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A Manual of Quantum GIS for Basic Forestry Applications

Version 1.0

QGIS

Forest Survey of India
Ministry of Environment, Forest & Climate Change, Government of India
Kaulagarh Road, Dehradun-248195

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Version 1.0

(an open source software)

Training and Forest Inventory Division

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Director General, Forest Survey of India

Preface

Remote Sensing and GIS has found diverse applications in forestry. For monitoring and assessment of forest resources, use of Remote Sensing and GIS has now become inevitable. With the implementation of National Working Plan Code 2014, there is extensive use of GIS in preparation of working plans. In this scenario, it is need of the hour to develop capacity of the State Forest Departments in using GIS software which are easily available to the users and are easy to operate.

Quantum GIS (QGIS) is one such software which is a freely downloadable and open source software of GIS applications. QGIS provides excellent capabilities, stable operation and support numerous vector, raster, database, formats and functionalities. Like other GIS applications, QGIS provides a geographical user interface wherein different layers of spatial data can be displayed and analysed. Many commercial GIS software available in the market are very expensive and cost a huge financial burden on users not only in purchasing licenses but also for their annual maintenance.

Considering numerous uses of GIS in different forestry applications and heavy cost of proprietary software, FSI has included modules on QGIS in its training programmes to develop capacity of the State Forest Departments (SFD) in use of QGIS.

The Manual of Quantum GIS for Basic Forestry Applications Version 1.0, developed by FSI is a step in popularising QGIS in the SFDs. The manual contains different chapters describing the basic concepts of QGIS and easy to understand steps illustrated through screen shots of GUIs. The manual will enable users to understand and perform basic GIS analysis such as geo-referencing, creating geo-spatial layers, vector processing, map composition etc.

I acknowledge the sincere efforts done by Dr. Madhu Bist, Project Scientist in preparing this manual. She has developed deep understanding of different functionalities of QGIS software. Contributions of Shri Sushant Sharma JD (TFID) and Shri Prakash Lakhchaura DDG are acknowledged. Thanks are also due to other officers and staff of FSI who have contributed in preparation of the manual. I hope, the manual will be immensely useful to the SFDs. FSI is in the process of developing an advanced manual on QGIS also for different forestry applications and the same will be shortly made available to the users.

23 May, 2019

(Dr. Subhash Ashutosh)
Director General, FSI

Contents

CHAPTER 1:
QUANTUM GIS

QGIS is an Open Source Geographic Information System. QGIS was first developed and established as a project Source Forge in 2002. QGIS known as Quantum GIS is a cross-platform, free and open source Geographic Information system (GIS) application that provides capability of data viewing, editing and analysis of spatial data. QGIS allow users to create maps with many layers using different map projections. It currently runs on multiple operating systems, most Unix platforms, Windows, and macOS. QGIS is developed using the Qt toolkit (https://www.qt.io) and C++. Therefore, easy-to-use graphical user interface (GUI). QGIS aims to be a user-friendly GIS, providing common functions and features. The initial goal of the project was to provide a GIS data viewer.

QGIS supports a number of raster and vector data formats. QGIS supports vector, raster and database formats. It supports many common spatial data formats (e.g. ESRI Shapefile, geotiff) with new format support easily added using the plugin architecture.

QGIS is released under the GNU General Public License (GPL). Developing QGIS under this license means that you can inspect, modify the source code and always have access to a GIS program that is free of cost and can be freely modified.

What QGIS can do?

