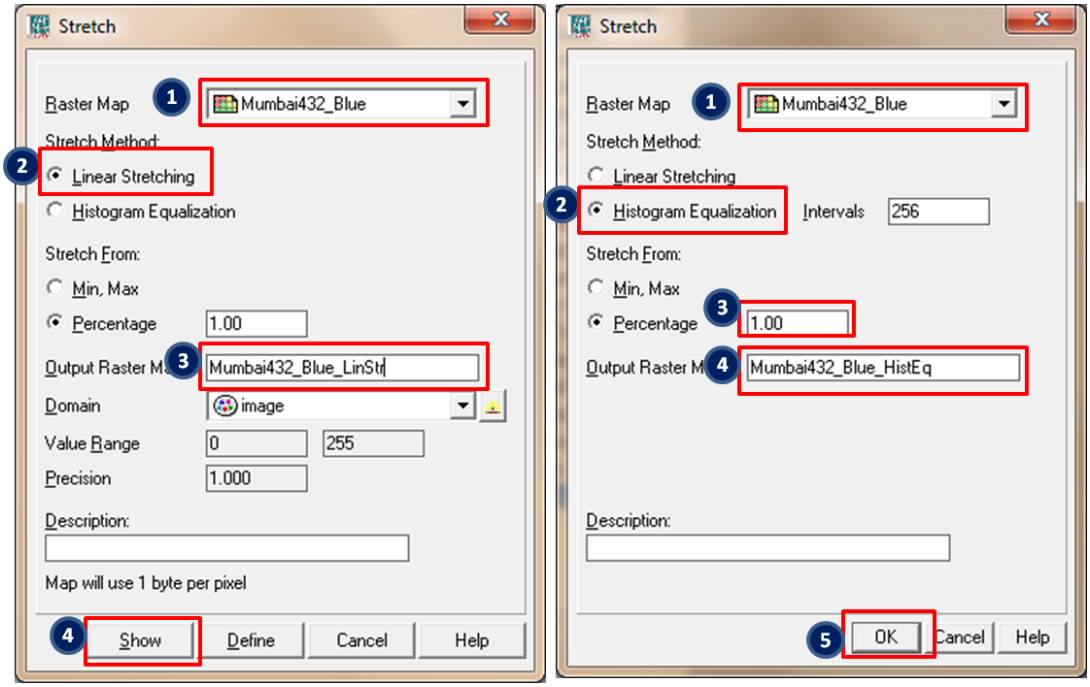
Contrast enhancement can be done using Histogram Equalization and Linear Stretching.

Steps:

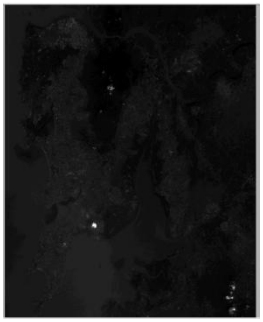
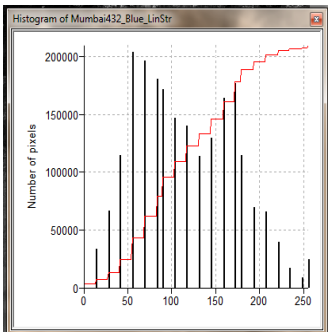
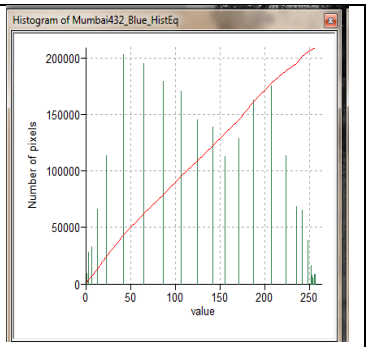
Find *Stretch* tool under the *Image Processing* option of *Operations* in main menu-

Operations → *Image Processing* → *Stretch.*

Stretching using Linear Stretching and Histogram equalization techniques-



Effect of Contrast Enhancement on Imagery-

 **Imagery before contrast enhancement**	 **Imagery after contrast enhancement**	 **Histograms of Linear stretched Image**	 **Histograms of Histogram Equalized Image**

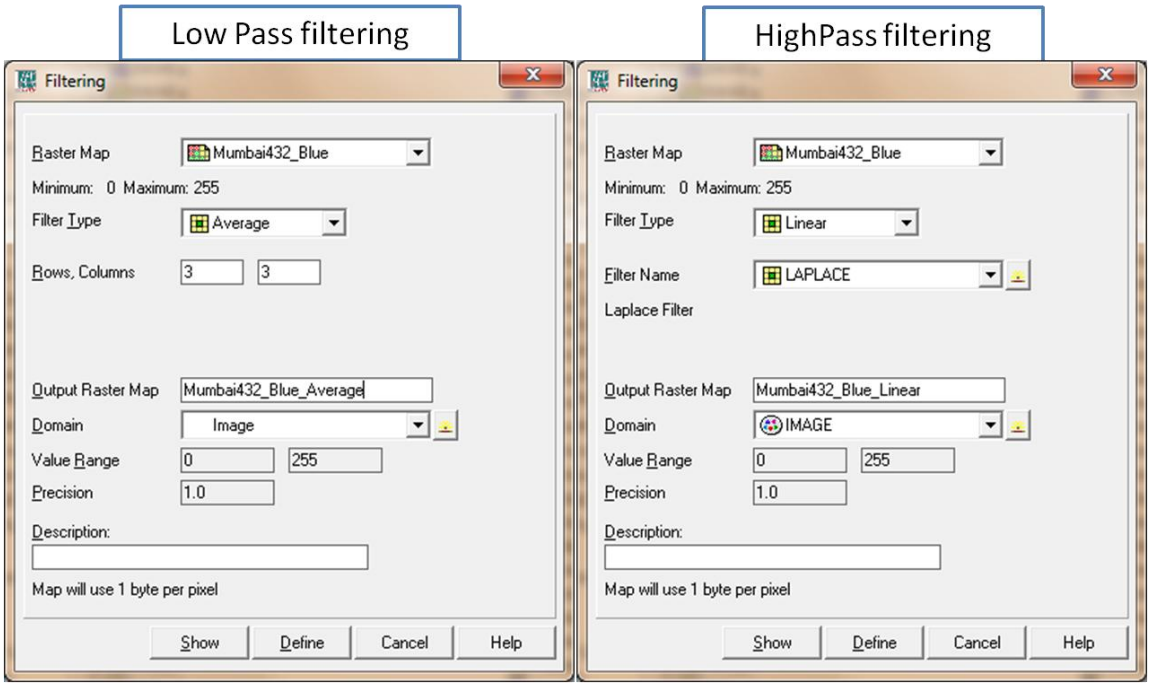
8.2 Spatial Enhancement

Image Filtering-

Low pass filters like Average, Median, Standard Deviation etc as well as High pass filters like Linear, Majority etc can be applied for spatial enhancement of the imagery. The domain value for any imagery band should be *IMAGE* only while applying filters.

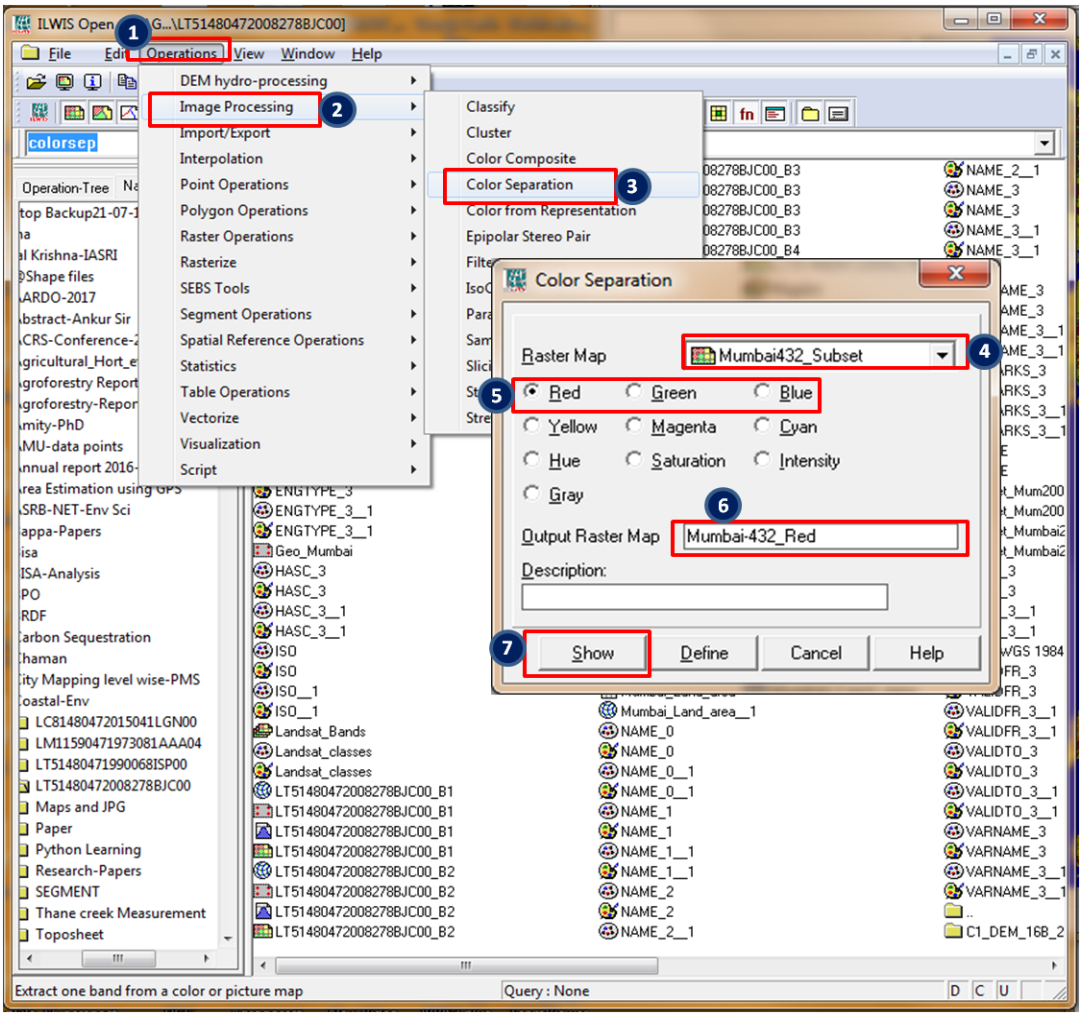
Filter dialogue box can be found under *Image Processing* option of *Operation* in main menu

Operations → Image Processing → Filter.



As shown in screenshot above, filters can be applied on an imagery band.

9. Colour Separation using RGB Colour Composite image



Using *Colour Separation* option of image processing, the red, blue, green and gray bands can be extracted from the RGB color composite image or we can use the bands that we have imported earlier.

Steps:

1. Click on *operations* in main menu.

2. Hover mouse over *Image Processing* to open image processing operations right side

3. Click on *Colour Separation*.

4. In the *Colour Separation* dialogue box choose raster map as Mumbai432_Subset.

5. Click the radio button in front of *Red*.

6. Give output raster name and

7. Finally click on *Show*.

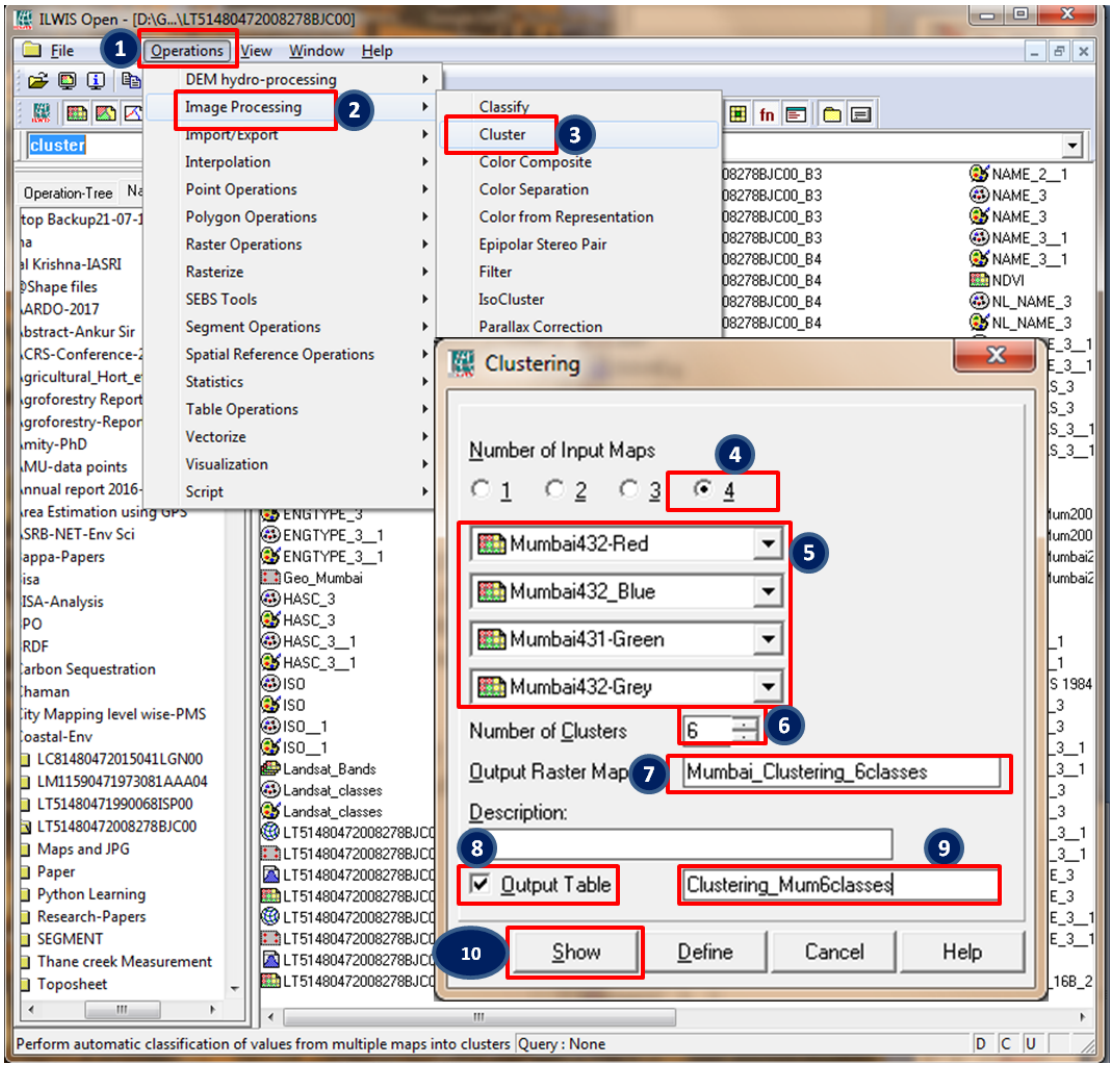
Repeat above steps for colour separation of *Blue*, *Green* and *Grey* bands.

Using this colour separation option, we can extract submap bands that also have linear stretching enhancement in them, which we have performed during colour composite creation.

10. Image Classification

10.1 Unsupervised Image classification:

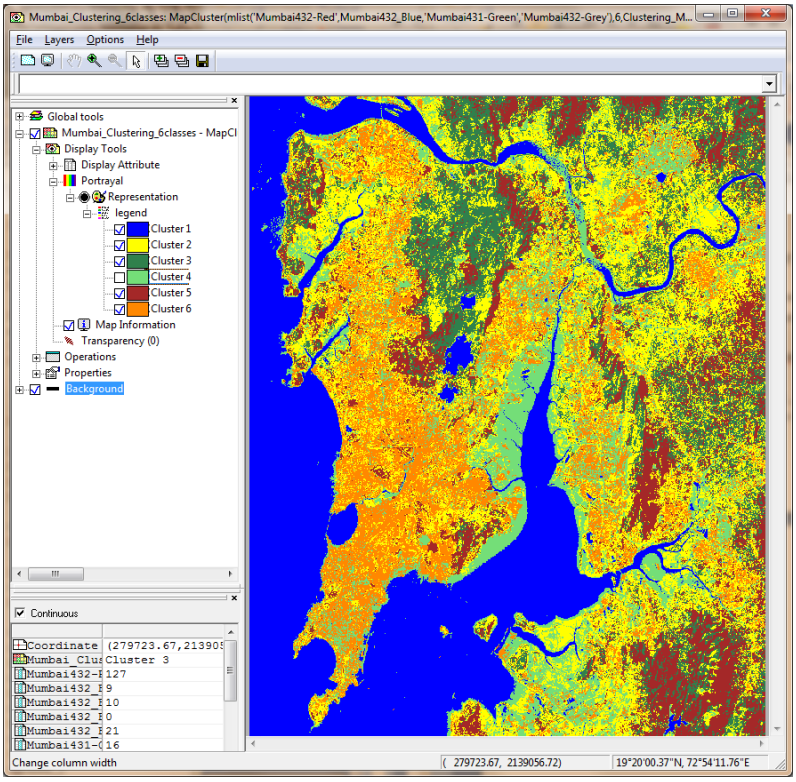
Clustering, or unsupervised classification, is a rather quick process in which image data is grouped into spectral clusters based on the statistical properties of all pixel values. It is an automated classification approach with a maximum of 4 input bands.



Steps:

1. Click on *Operations* in main menu.
2. Hover mouse over *Image Processing* to open image processing operations right side
3. Click on *Cluster*.
4. In the *clustering* dialogue box, choose *Number of Input Maps* as 4.
5. Choose one by one four different raster bands from drop down menu.
6. Put *Number of Clusters* as 6.
7. Give *Output raster map* name as Mumbai_Clustering _6classes.
8. Check *output table* option and
9. Provide name of table as Clustering _Mum6classes.
10. Finally click on *Show* to generate a cluster map.

The Unsupervised classified raster map is given below after legend colour modification-



- To see legend of unsupervised cluster map, click on + button in front of-

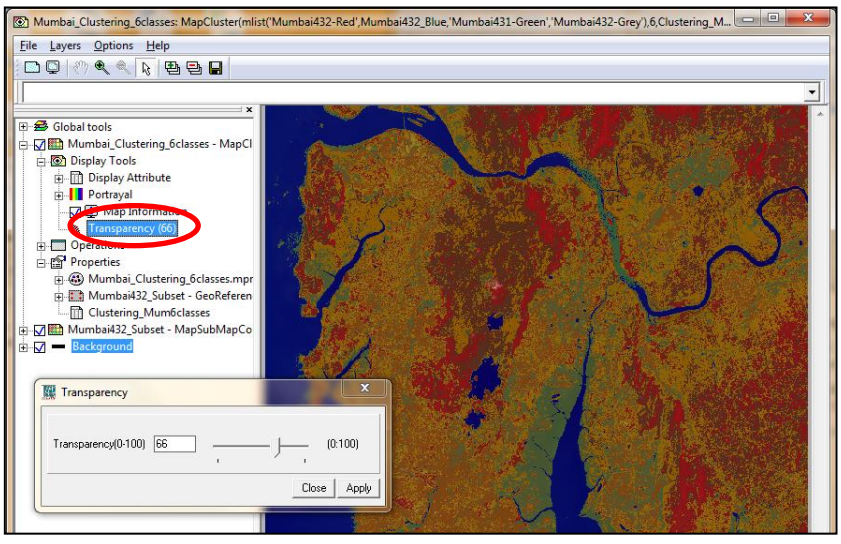
  Mumbai clustering 6 classes → Display tools → Portrayal → Representation.