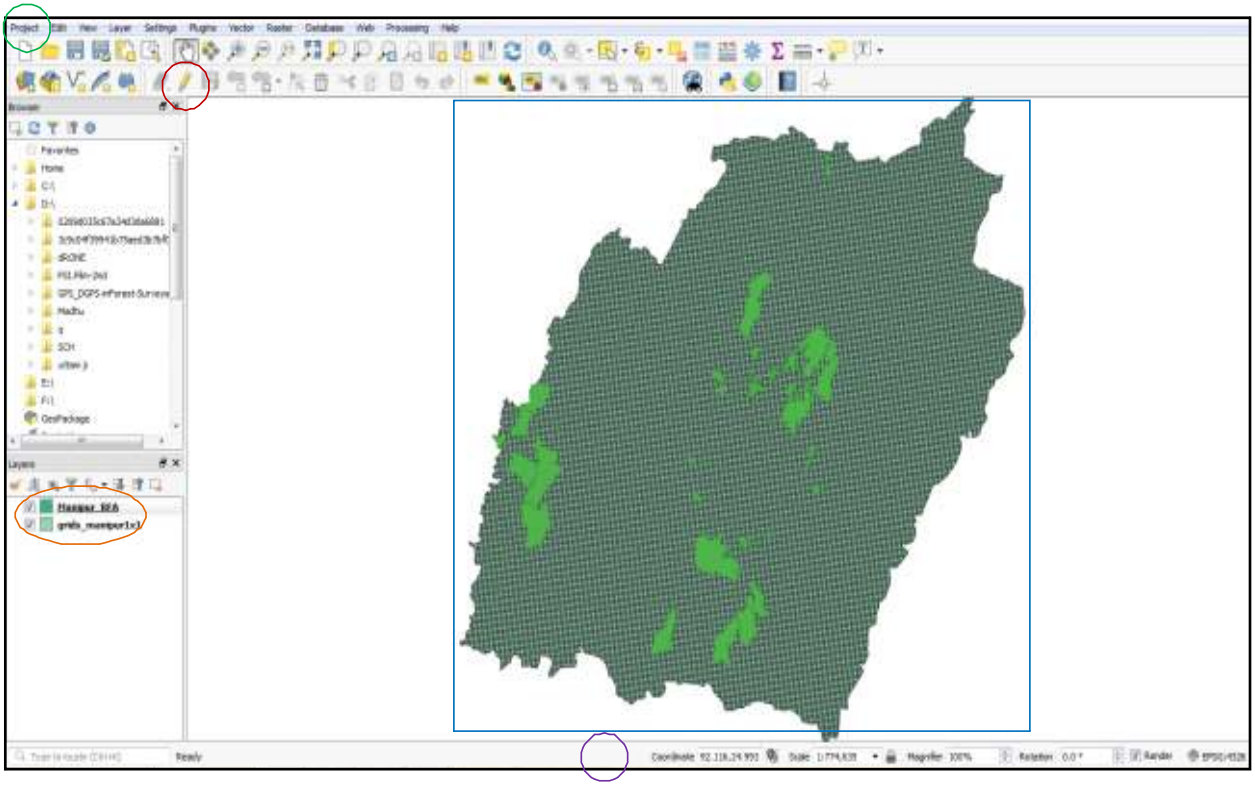
- View spatial data.
- Digitise points, lines and polygons.
- Import GPS data in GIS layer, view GPS data (point, line, polygon on Google earth).
- Georeference Satellite images including Google earth images.
- Measure area, perimeter, length .
- Compose maps on desirable scale.
- Create buffer along the roads around the villages, forest etc.

Note: **Installation of QGIS Software**

- Insert the Compact disc (CD) where the Software is saved.
- Double click on QGIS .exe setup file and click on next button.
- Read the License Agreement and click on I Agree button.
- Choose the location (Local Drive) you want to install the software and click on next button then click install.
- Please wait while installation and extraction process is in progress.
- When installation is completed, click on Finish button and open the software.

1.1 QUANTUM GIS GRAPHICAL USER INTERFACE

When QGIS starts, you are presented with the GUI as shown in the figure:



The QGIS GUI is divided into five areas:

1. **Menu Bar:** Provides access to various QGIS features using a standard hierarchical menu.
2. **Tool Bar:** Provides access to most of the functions as the menus, plus additional tools for interacting with the map.
3. **Map Legend:** Lists all the data layers in the project. This area also allows to change style or label the layer.
4. **Map View:** The map displayed in this window will depend on the vector and raster layers you have chosen to load.
5. **Status Bar:** The status bar shows you your current position in map coordinates as the mouse pointer is moved across the map view.

    - Using these five areas (as mentioned above), you can add a data layers, zoom to a specific area in the data, hide or show relevant layers and see the coordinates, scale and projection of your displayed map.

NOTE: You can use middle button of your mouse to pan the map.

CHAPTER 2:

GEOREFERENCER PLUGIN

- The Georeferencer Plugin is a tool for generating world files for rasters. It allows you to reference rasters to geographic or projected coordinate systems by creating a new GeoTiff or by adding a world file to the existing image. The basic approach to georeferencing a raster is to locate points on the raster for which you can accurately determine coordinates.

Icon	Purpose	Icon	Purpose
	Open raster		Start georeferencing
	Generate GDAL Script		Load GCP Points
	Save GCP Points As		Transformation settings
	Add Point		Delete Point
	Move GCP Point		Pan
	Zoom In		Zoom Out
	Zoom To Layer		Zoom Last
	Zoom Next		Link Georeferencer to QGIS
	Link QGIS to Georeferencer		Full histogram stretch
	Local histogram stretch		

Table: Georeferencer Tools

- As X and Y coordinates (DMS (dd mm ss.ss), DD (dd.dd) or projected coordinates (mmmm.mm)), which correspond with the selected point on the image, two alternative procedures can be used:

  (i) Enter the GCP's (Ground Control Points) by specifying coordinates manually:
  It involves selecting multiple points/ GCP's on the raster, specifying their coordinates, and choosing a relevant transformation type. The more GCP's provides the better would be the result.

  (ii) Using already georeferenced layers:
  The georeferenced layer can be either belong to vector or raster data that contain the same objects/features that you have on the image to georeference. In this case, you can enter the coordinates by clicking on the reference dataset loaded in the QGIS map canvas.

2.1 Entering ground control points (GCPs)

- To start georeferencing an unreferenced raster, we must load it using the button. The raster will show up in the main working area of the dialog. Once the raster is loaded, we can start to enter reference points.

- Using the Add Point button, add points to the main working area and enter their coordinates (see Figure). For this procedure there are three options:

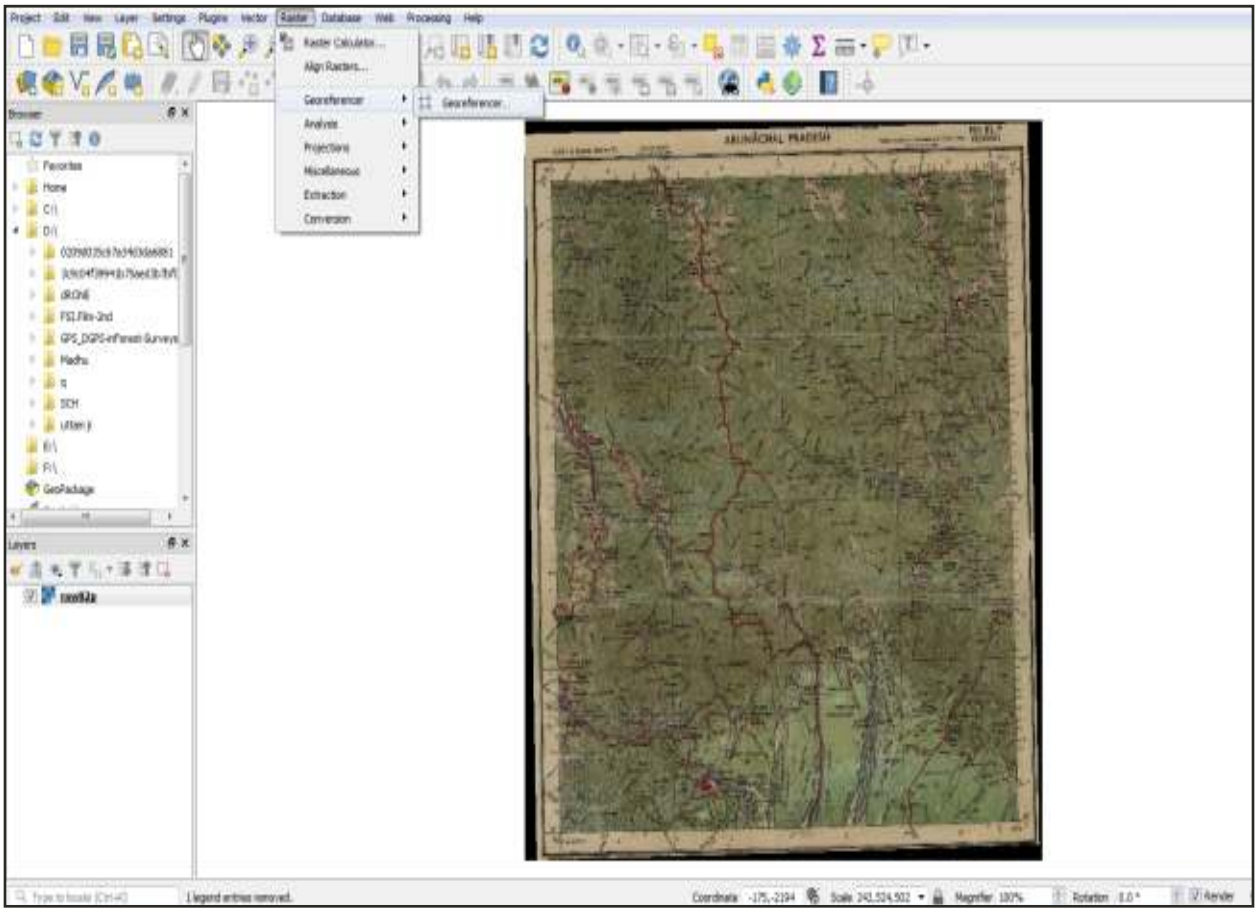
a. Click on a point in the raster image and enter the X and Y coordinates manually.

b. Click on a point in the raster image and choose the from map canvas button to add the X and Y coordinates with the help of a georeferenced map already loaded in the QGIS map canvas.

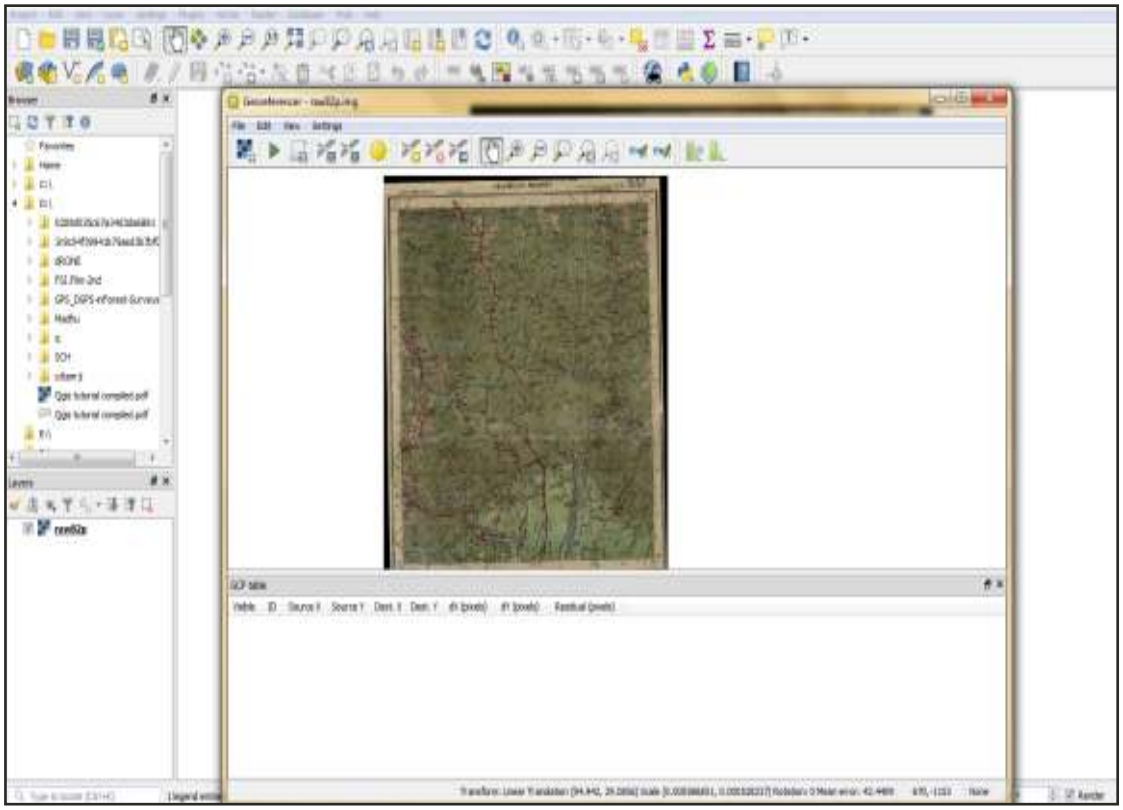
c. With the button, you can move the GCPs in both windows, if they are at the wrong place.