  It will show the legend or classes of the cluster map.

- To identify the cluster classes in map, add raster map (Mumbai432_Subset.mpr) in the same window having cluster map (Mumbai_Clustering _6classes.mpr) and follow steps given below by clicking on + button in front of -

  Mumbai clustering 6 classes → Display tools → Transparency

- Double click on *Transparency* and move the bar to increase-decrease transparency.



10.2 Supervised Image classification:

The process is divided into two phases: a training phase, where the user 'trains' the computer, by assigning for a limited number of pixels to what classes they belong in this particular image, followed by the decision making phase, where the computer assigns a class label to all (other) image pixels, by looking for each pixel to which of the trained classes this pixel is most similar (ILWIS user Guide).

The main steps for supervised classification using ILWIS Open software are-

1- Create a New Map List (Three or maximum four bands on which sample pixels will be selected)

2- Create a New Sample Set (Sample pixels)

3- Create a New Domain (Land Use & Land Cover (LULC) categories)

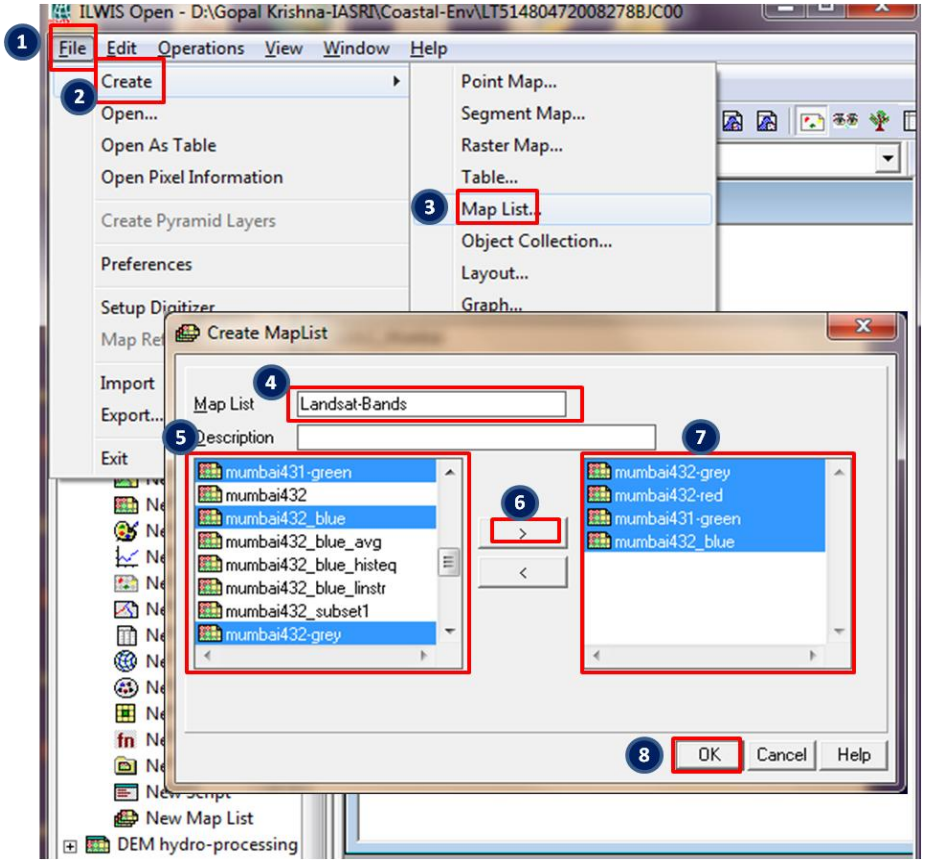
4- Define colours for Representation classes

5- Select Pixels for training set/Sample set using imagery in Sample Set Editor.

6- Choose an appropriate classification algorithm.

Steps in detail for executing a supervised image classification are given below-

(i) Create a New Map List



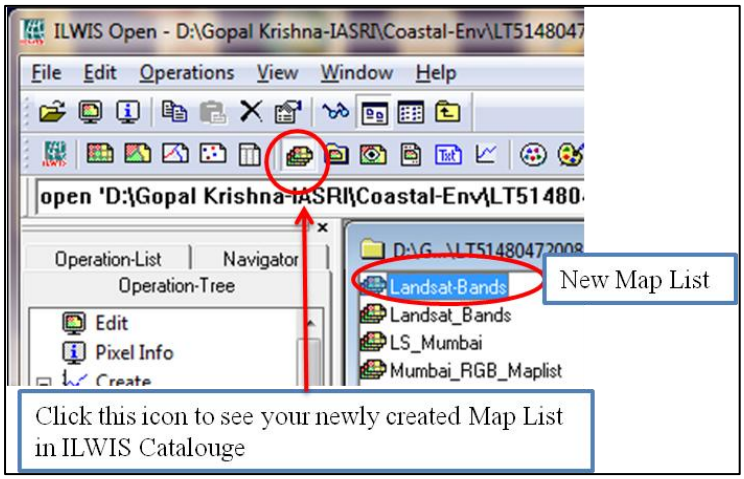
Steps:

- From the *ILWIS Open* GUI main menu go to-
  File → Create → Map List (Step 1 to 3 as shown in above figure).

In the *Create MapList* Dialogue box-

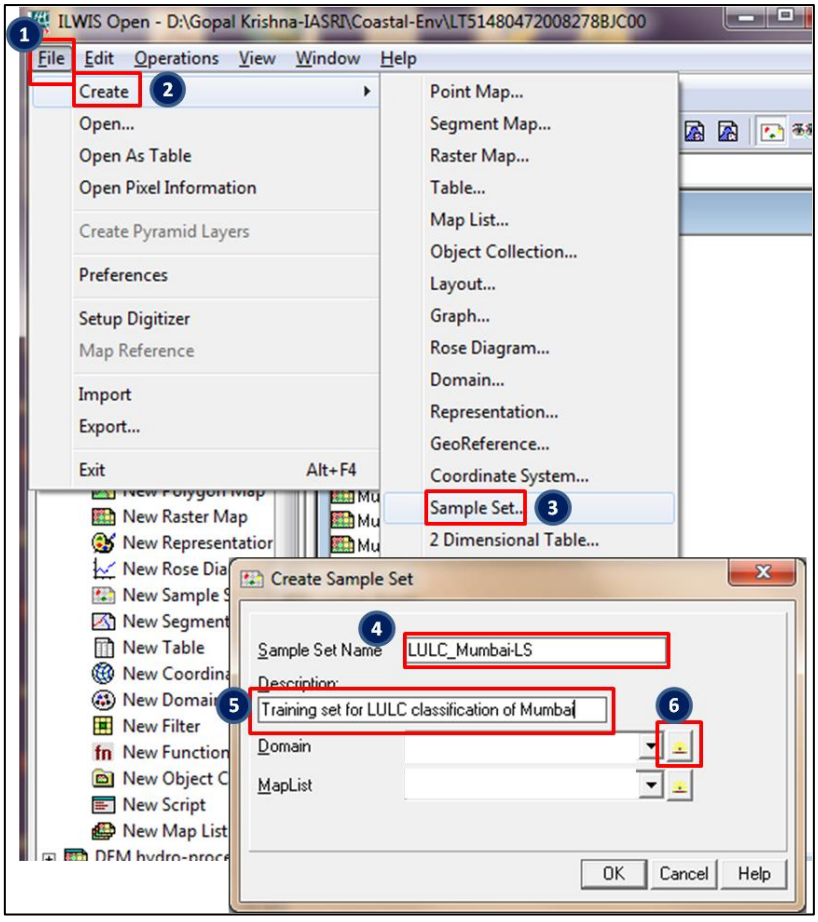
- Write "Landsat-Bands" in *Map List* (Step-4)
- Under *Description* select Green, Blue, Grey and Red Bands (Step-5)
- Click button having > symbol (Step-6)
- Check that you have properly selected above mentioned four bands (Step-7)
- Finally click *Ok* (Step-8)

Visualisation of new Map List in ILWIS Catalogue-



- Figure shows how to see the newly created Map List in ILWIS Catalogue.
- The new Map List named "Landsat-Bands" can be double clicked to check the containing bands.

(ii) Create a New Sample Set



To create a new sample set, step are given below-

1- Click on *File* option in main menu.

2- Hover mouse on *Create.*

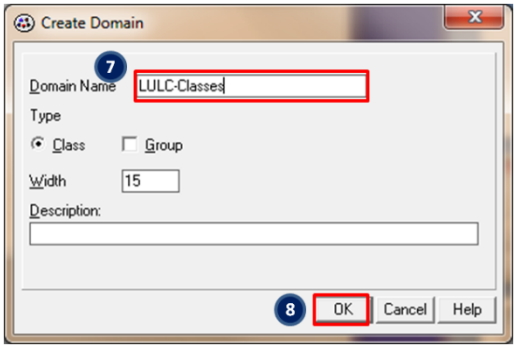
3- Choose *Sample Set* option from the given options.

4- In the *Create Sample Set* dialogue box, write down *Sample Set Name* as "LULC_Mumbai-LS".

5- In the text box of *Description* type "Training set of LULC classification of Mumbai".

6- Click the yellow button given in front of *Domain.*

A new Dialogue box will be opened to create a new Domain as shown in figure below-



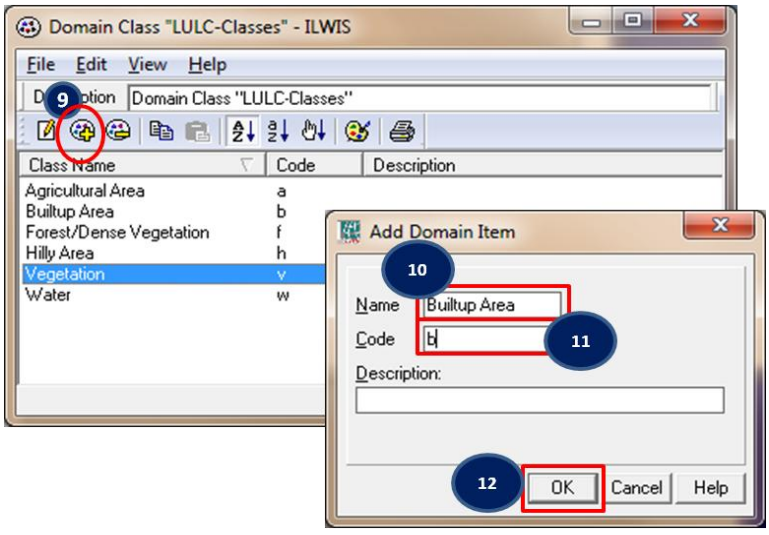
7- In the *Create Domain* dialogue box, Type "LULC-Classes" in the text box of Domain Name.

8- Click Ok.

By clicking ok, a new dialogue box will be opened.

(iii) Create a New Domain (LULC categories)

The New Dialogue box is named as *Domain Class* as shown in adjacent figure.



9- Create the *Add Domain* Icon depicted by plus symbol.

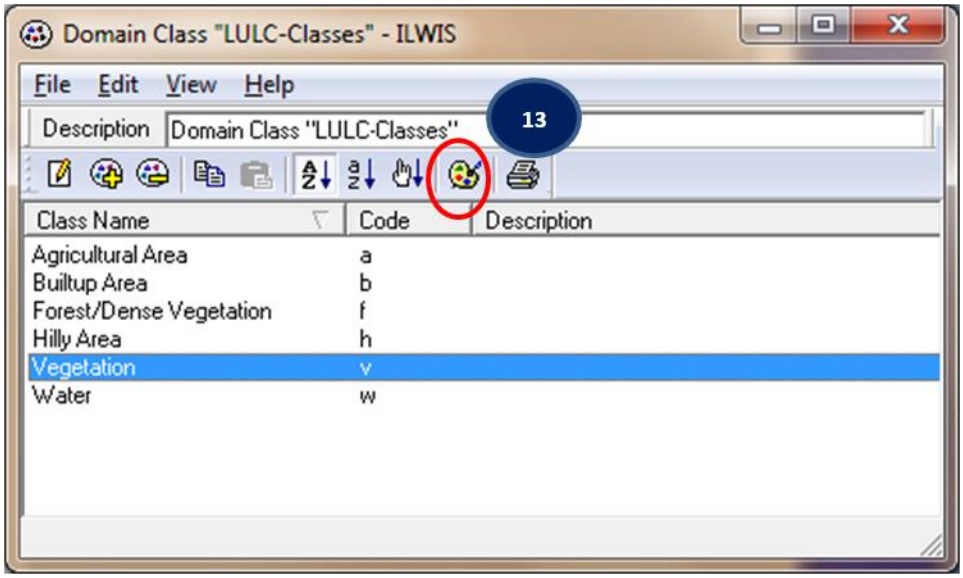
10- In the new *Add Domain* dialogue box, type "Builtup Area" in the text box in front of *Name*.

11- Give a *Code* as "b".

12- Click Ok.

- This will add a new LULC class in the Domain class dialogue box. Follow the steps 9 to 12 again to add all six LULC classes as given in the table-

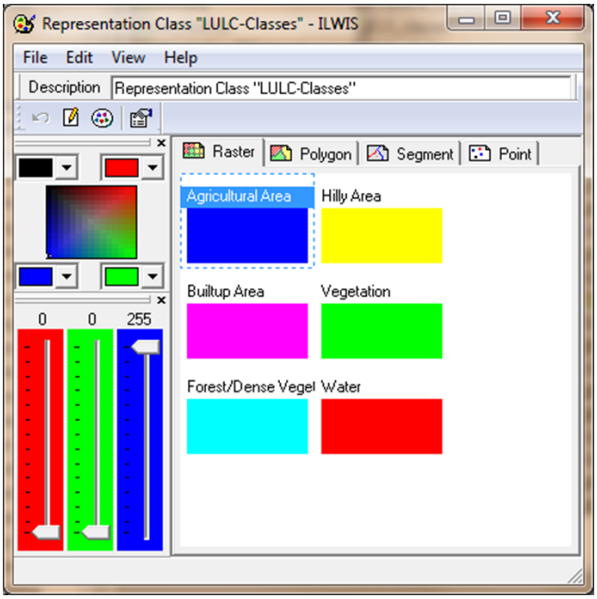
Class Name	**Code**
Agricultural area	a
Forest/Dense Vegetation	f
Hilly area	h
Vegetation	v
Water	w



13- After creating all the classes, click on *Representations* icon as shown in above image.

(iv) Define colours for Representation classes

Step 13 will open a new dialogue box named as *Representation Class*, shown in figure below. Here, by clicking on colours shown, one can choose the desired colour for already defined classes.

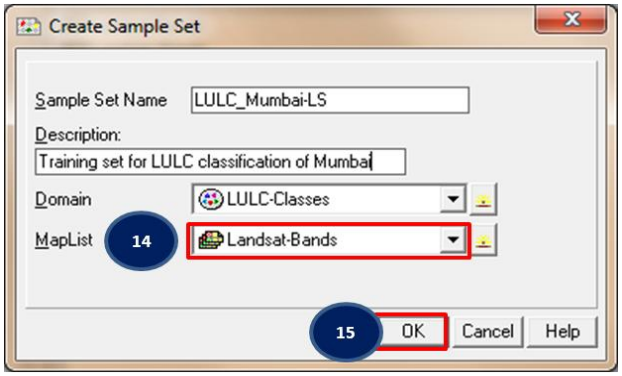


Close *Representation class* & *Domain class* dialogue boxes and return on the *Create Sample Set* dialogue box. You will see that in the *Domain* option "LULC-Classes" domain has been filled that you have created recently.

14- In the drop down menu given against *Map List*, Choose the Map List you have created during the *Create the New Map List* instructions, named as Landsat-Bands.

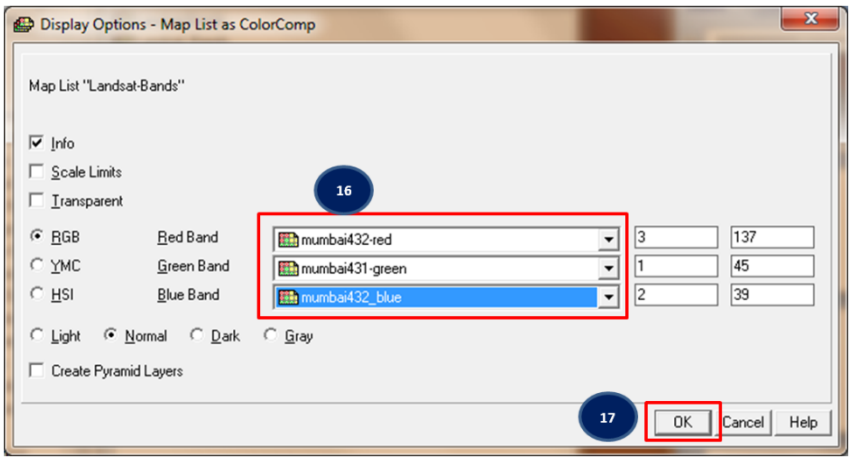
15- Finally click *Ok* to finish creating a new Sample Set.