2.1a (i) Add GCPs

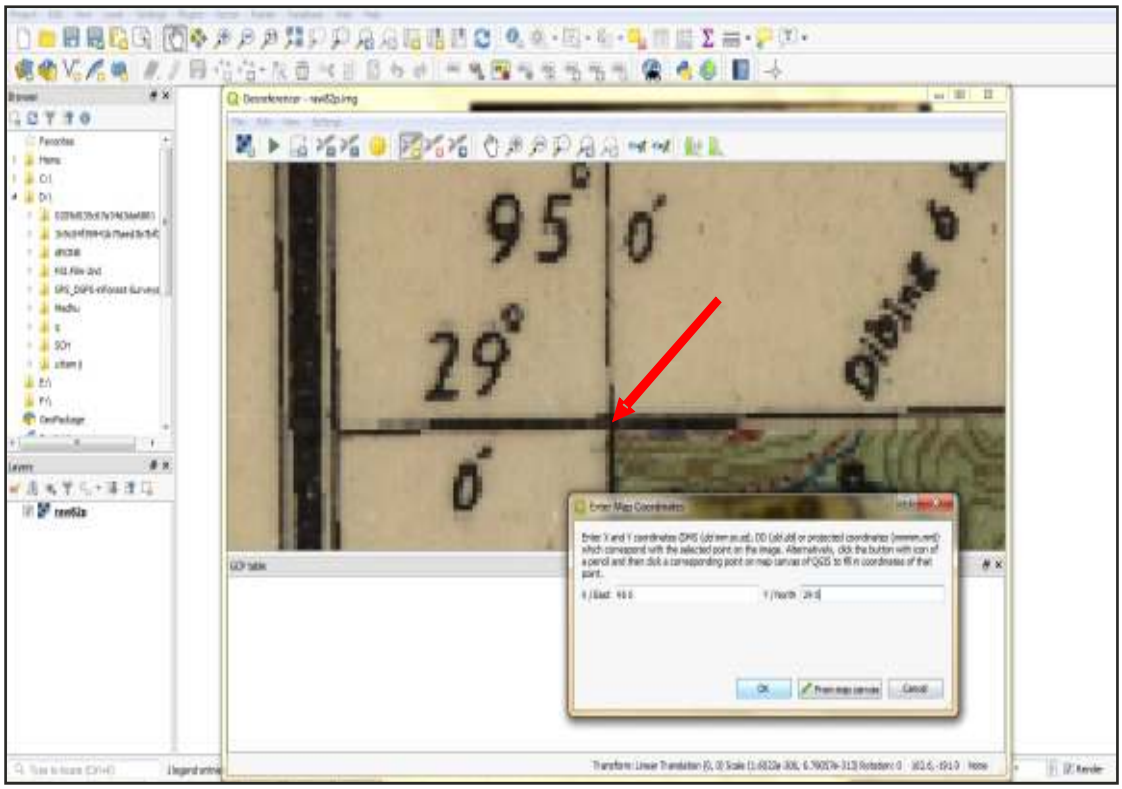
- To add GCPs go to Raster > Georeferencer > Georeferencer.



- Then Georeferencer window will appear as viewing in the figure below.

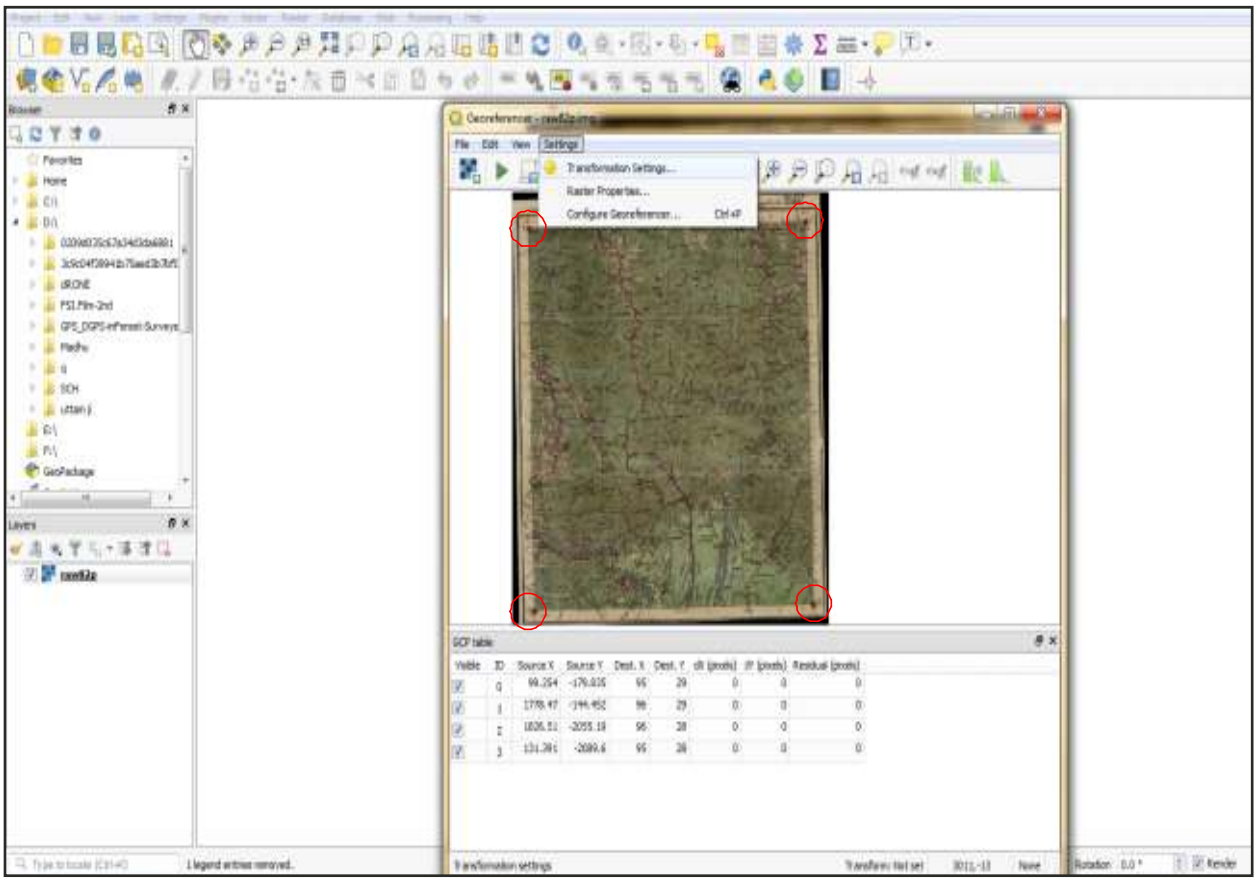


- Click on to add points and place first GCP point in top left corner.