The details filled in *Create Sample Set* window will look like the figure given below-



(iv) Select Pixels for training set/Sample set from imagery, in Sample Set Editor

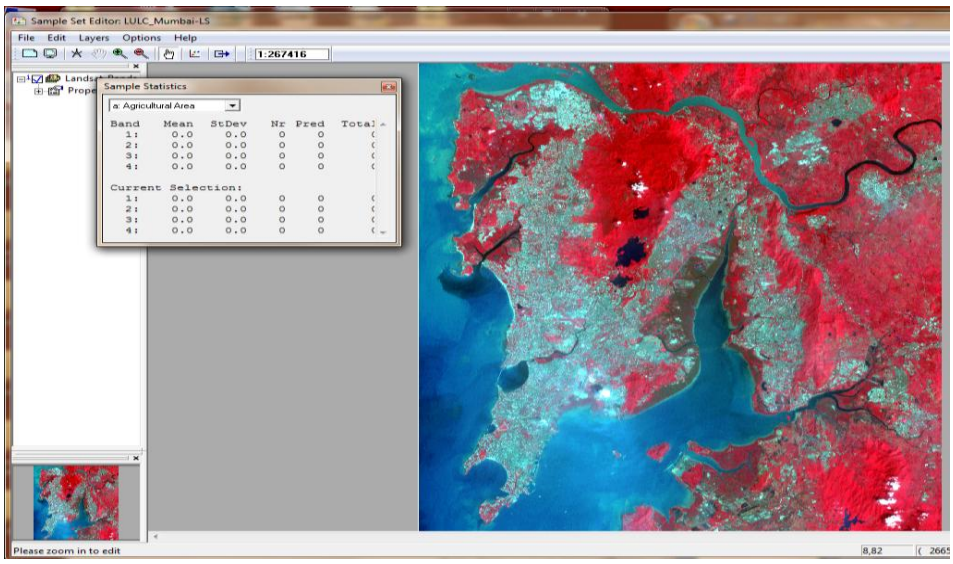
Just after step 15, a new dialogue box named as "Display option – Map List as ColorComp" will be opened as shown in figure below-



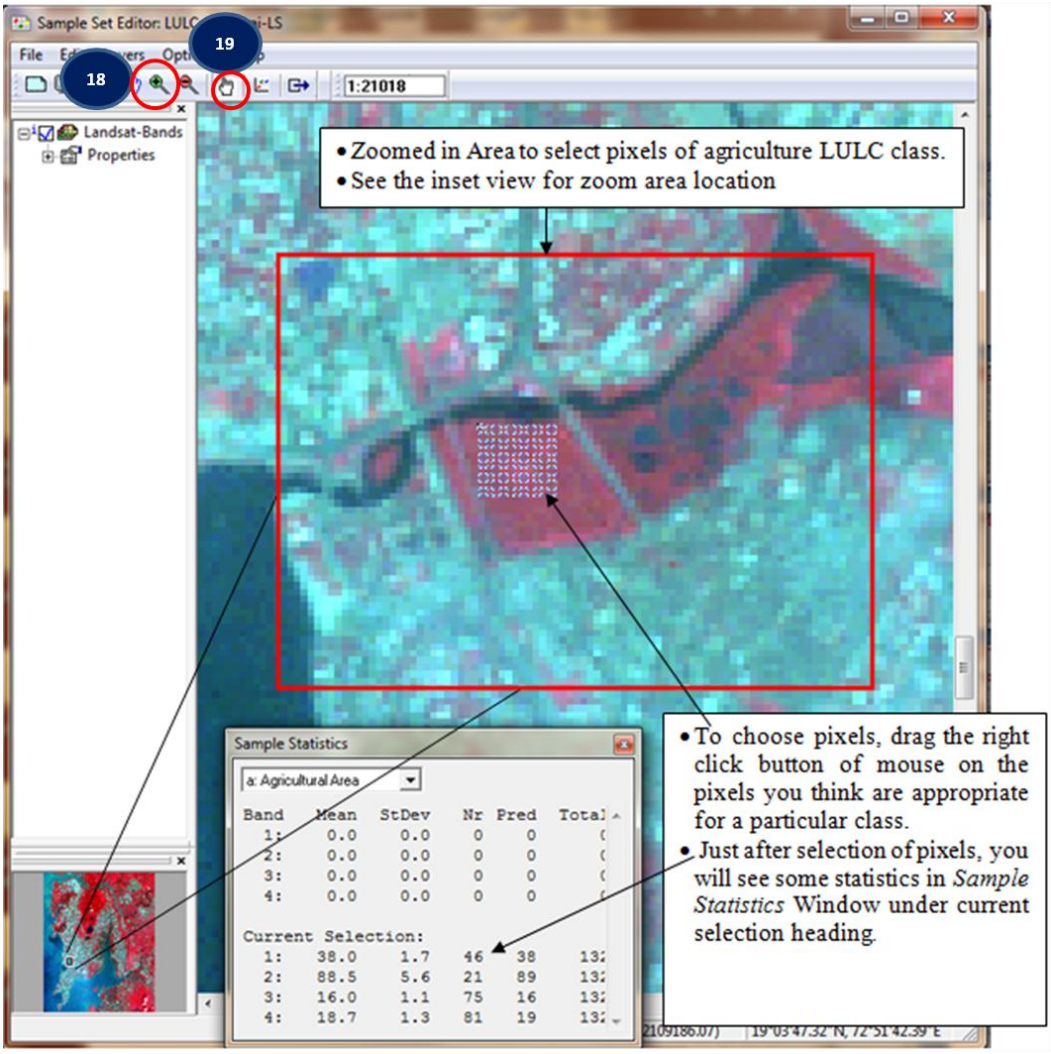
16- Choose Red, Green and Blue bands from drop down menu of *Display Options* and

17- Click *Ok*.

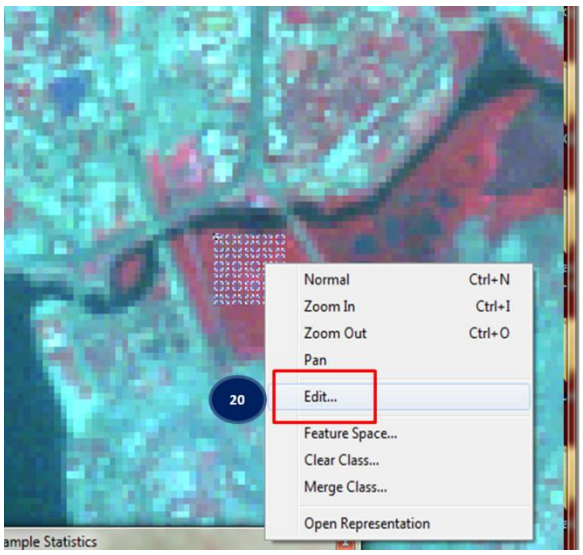
This will open a colour composite image in new window that will look like screenshot below-

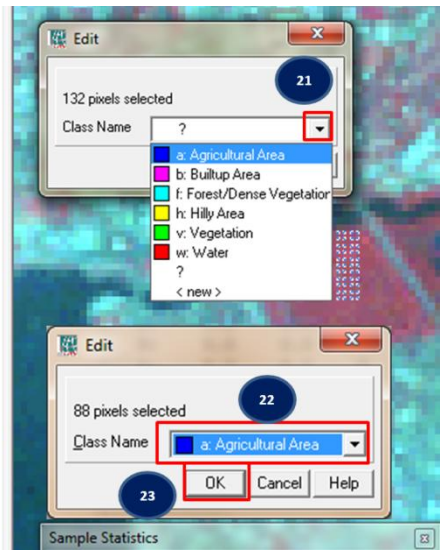


18- Now zoom in to an appropriate area from where you want to select the pixels of a particular class.



19- Now choose *Normal* tool as shown in above figure and to choose pixels, drag the right click button of mouse on the pixels you think are appropriate for a particular class.





20- After selecting the pixels, right click and choose *Edit* option, as shown in above image.

21- An *Edit* window will be opened, click on the drop down menu given against *class name* in *Edit* window.

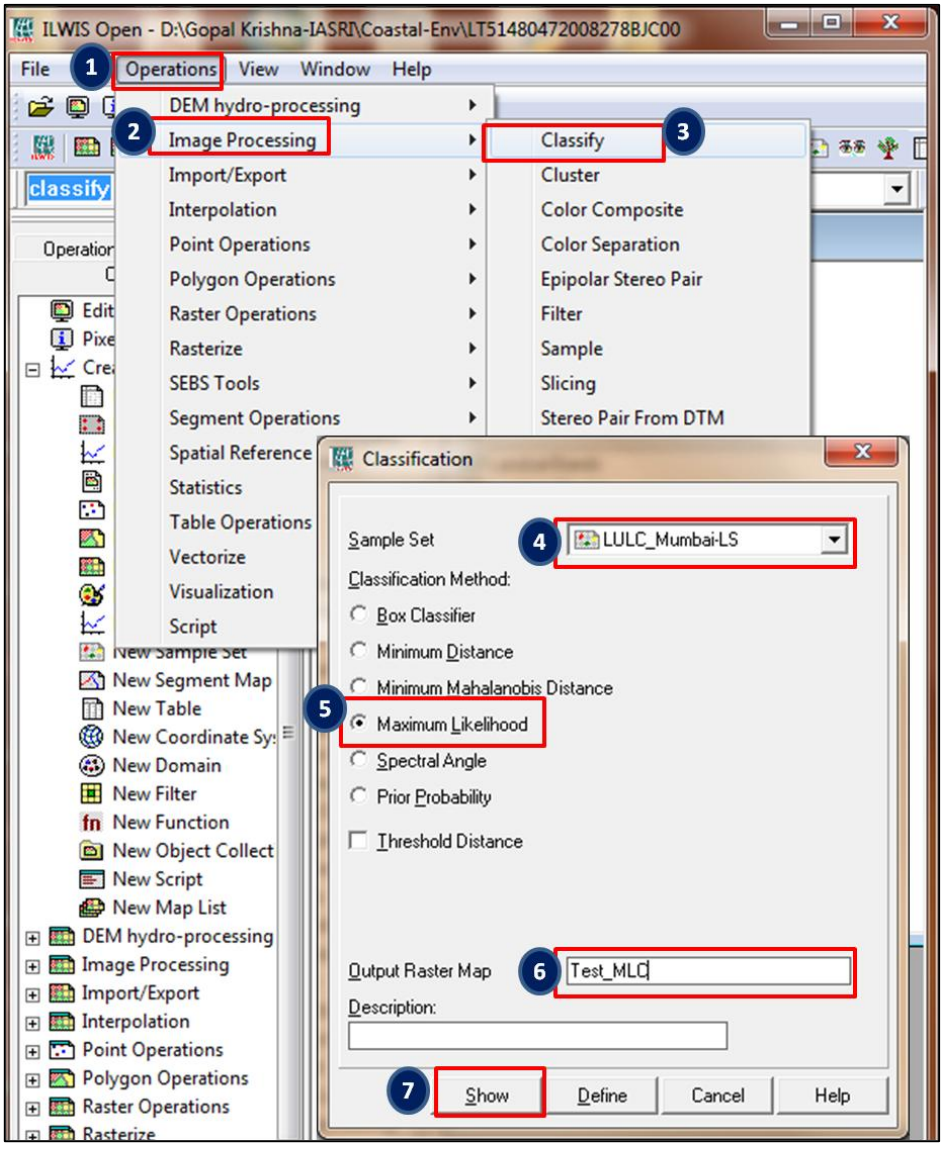
22- Choose the class for which you have selected the pixels and

23- Click Ok.

Now you can see that some statistics showing mean, std dev etc has been populated just above *Current Selection* heading. That shows your selection of pixels has been updated with selected class.

Follow steps 18 to 23 again for rest five LULC classes by selection of appropriate pixels from the imagery. Once pixel selection is completed for all the classes, close the Sample Set Editor window. Now you have successfully created a new Sample Set consisting of 6 LULC classes.

(vi) Choose an appropriate classification algorithm



Classification using Maximum Likelihood Classification Method-

Steps:

1- Click on *Operations* given in main menu

2- Hover mouse on *Image Processing* option

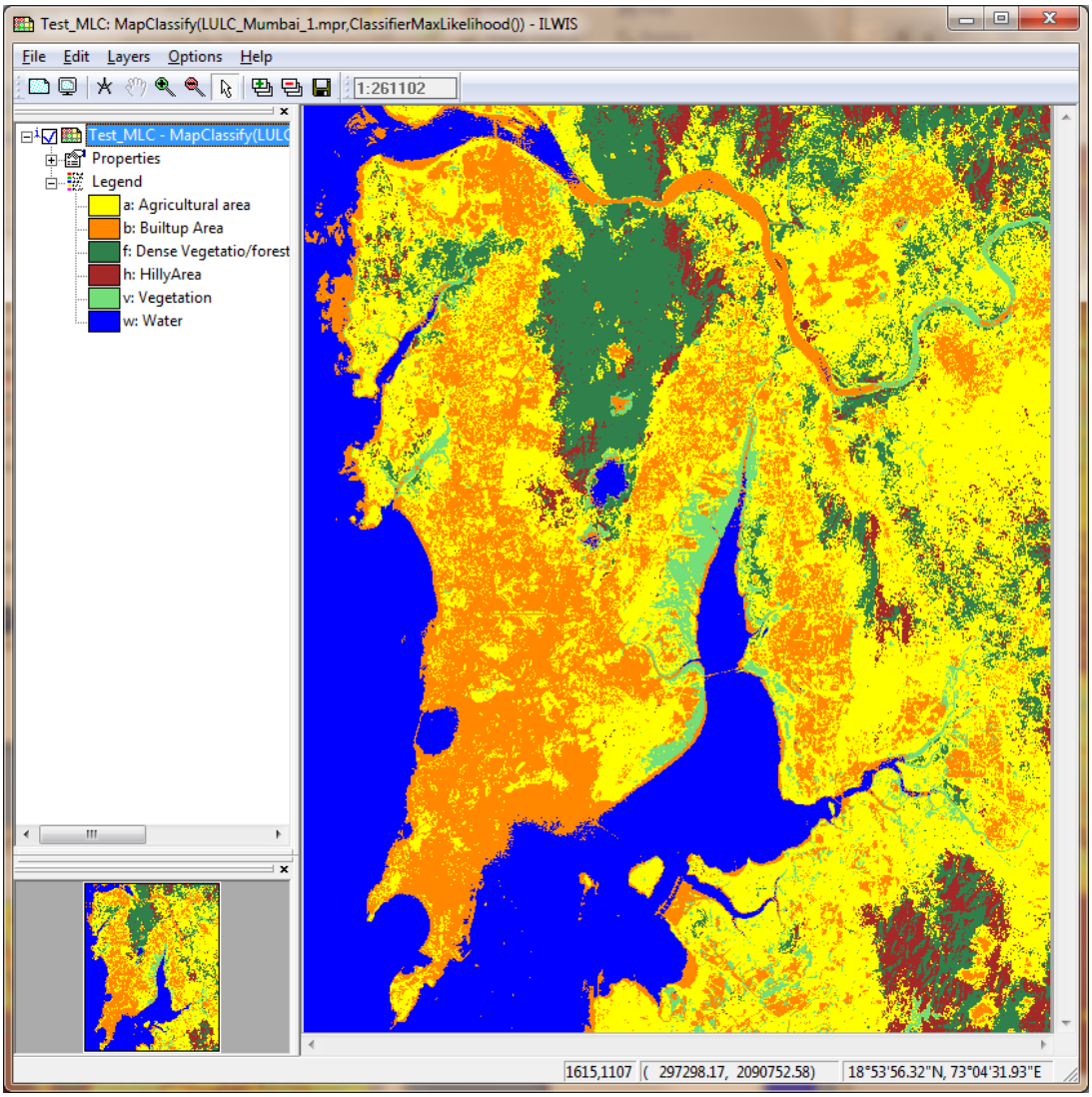
3- Choose *Classify*

4- In the *Classification* window, provide sample set that has been created in previous exercise named as "LULC_Mumbai-LS"

5- Click radio button near *Maximum likelihood* classification method

6- Provide output Raster Map name as Test_MLC.

7- Finally click on *Show*, to show the classified Landsat image having six LULC classes as shown below-



Classification using Spectral Angle Mapper Classification Method-

Steps:

1- Click on *Operations* given in main menu

2- Hover mouse on *Image Processing* option

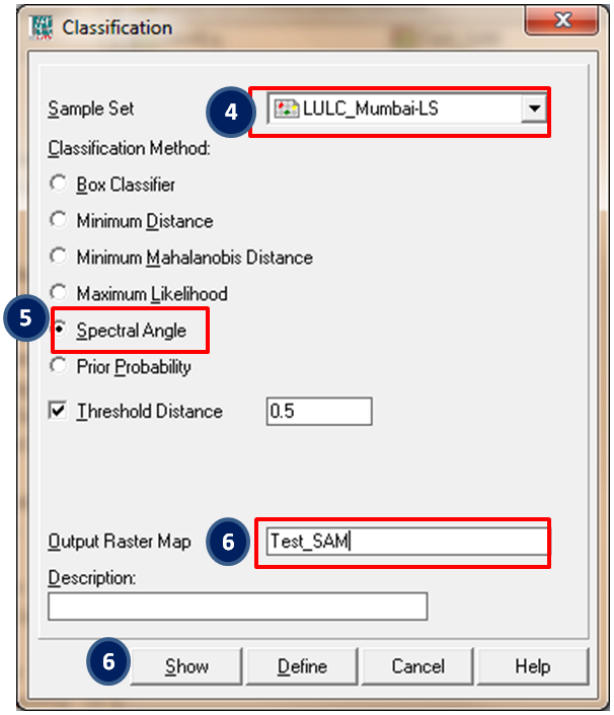
3- Choose *Classify*
(As shown in above instructions)

4- In the *Classification* window, provide sample set that has been created in previous exercise named as "LULC_Mumbai-LS"

5- Click radio button near *Spectral Angle* classification method

6- Provide output Raster Map name as Test_SAM.

7- Finally click on Show. To show the classified Landsat Image having Six LULC classes as shown below-



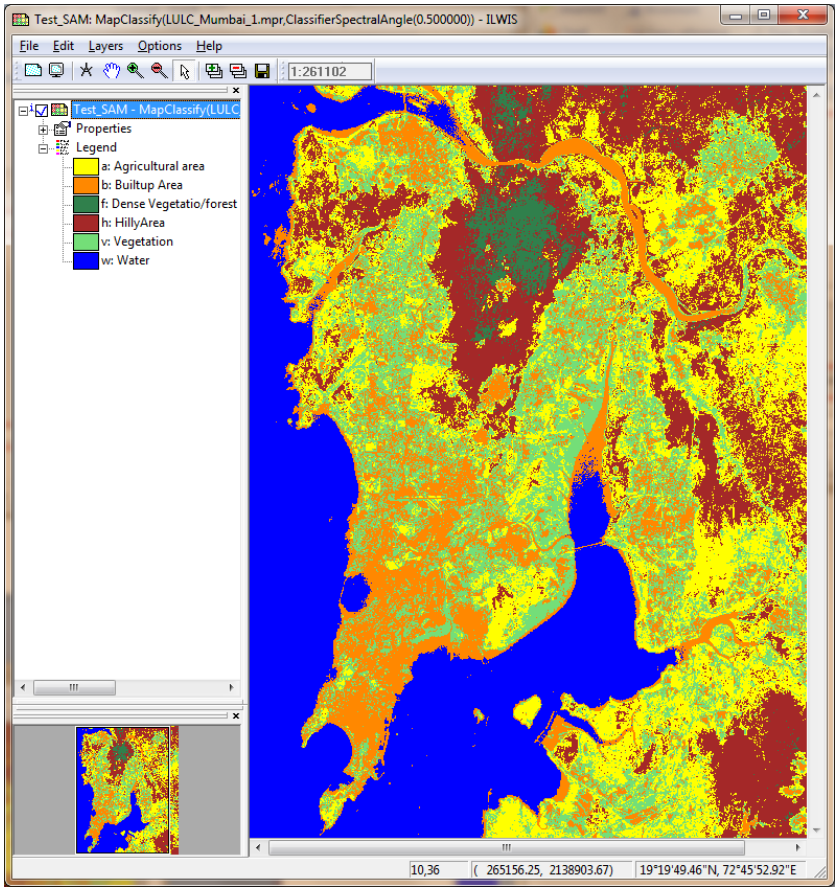
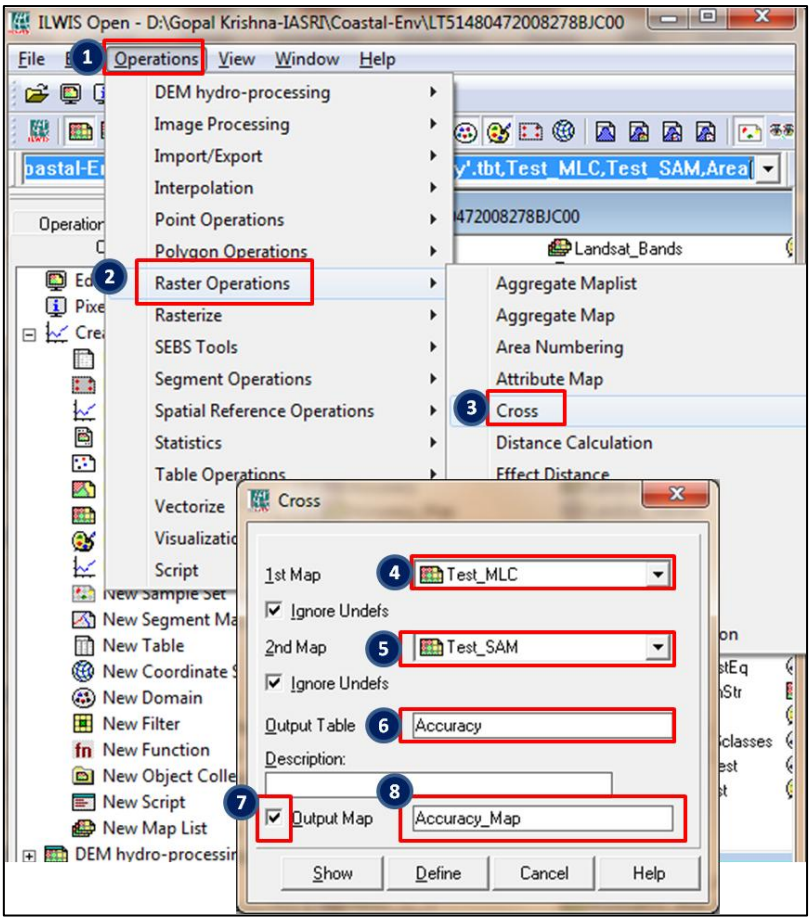


Fig: Classified Landsat Scene using Spectral Angle Mapper Classifier

11. Classification Accuracy Assessment



Steps:

1- Click *Operations* option given in main menu

2- Hover mouse on *Raster Operations*

3- Click on *Cross* option

4- A new *Cross* window will be opened as shown in above image. In this window, Choose 1st map from drop down menu whose accuracy is to be checked.

5- Choose 2nd map from drop down menu that should be created by classification using ground truth training classes.

6- Provide a name for *Output Table* as "Accuracy".

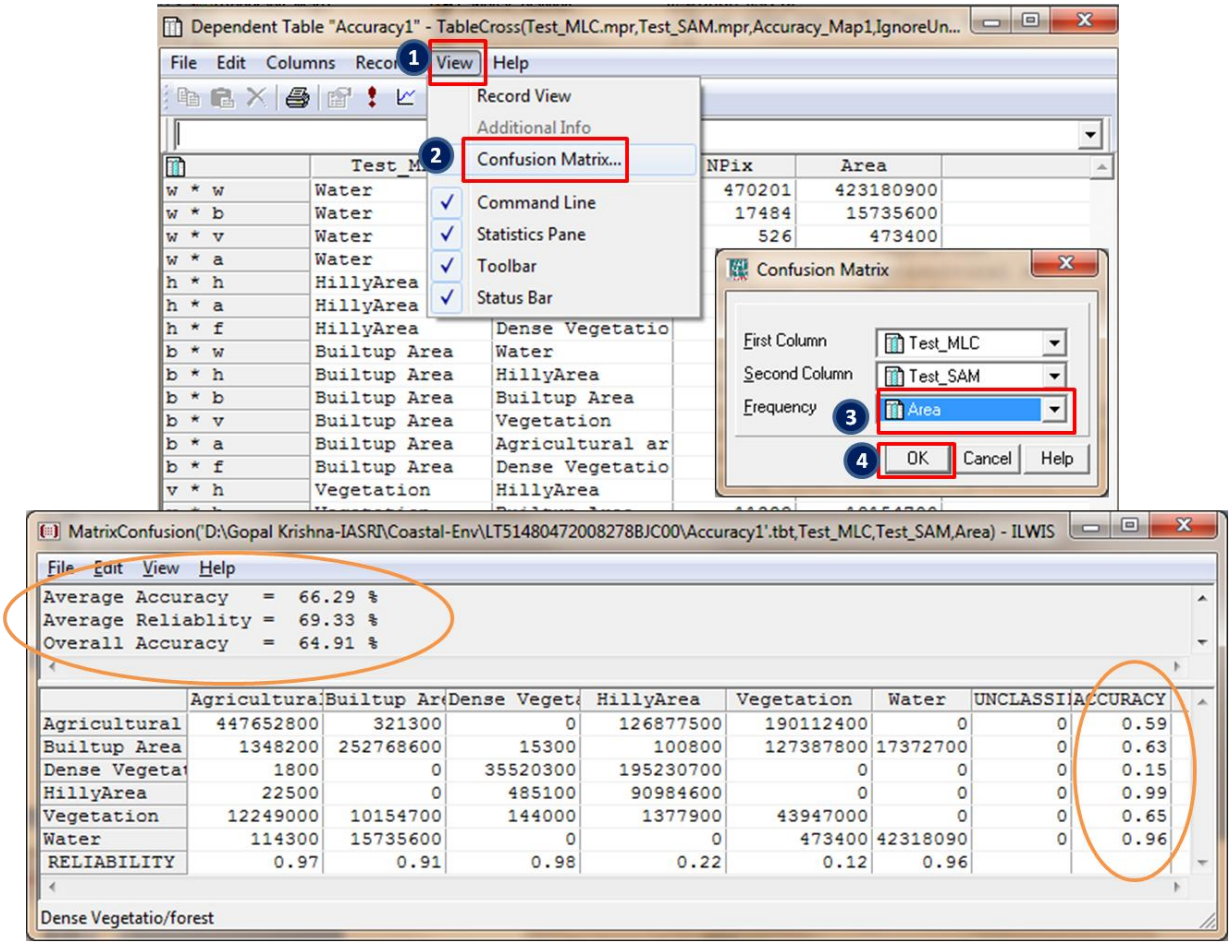
7- Check the box near *Output Map* and

8- Provide *Output Map's* name as Accuracy_Map.

9- Click *Show*.

Above process will open a *Dependent Table* showing all possible combinations of LULC classes with Number of Pixels (NPix) classified and Area of the category.

- To get the Confusion Matrix of the classification, follow steps given below-



	Agricultura	Builtup Ar	Dense Veget	HillyArea	Vegetation	Water	UNCLASSI	ACCURACY
Agricultural	447652800	321300	0	126877500	190112400	0	0	0.59
Builtup Area	1348200	252768600	15300	100800	127387800	17372700	0	0.63
Dense Vegeta	1800	0	35520300	195230700	0	0	0	0.15
HillyArea	22500	0	485100	90984600	0	0	0	0.99
Vegetation	12249000	10154700	144000	1377900	43947000	0	0	0.65
Water	114300	15735600	0	0	473400	42318090	0	0.96
RELIABILITY	0.97	0.91	0.98	0.22	0.12	0.96		

Steps:

1- Click on *View* option in main menu of *Dependent Table*.

2- Click on *Confusion Matrix* option.

3- In the *Confusion Matrix* window, choose "Area" from the drop down menu given against *Frequency*.

4- Click Ok to get the confusion matrix table as shown in figure above.

QGIS

QGIS 2.18

IASRI, Library Avenue, New Delhi-110012

1. Introduction

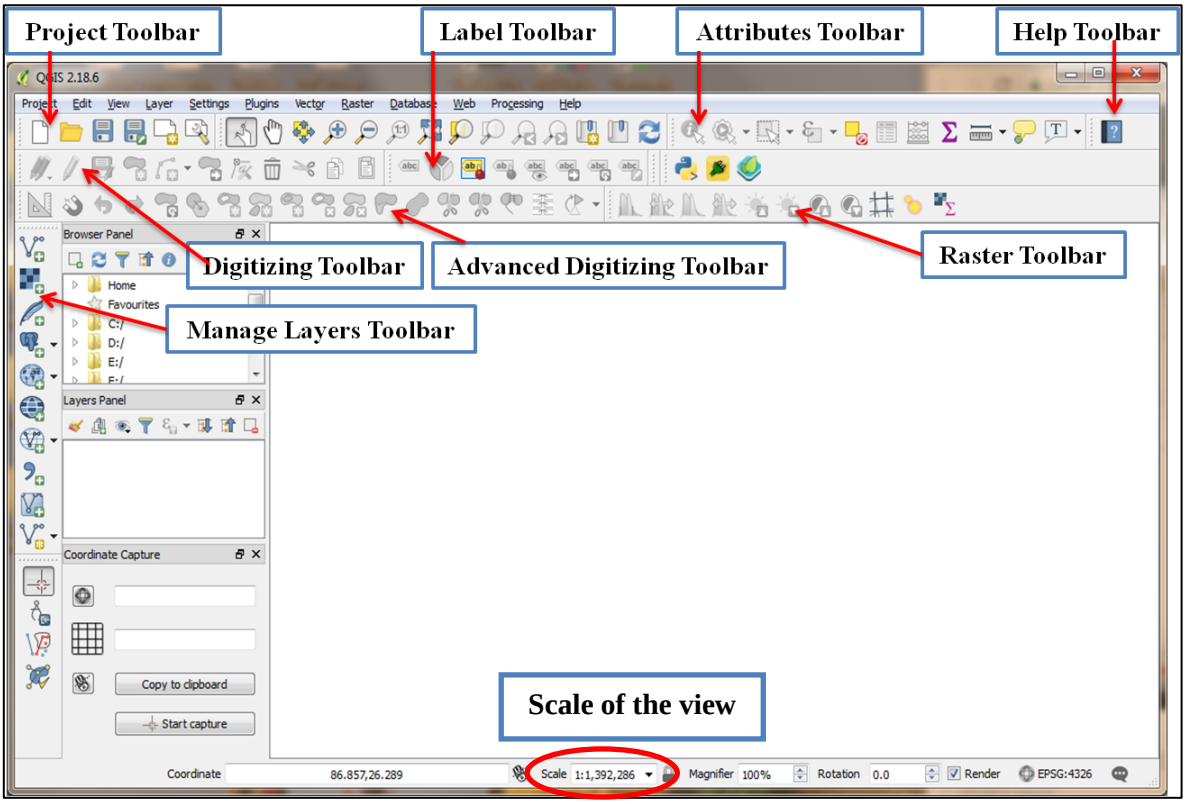
The QGIS (Quantum GIS) is free and open source GIS (Geographic Information System) software. QGIS offers many common GIS functionalities provided by core features and plug-ins. We can visualize, create, edit, manage and export geo-spatial data using QGIS. By exploration of GIS data many types of analysis can be performed. Further many types of very useful maps can be created.

QGIS was first developed by Gary Sherman in early 2002 using C++ language. Later it became an incubator project of the Open Source Geospatial Foundation in 2007 (OSGeo Annual Report). Version 1.0 was released in January 2009 (Sutton et al, 2009). QGIS supports both raster and vetcor data. QGIS supports shapefiles, coverages, personal geodatabases, dxf, MapInfo, PostGIS, and other formats and multiple formats of raster images area supported.

QGIS integrates with other open-source GIS packages, including PostGIS, GRASS GIS, and MapServer. Plugins written in Python or C++ extend QGIS's capabilities. Plugins can geocode using the Google Geocoding API, perform geoprocessing functions, which are similar to the standard tools found in ArcGIS, and interface with PostgreSQL/PostGIS, SpatiaLite and MySQL databases (wiki QGIS).

The QGIS also have QGIS browser and QGIS Server applications. Both of them use same code for data access but come with different front-end interfaces. The QGIS browser is designed to manage geospatial data sets.

2. Quantum GIS - Graphical user interface



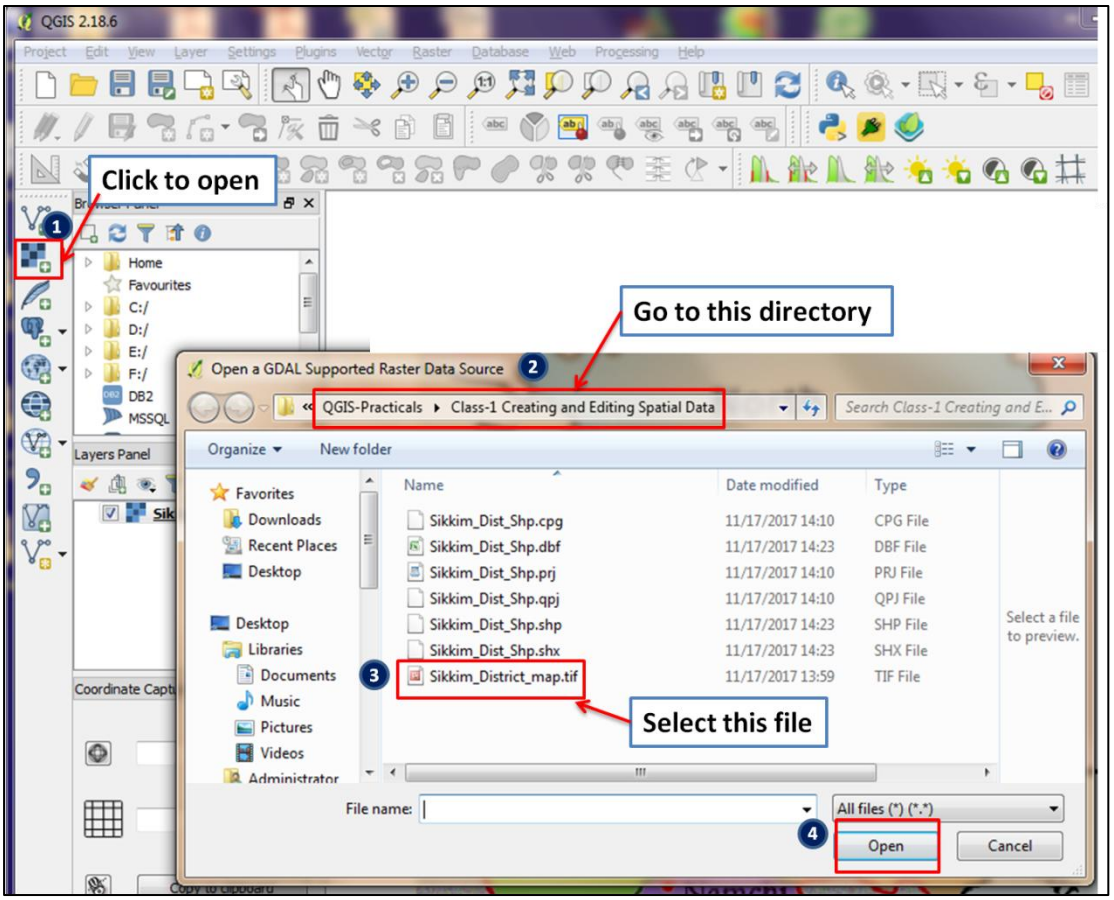
3. Creating and Editing Spatial Data

3.1 Open Raster data-

To create vector data in a shape file, we require a georeferenced raster image. Therefore first step is to open a raster data into QGIS environment.

Steps:

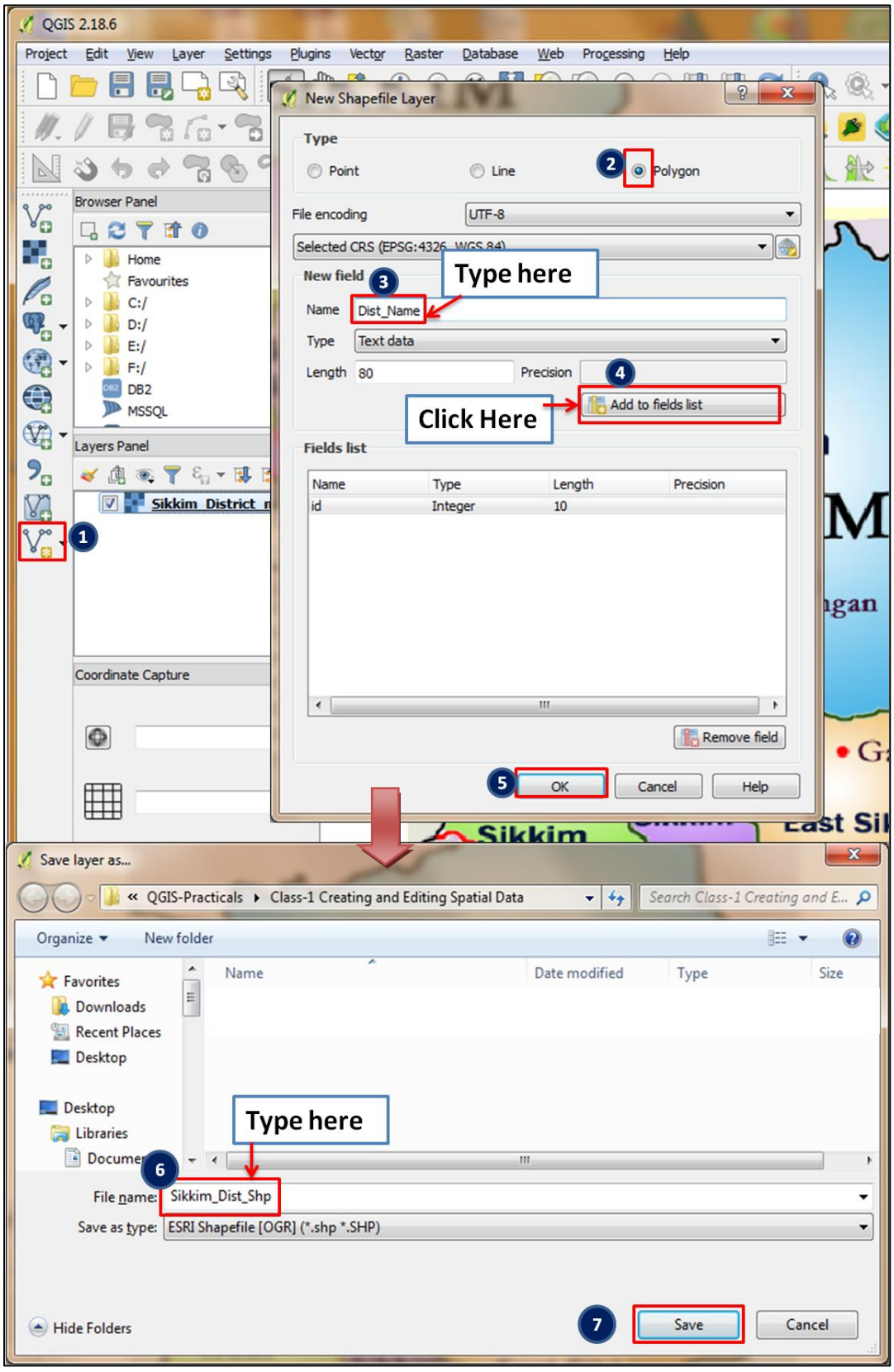
1- Click on *Add Raster Layer* button.
2- In the *Add Raster Layer* dialogue box click on Browse button and go to directory → QGIS Practicals / Class-1 Creating and editing spatial data and choose "Sikkim_District_Map.tif"



3.2 Create a new Shapefile-

1- Click on *New Shapefile Layer* button
2- In the *New Shapefile layer* dialogue box, click on radio button of *Type* of shape file as *Polygon.*
3- To add a new field, write down the name of the *New field* as "Dist_Name". Leave other option as default.
4- Click *Add to fields list* button as shown in image below
5- Click *Ok*. This will redirect you to *Save layer as* dialogue box.
6- Type the name as "Sikkim_Dist_Shp" in the *File Name* text box and

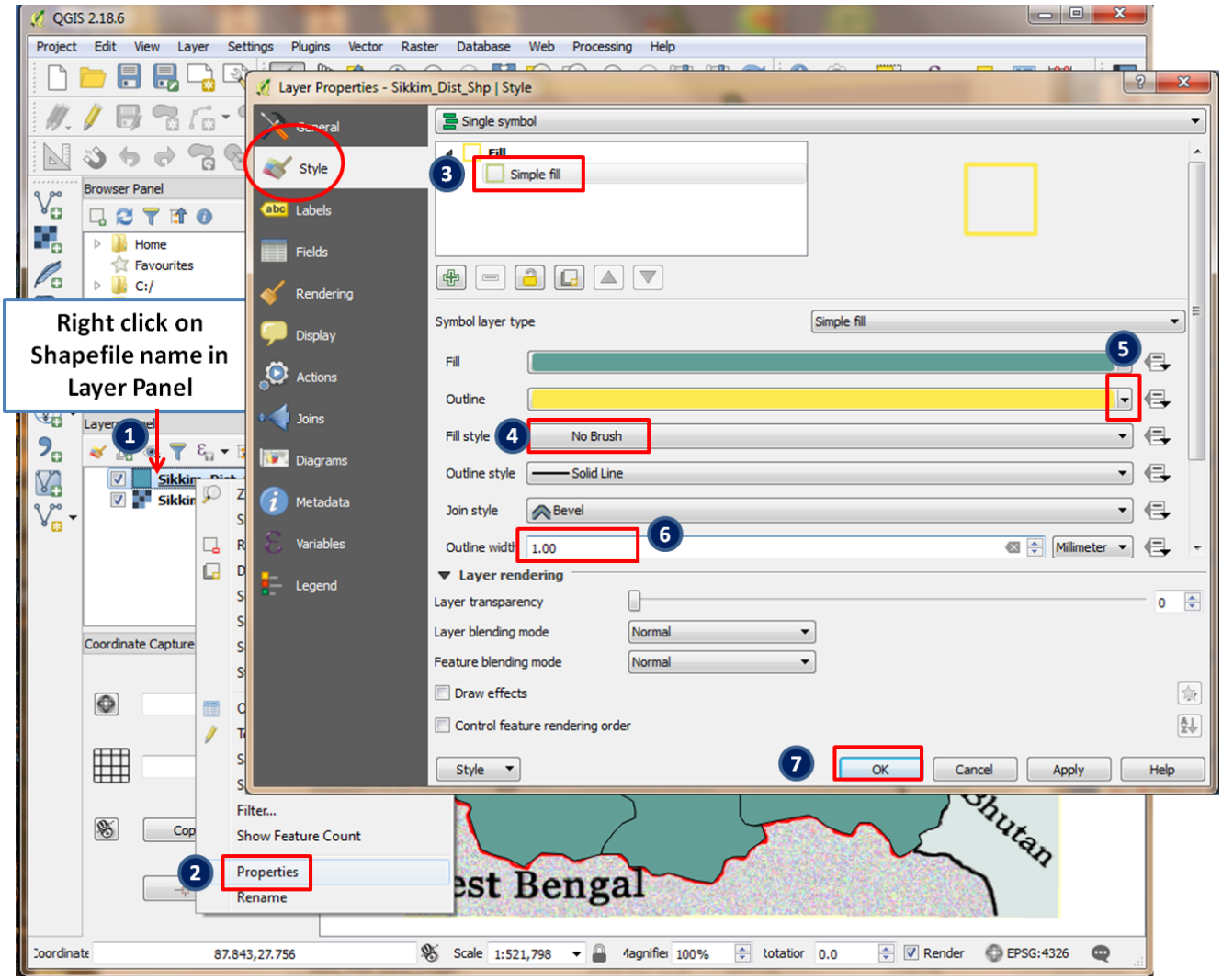
7- Click on *Save* button.



A new shape file with "Sikkim_Dist_Shp" name will be added in layers panel.

3.3 Changing style (Symbology) of the Shapefile before digitization-

When a new Shapefile is created it comes with filled in /solid polygons style that has to be change before digitisation. To change the style of the Shapefile, step are given below-



Steps:

1- Right click on Shapefile name in Layer Panel

2- Click on *Properties* option to open *Layer Properties* dialogue box

3- In the *Style* option given in left pane of the window, select *Simple fill.*

4- In the Fill Style select '*No Brush'* option

5- In the *Outline* option drop down menu, choose 'yellow' colour box, out of given colours.

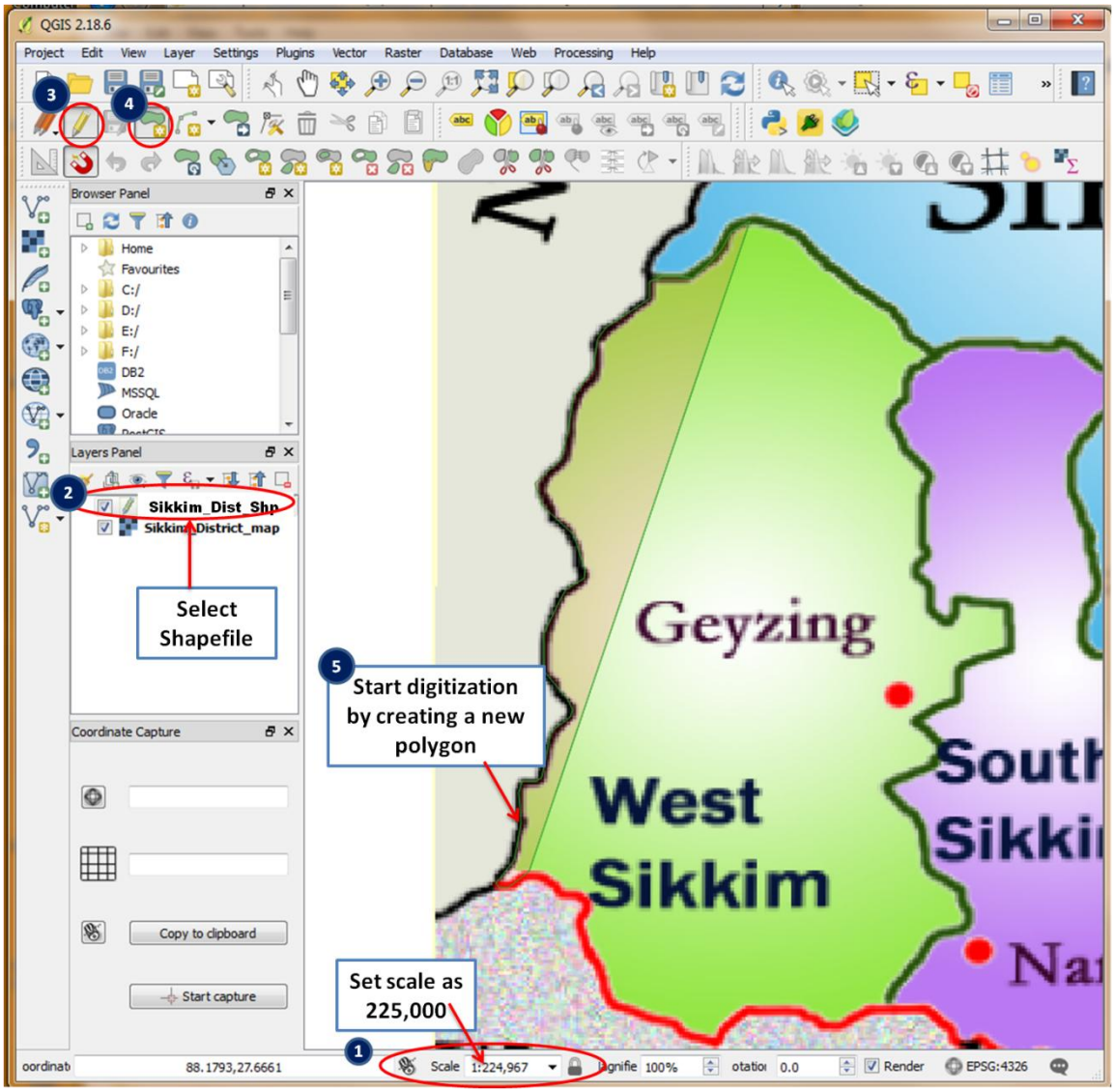
6- Set *Outline Width* as '1.00'.

7- Click Ok.

3.4 Digitization-

Steps:

1- Set Scale of the view as 1:225,000 and zoom to the west Sikkim district shown in image given below-



2- Select Shapefile in *Layer Panel*.
3- Start editing of Shapefile by *Toggle editing* Button.
4- Click *Add Feature* button.
5- Start digitization as shown in above image by putting nodes at appropriate places using left click of mouse.
After digitizing current polygon, to finish, press right click of mouse, give some number in Id field and press Ok.

3.5 Snapping for subsequent polygon digitization-

- After completing the digitization of West Sikkim district, start *Snapping Option* before digitization of subsequent polygon because each polygon shares boundary with at least one polygon. Go to –

Settings → Snapping Option → Snap to Vertex → Tolerance 10.0 → Pixels → Ok

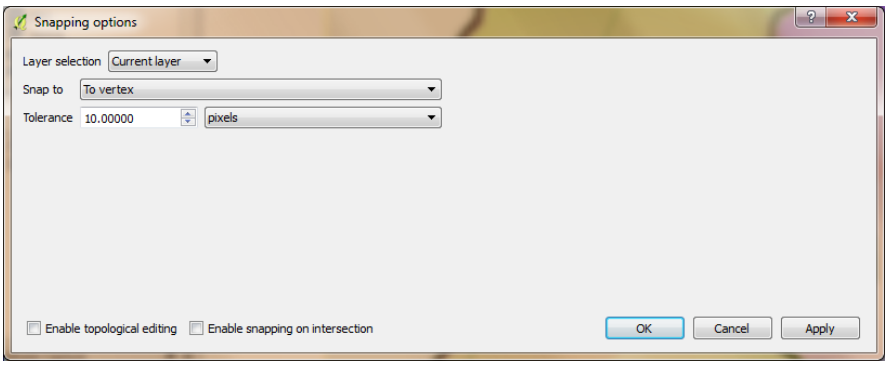
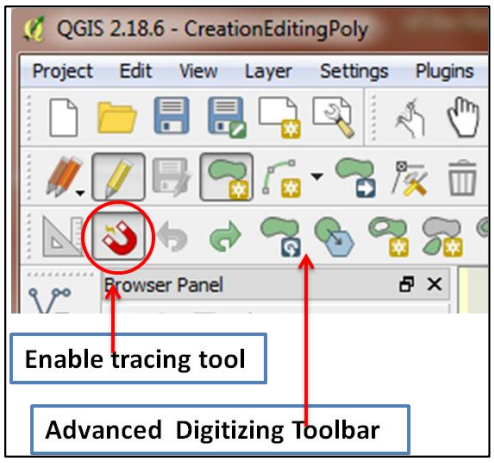


Fig. Snapping settings option window

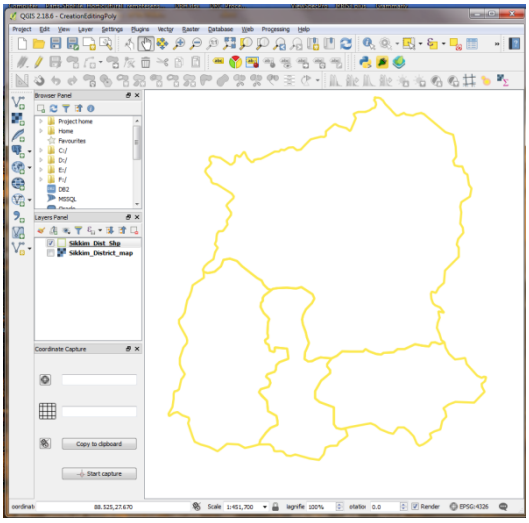
3.6 Tracing of shared boundary

✓ Each polygon has at least one shared boundary with another polygon. Therefore, to avoid gaps between two polygon boundaries, click to *enable tracing tool* given in 'Advanced digitizing toolbar' as shown in adjacent image.



✓ After finishing the digitization of all polygons (Sikkim Districts), click on *Toggle editing* tool, it will ask you to save the changes in Shapefile. Press *Save* button.

✓ Digitized Shapefile of Sikkim Districts is shown in adjacent screenshot.

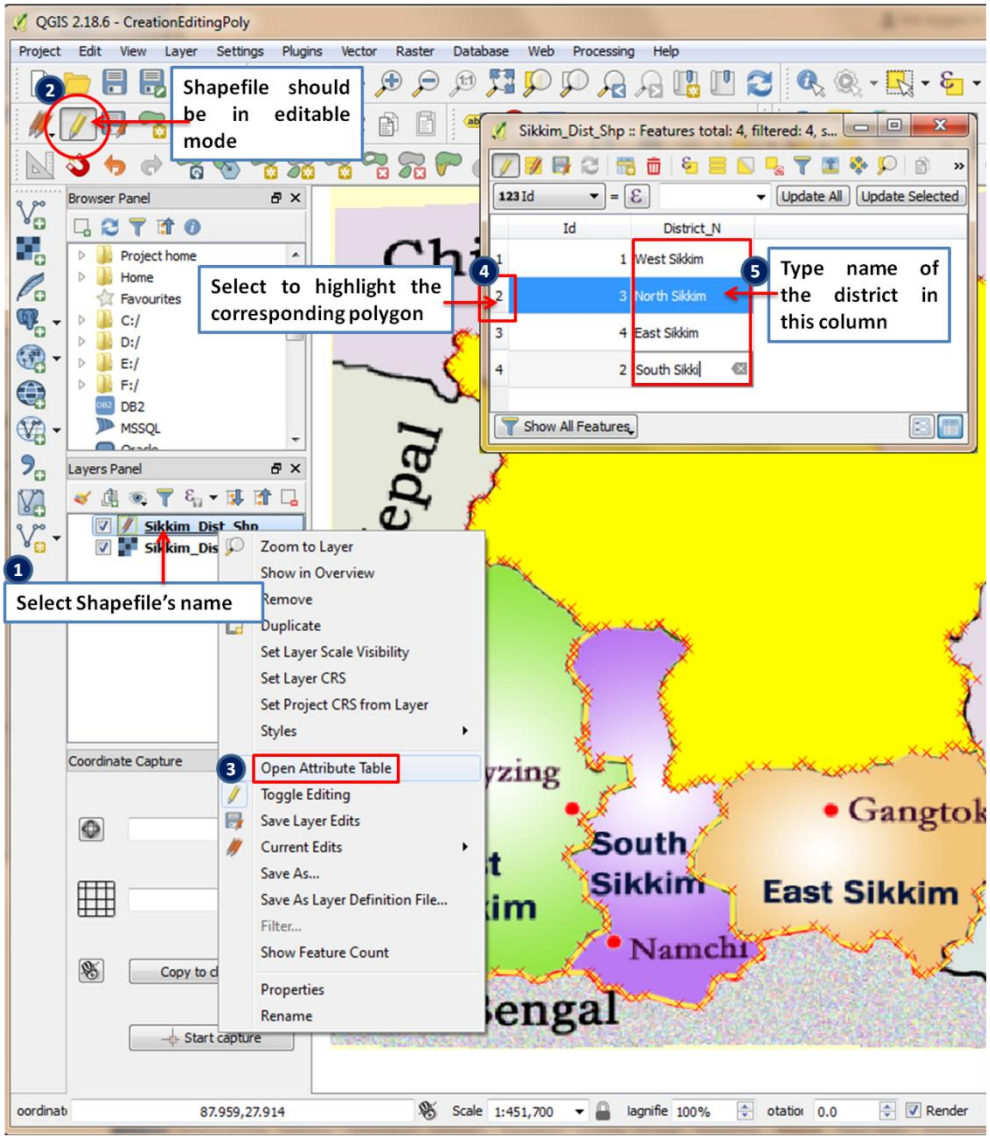


4. Updation of attributes of the vector data in Shapefile

4.1 Updation of Attributes by Manual Entry-

Steps:

1- Select shape file that you have digitized in previous exercise.
2- Click on Toggle editing button, to make shape file editable.
3- Click with right mouse button on shape file's name and choose 'Open Attribute Table' option.
4- In the attribute table, select serial no. of rows as shown in screenshot below. This will highlight the polygon attached with that row.
5- Now fill the name into District_N column by seeing raster map.
Fill the name of all the districts one by one.
Click on toggle editing button again and save your data.



4.2 Updation of Attributes using Microsoft Excel –

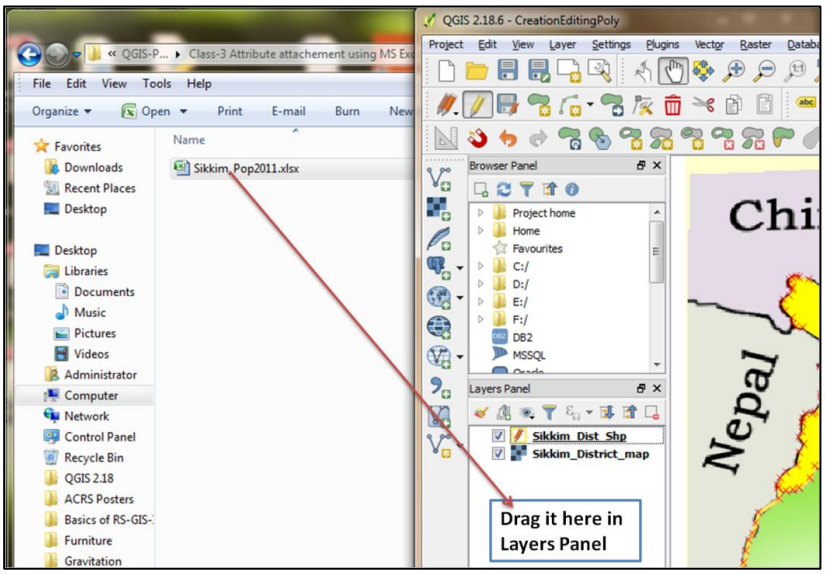
The table given below is provided to you as Microsoft -Excel file (without Map column) named as "Sikkim_Pop2011.xlsx" in the following directory- QGIS-Practicals\Class-3 Attribute attachment using MS Excel.

Code	District	Headquarters	Population (2011)	Area (km²)	Density (/Km2)	Map
ES	East Sikkim	Gangtok	2,81,293	954	257	
NS	North Sikkim	Mangan	43,354	4,226	10	
SS	South Sikkim	Namchi	1,46,742	750	175	
WS	West Sikkim	Geyzing	1,36,299	1,166	106	

Open the folder containing excel file and follow the steps given below-

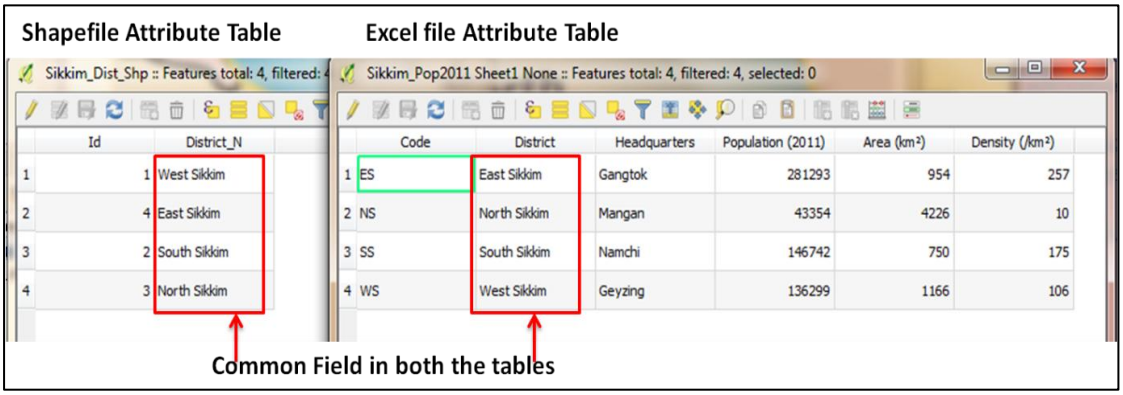
Steps:

- Drag the excel file into 'Layer Panel' of QGIS

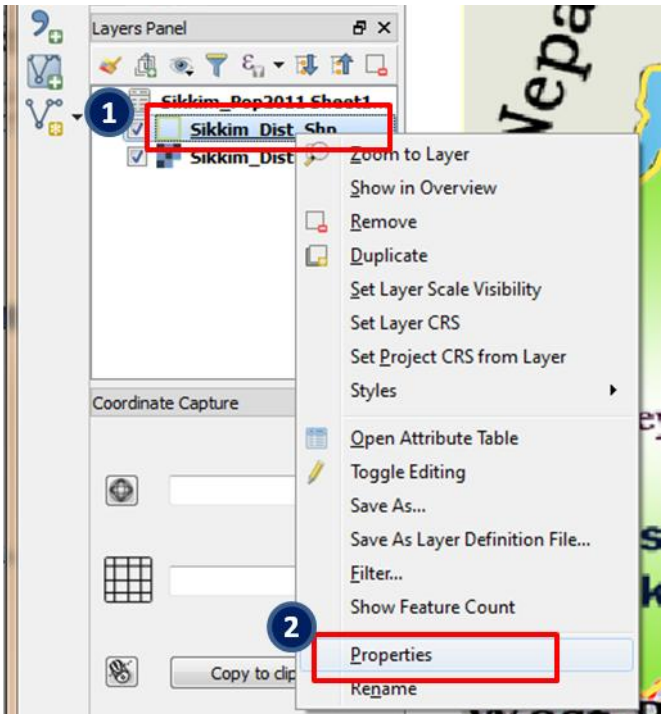


- Right click on name of Shapefile and open its attribute table. Right click on name of excel file and open its attribute table.

  You will see that there is a common filed in both the tables (As shown in screenshot below). This common field is required for joining of two tables. You can close both the tables.

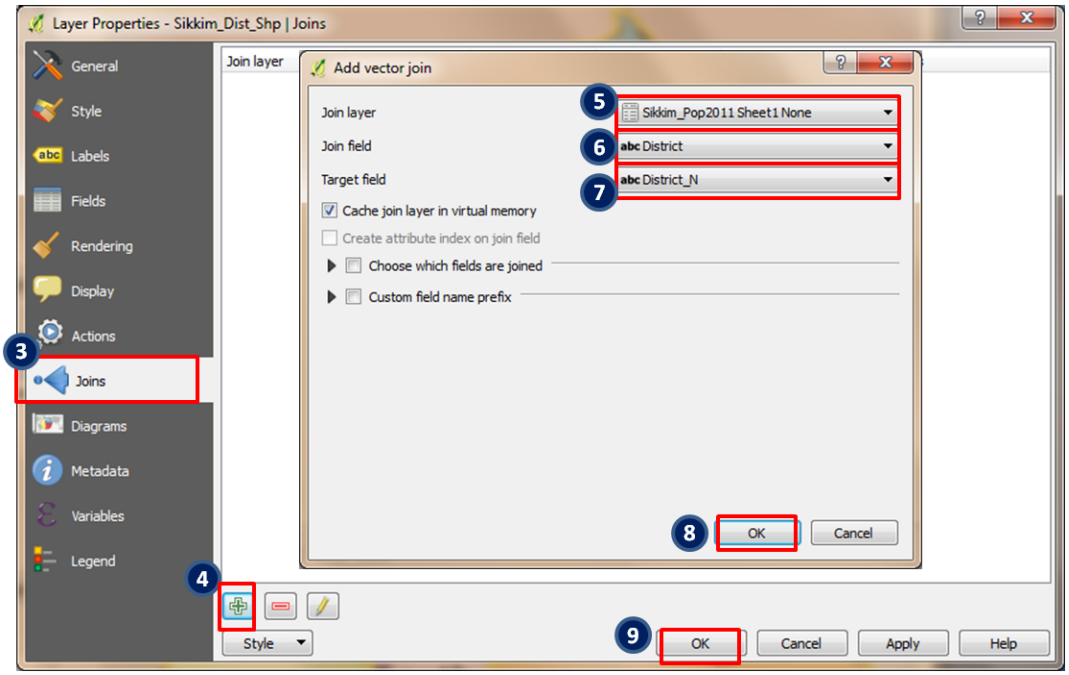


1- Right click on Shapefile's name in Layer Panel of QGIS.
2- Choose Properties option.



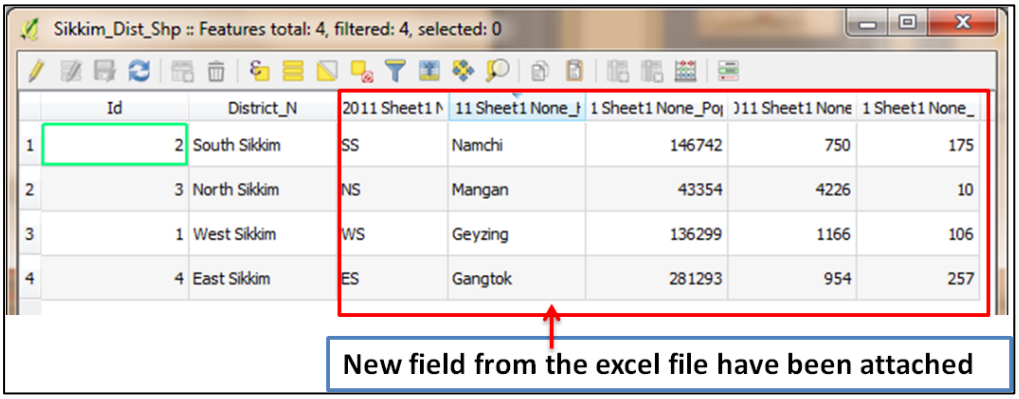
3- Click on *"Joins"* in left pane of Layer Properties dialogue box as shown in screenshot below.
4- Locate the + symbol in bottom of the Layer Properties dialogue box. This will open "Add vector join" window.
5- Make sure that "Sikkim_Pop2011" is selected against *Join Layer* text.
6- Select "*District*" field of the excel file in Join field option.

7- Select "*District_N*" field of the Shapefile in the Target field option.
8- Click Ok in *Add vector join* dialogue box.
9- Click Ok in *Layer Properties* dialogue box.



Check the joined data in Shapefile attribute table-

Now in the Layers Panel of QGIS, by Right clicking on Shapefile's name, open the attribute table. You can see that the fields of the excel file have been attached in the attribute table of Shapefile as shown in image below-



Save the Shapefile-

In the Layer Panel, select Shapefile and right click on it. From the options choose Save as option. Save this Shapefile (provide name as "Sikkim_Dist_Shp_attributed") in the class-1 folder where you have created a Shapefile in previous exercise.

To save the joined shapefile as a new Shapefile, is important because once the session is closed, the joined data will be removed from the attribute table.

Remove the Shapefile "Sikkim_Dist_Shp".

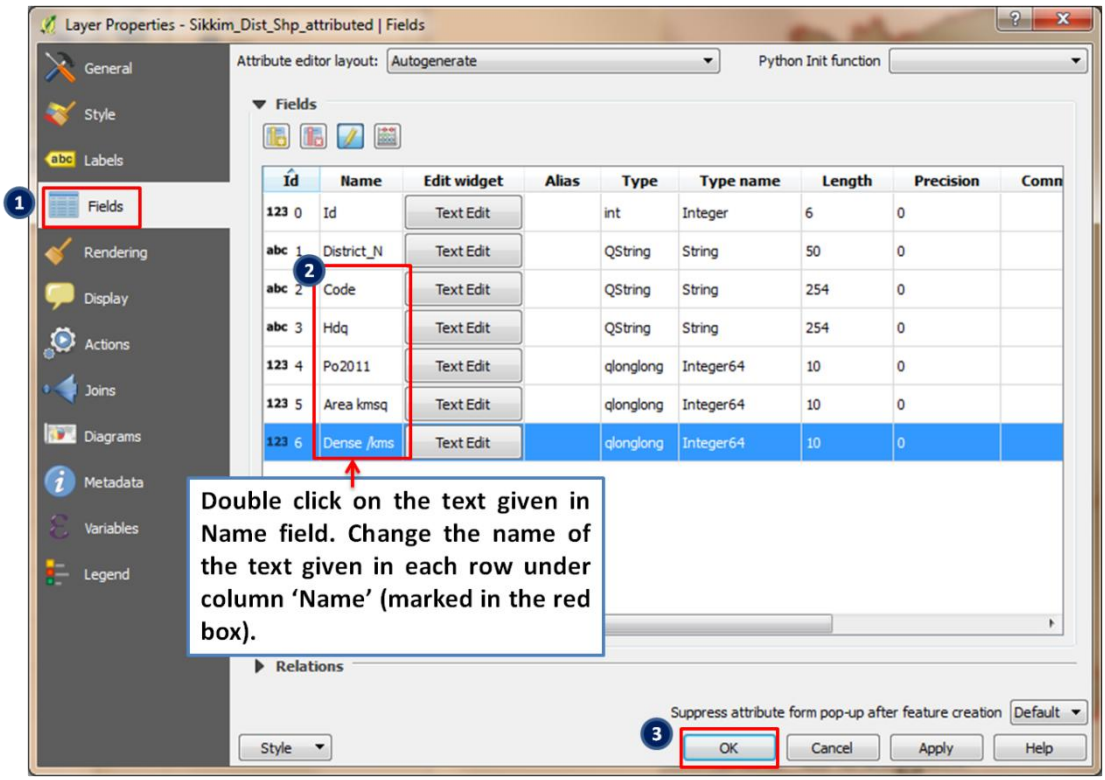
4.3 Edit Names of the Fields in a Shapefile -

The new field which has been joined from excel do not have appropriate names in the Shapefile. To recognise new fields by their proper names for further exercises, it is necessary to change the name of the fields.

Steps:

- Make the Shapefile editable by *selecting the Shapefile* and *clicking on toggle editing* button.
- In the Layer Panel of QGIS, Right click on the Shapefile and choose *properties* option.

1- In the *layer properties* dialogue box, select *Field* option given in left pane (as shown in screenshot below).



2- Under the column "Name", change the name of columns as given in screenshot above. New fields name under column "Name" will be -
Id, District_N, Code, Hdq, Po2011, Area kmsq, Dense /kmsq.

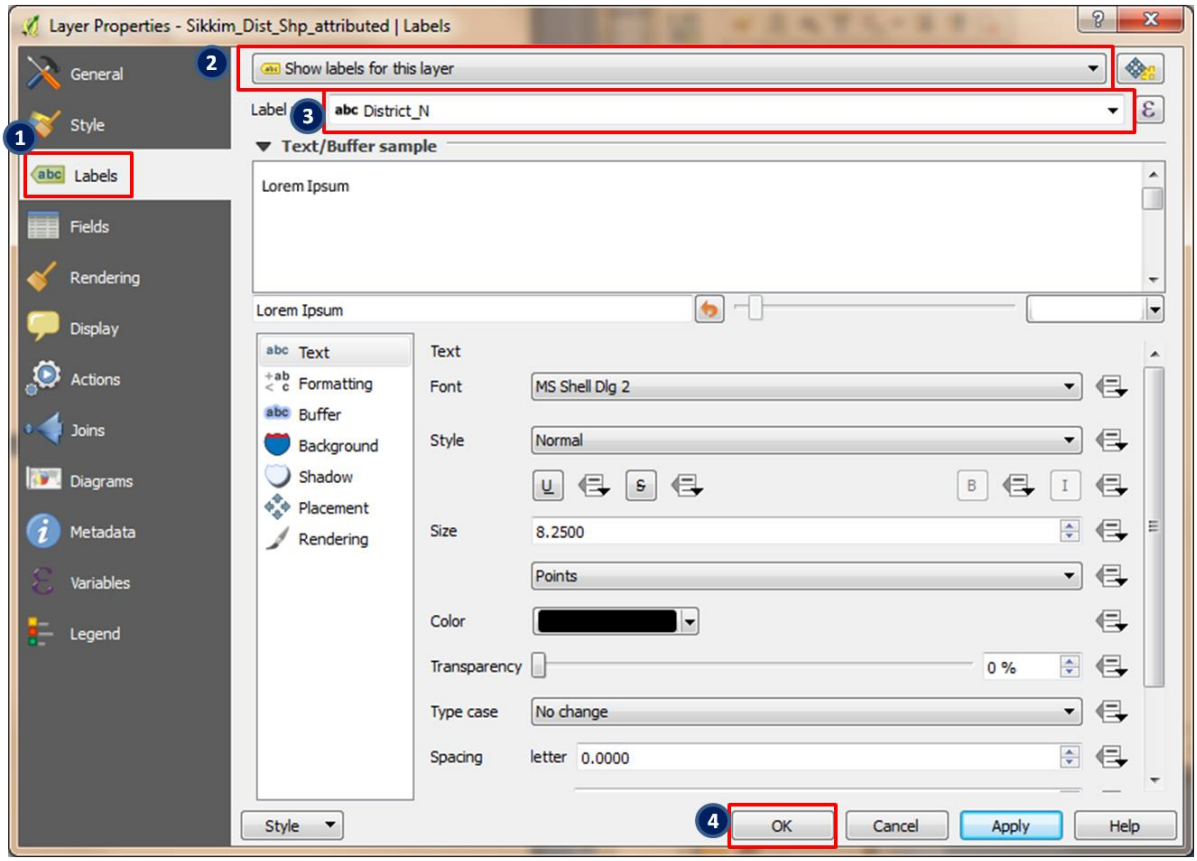
3- Click Ok.

5. Labelling of Vector data

Right click on Shapefile's name → Properties.

In the layer properties window

Labels → Show labels for this layer → Label using 'District_N' → Ok.



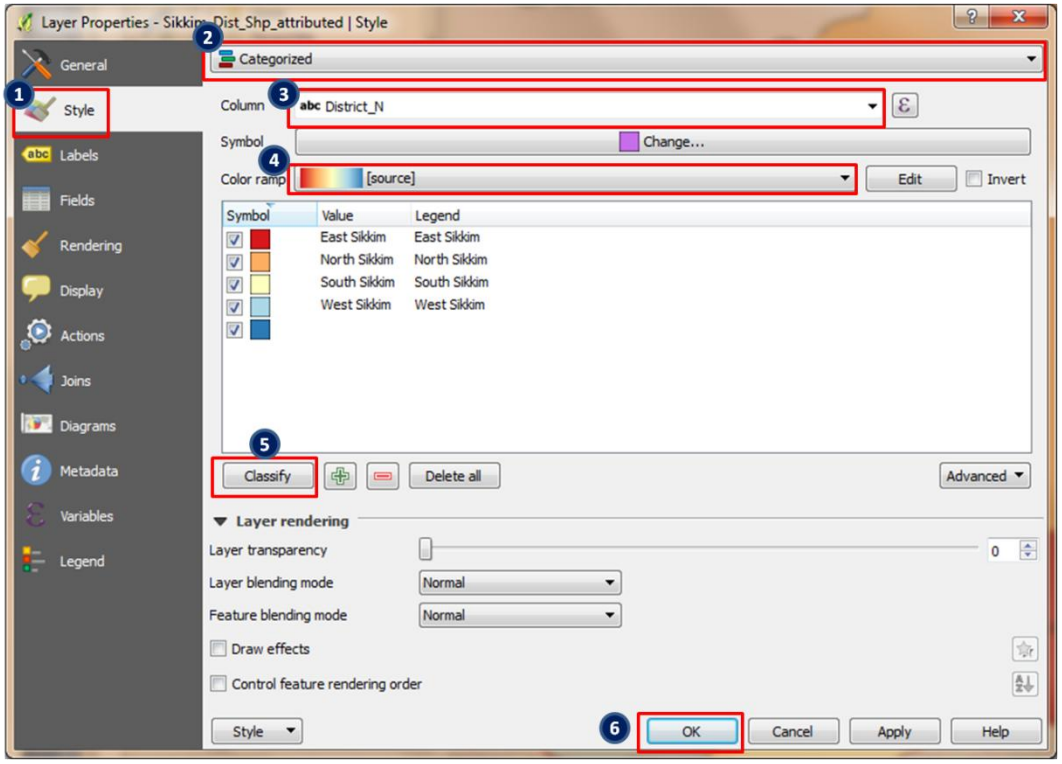
6. Creation of Thematic Maps

6.1 Using Categorized Colours Symbology-

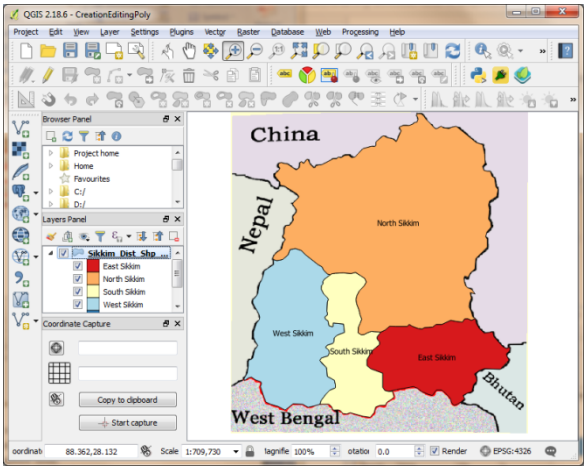
Steps:

Right click on Shapefile's name → Properties.

1- Select *Style* option from left pane of *Layer Properties* wimdow.
2- Choose 'categorized' option from the drop down list.
3- In the *column* field, choose 'District_N' that is one of the Shapefile attribute table's column name.



4- In the *Color ramp* option, choose a color ramp from the drop down menu. See the screenshot given above.
5- Click on *Classify* button. This will populate the area above classify button with names of districts and different colours against them.
6- Click *Ok*.



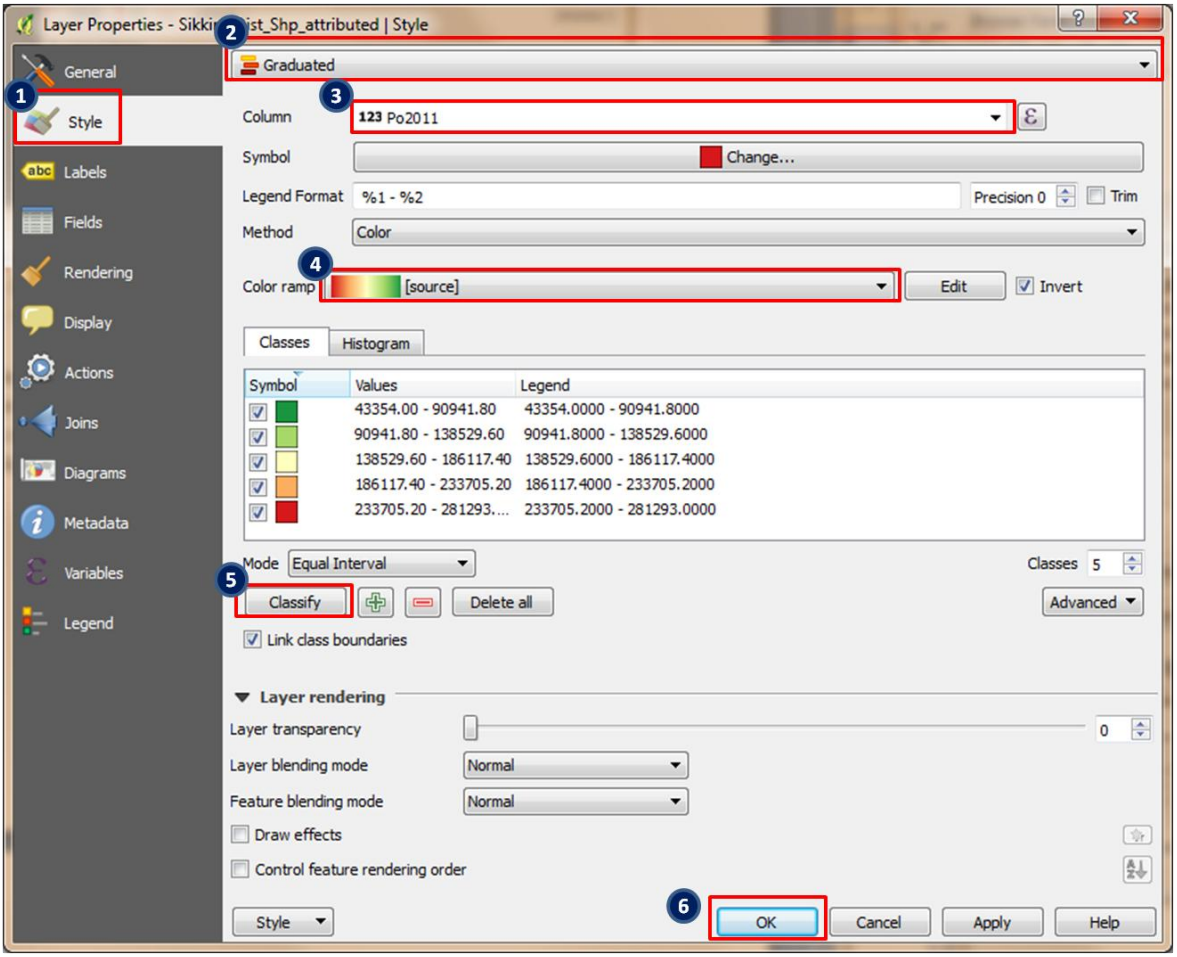
6.2 Using Graduated Colours Symbology-

Steps:

Right click on *Shapefile's name* → *Properties.*

In the 'Layer Properties' window-

Style → *Graduated* → *Column – Po2011* → *choose a Color ramp* → *Classify* → *Ok.*



6.3 Pie chart diagrams with symbology-

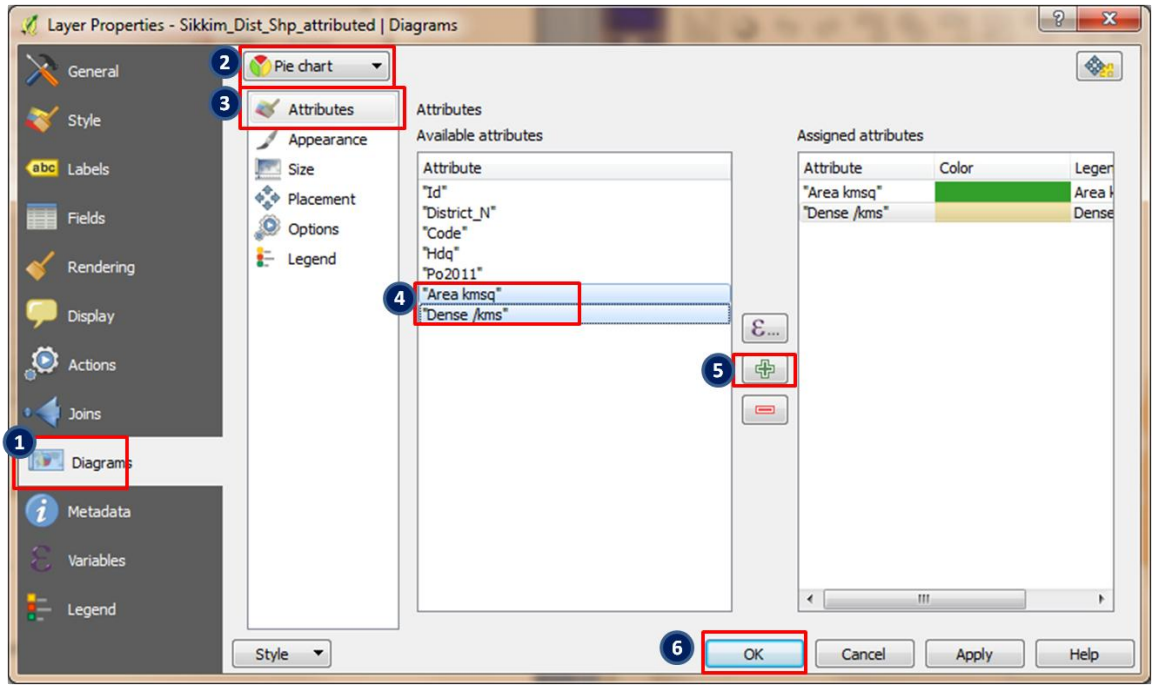
Steps:

Right click on *Shapefile's name* → *Properties.*

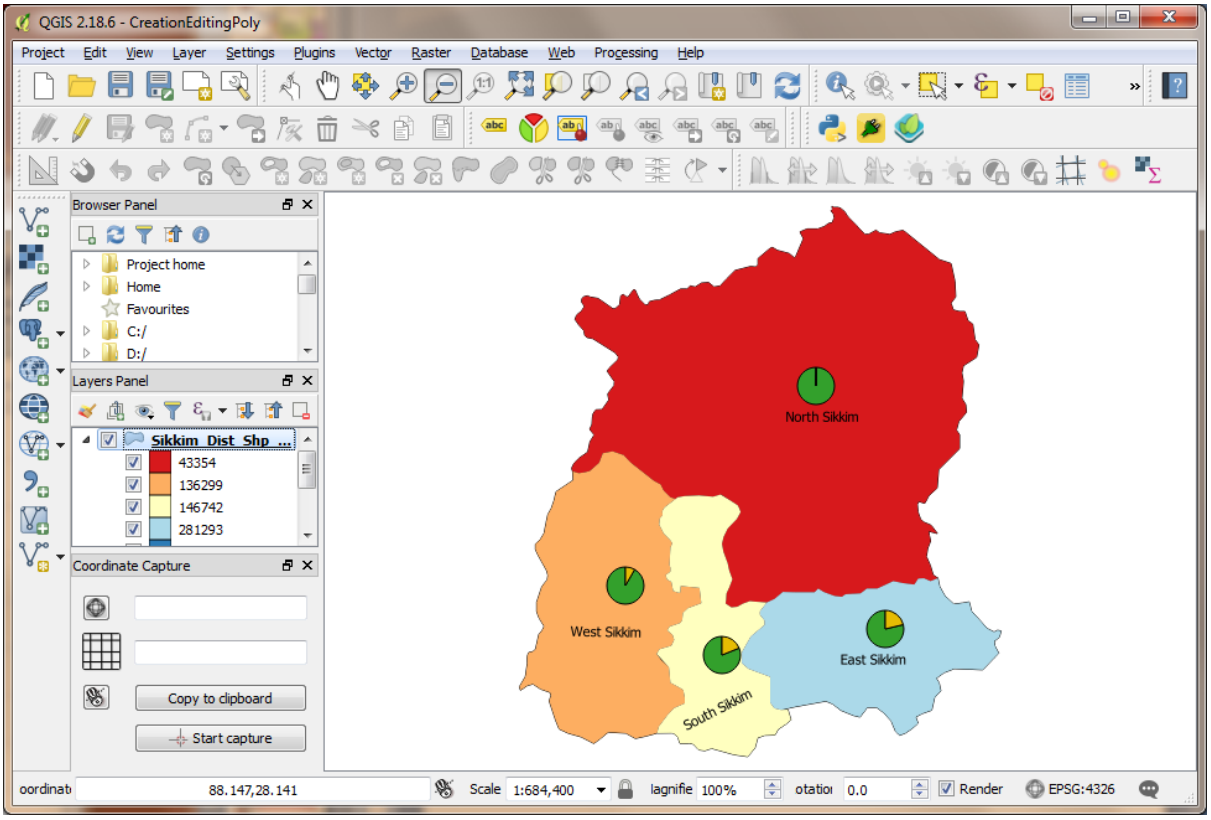
In the 'Layer Properties' window-

Select *Diagrams* → Choose *Pie chart* → Select *Attributes* → Select last two attributes → press + → Ok

(Refer Screenshot below)



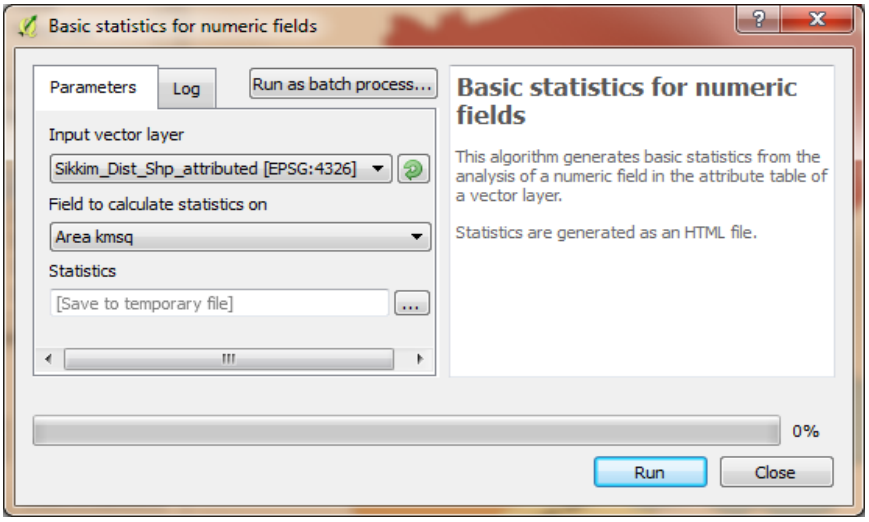
By clicking ok, Pie chart will be overlaid on the respective polygons as shown in screenshot below-



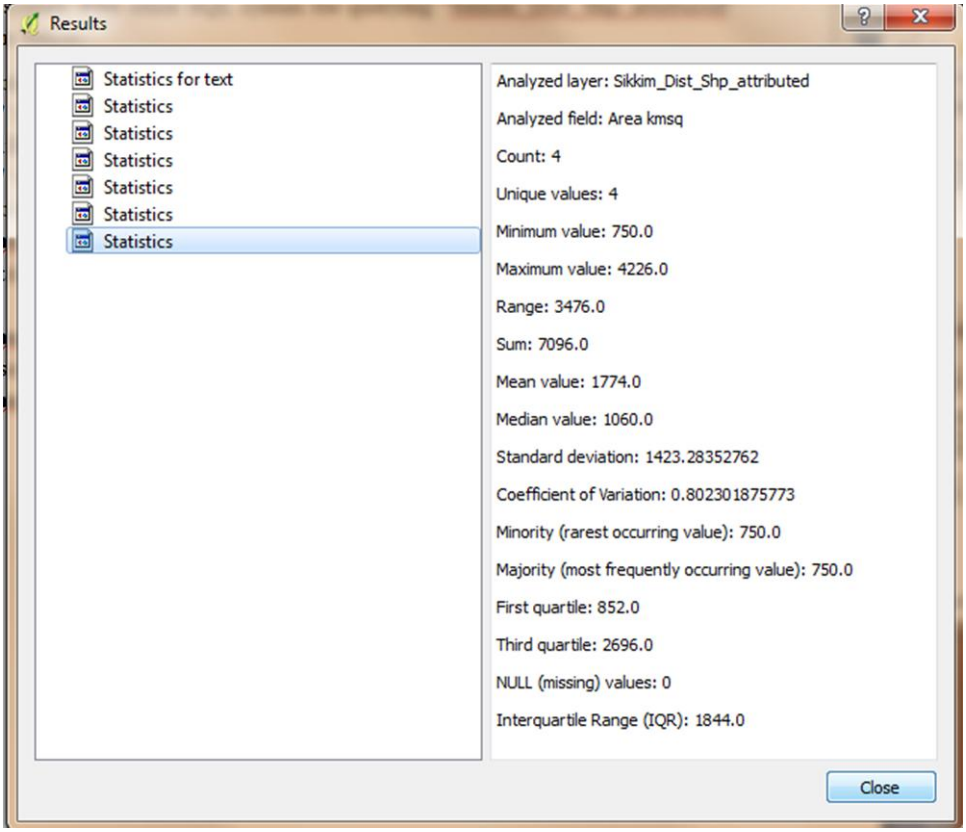
7. Extraction of basic statistics for numeric fields

From the main menu of QGIS, choose-

Vector → Analysis Tools → Basic statistics for numeric fields → Select shapefile's name and a numeric field → Run.



Using this option, one can compute the basic statistics like min value, max value, median, mean, sum, etc for a numeric field given in a Shapefile. One example of the field "Area kmsq" of the Shapefile "Sikkim_Dist_Shp_attributed" has been given in the screenshot below-



8. Performing spatial queries

In QGIS, spatial queries can be performed using SQL like expressions. For many GIS analysis, the spatial queries are very much essential to be performed. In a huge set of vector data queries provide a very specific and desired results.

Steps:

1- Right click on Shapefile name

2- Select “open attribute table” option. Attribute table of the Shapefile will be opened.

3- In this table, a toolbar is given in top of the window. Click on “Select Feature using Expression” button (as shown in screenshot below).

4- In the *Select by Expression* dialogue box, click on “Fields and Values” drop down list

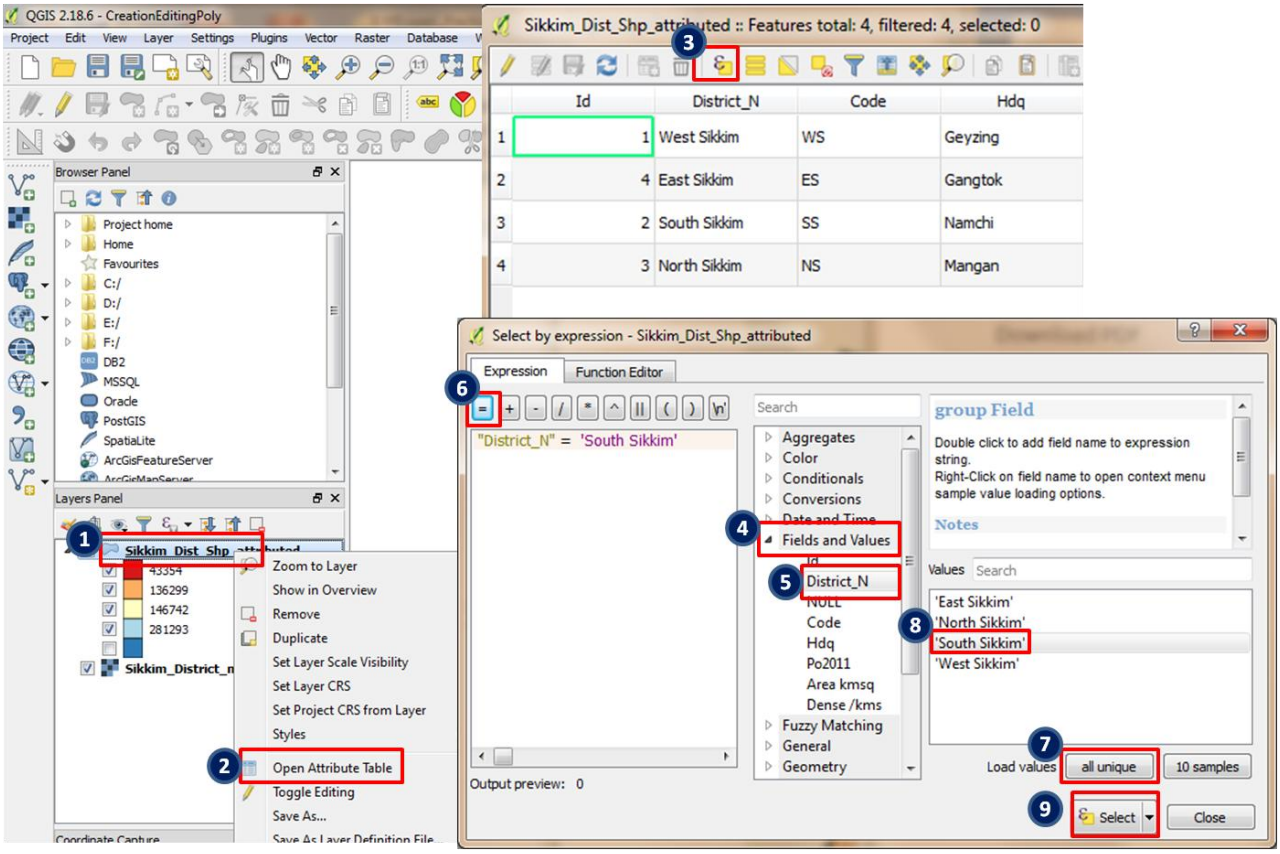
5- Double click on “District_N”

6- Click on “=” (equal to) sign

7- Click on “all unique” button in front of *Load values* text.

8- Double click on any district name. For example ‘South Sikkim’ is shown here.

9- Now finally click on ‘Select’ option.

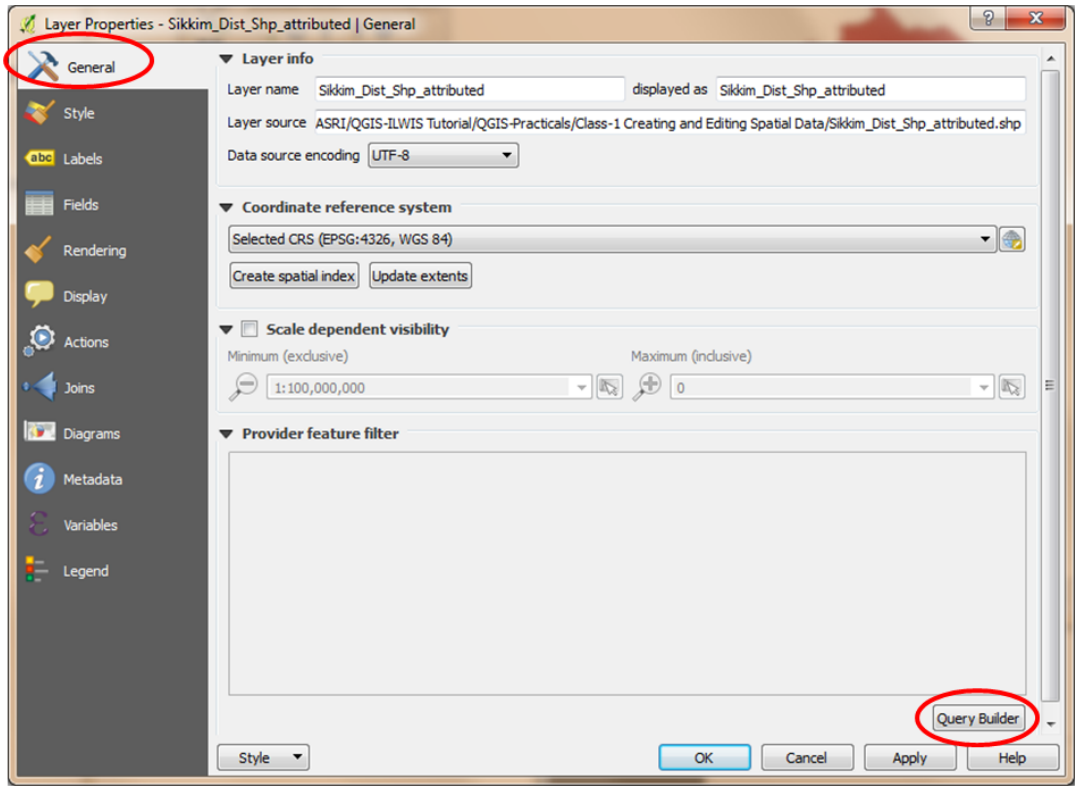


Similarly, using *Select by Expression* dialogue box, spatial queries can be executed by typing an appropriate SQL syntax. Few other SQL syntax for querying "Sikkim_Dist_Shp_attributed" Shapefile are given below-

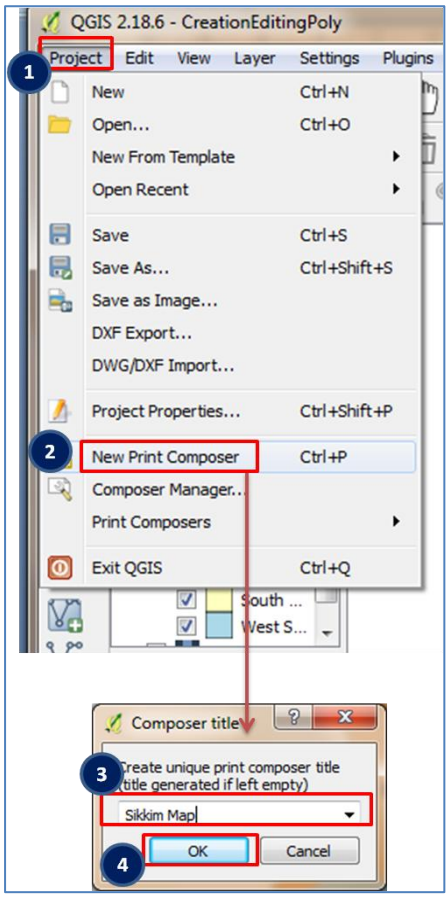
1) Select districts having population greater than or equal to 130000-
   "Po2011" >= 130000
2) Syntax fulfilling to conditions-
   "Po2011" >= 136299 AND "District_N" = 'South Sikkim'
3) Select districts having area (km^2) greater than 1000
   "Area kmsq" > 1000
4) Select districts having area greater than 1000 km^2 and having density greater than 100 $km^{2.}$
   "Area kmsq" > 1000 AND "Dense /kms" > 100
5) The expression satisfying three conditions-
   "Area kmsq" < 1000 AND "Dense /kms" > 100 AND "Code" LIKE 'SS'.

Note: A simple 'Query Builder' dialogue box can also be opened from-

Right click on Shapefile's name → Properties → General → Query Builder (Bottom of the window)



9. Map Composition



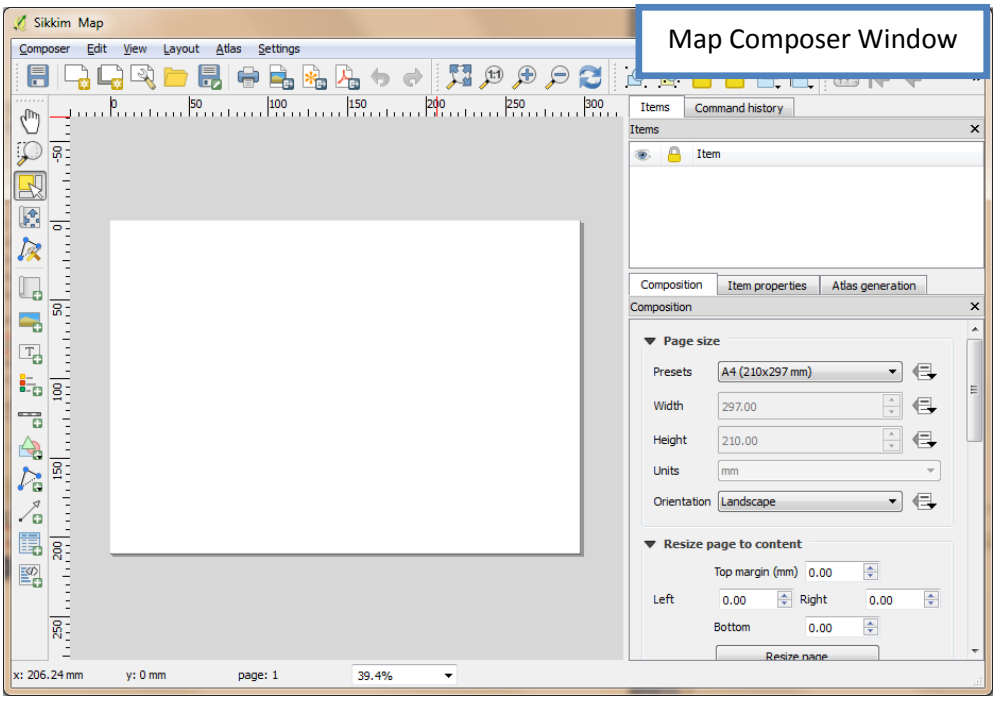
To compose a map in QGIS, follow steps given below-

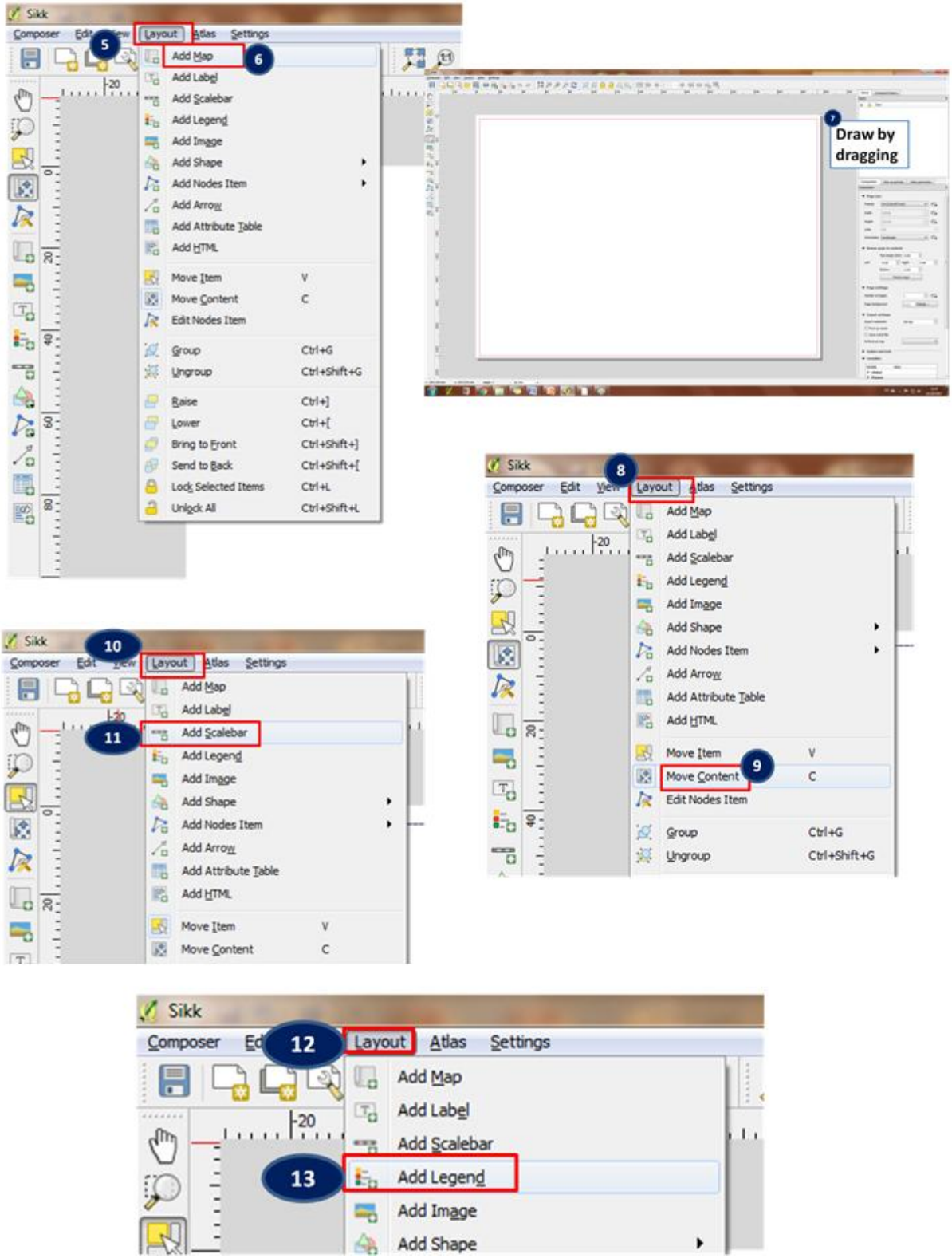
Steps:

In the main menu of QGIS, Go to-

1- Click on *Project* in main menu
2- Click *New Print Composer*
3- Type "Sikkim Map" title as a composer title.
4- Click *Ok.*
5- Click on *Layout* in *Map composer window.*
6- Click on *Add Map* option.
7- Draw a rectangle in the Map composer page (as shown in screenshot on next page)

After drawing a rectangle (using Add Map option), the vector data will be shown inside it.



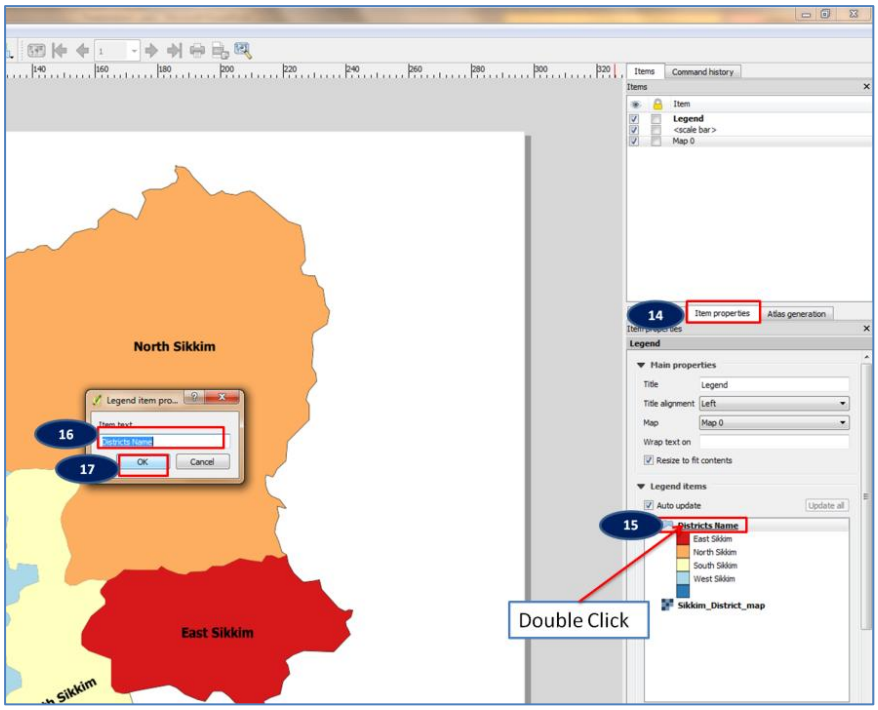


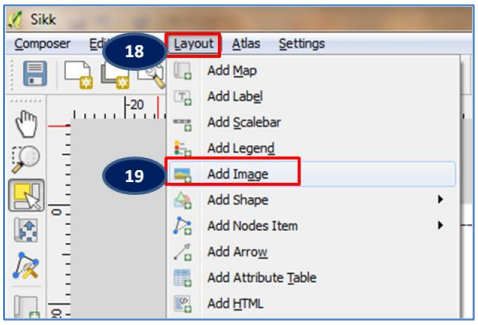
8- Click on *Layout* option of Map composer menu and

9- Click on *Move content* option, to adjust the map contents.

10- Again Click on *Layout* option and

11- Click on *Add Scalebar* option and place scale bar in the bottom of the map composer window.





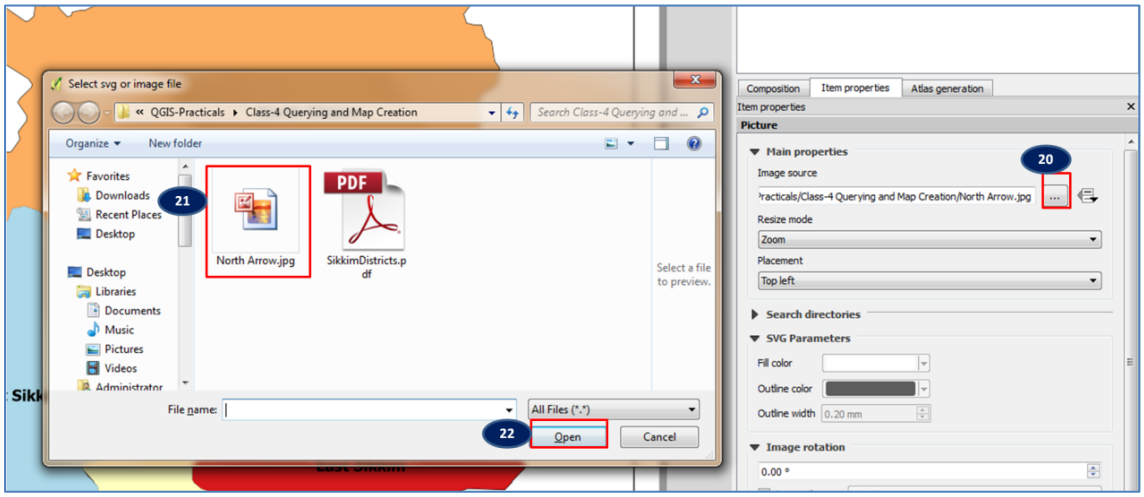
To add legend on the map-

12- Again Click on *Layout* option and

13- Choose *Add Legend option.*

14- In the right pane, Click on *Item Properties*

15- Double click on the name as shown above. A new dialogue box prompting you to provide name will be opened.



16- Type “Districts name” in the dialogue box.

17- Click *Ok*. This will change the Subheading of the Legends

18- To add north arrow in the map, we have to choose an image having north arrow from the system directory.

Click on the *Layout* option.

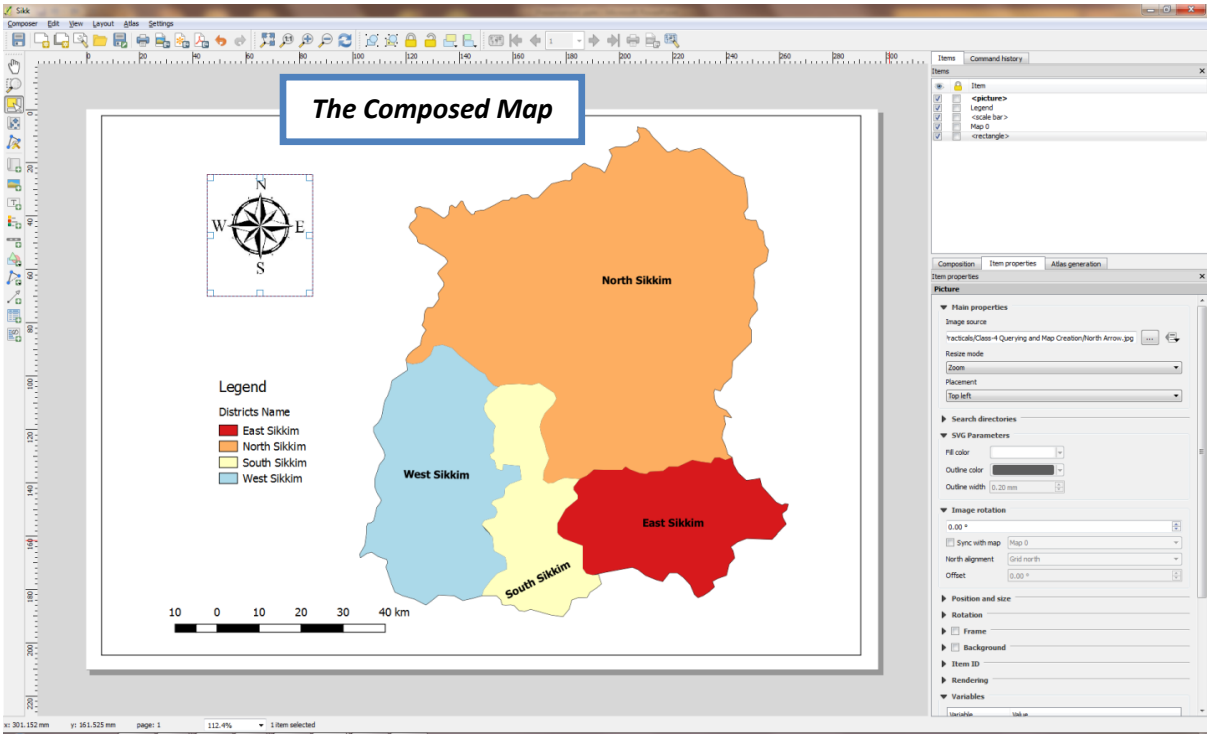
19- Choose *Add Image* option and draw a rectangle on upper left corner of map.

20- In the Item Properties, under *Image Source* text, a button is provided, Click on this button and

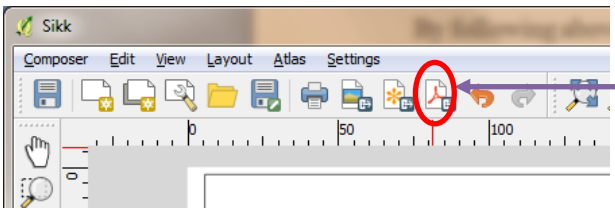
21- Choose image named as ‘North Arrow.Jpg’ from the Class-4 folder in the same directory.

22- Click *Open* (See image above). It will populate the image in the North arrow rectangle that you have drawn in the step-19.

By following above steps, a map will be created as shown in screenshot below.



- This map can be exported as a PDF file, using the option given in main menu of Map Composer window.



Export as PDF option, for exporting the composed map as a .pdf file.

References-

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