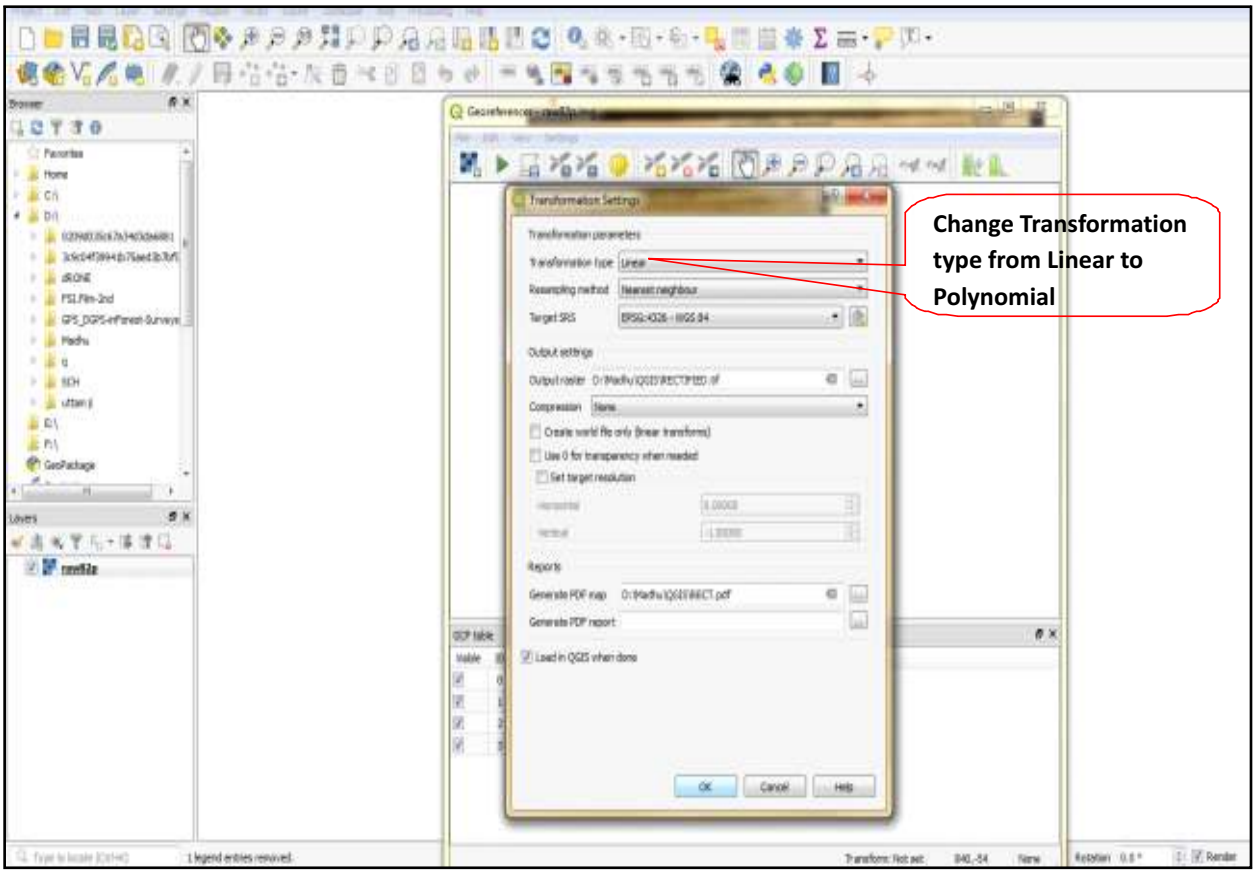
2.1a (ii) Defining the transformation settings

- After you have added your GCPs to the raster image, you need to define the transformation settings for the georeferencing process.
- Go to Settings > Transformation Settings and set transformation parameters accordingly.



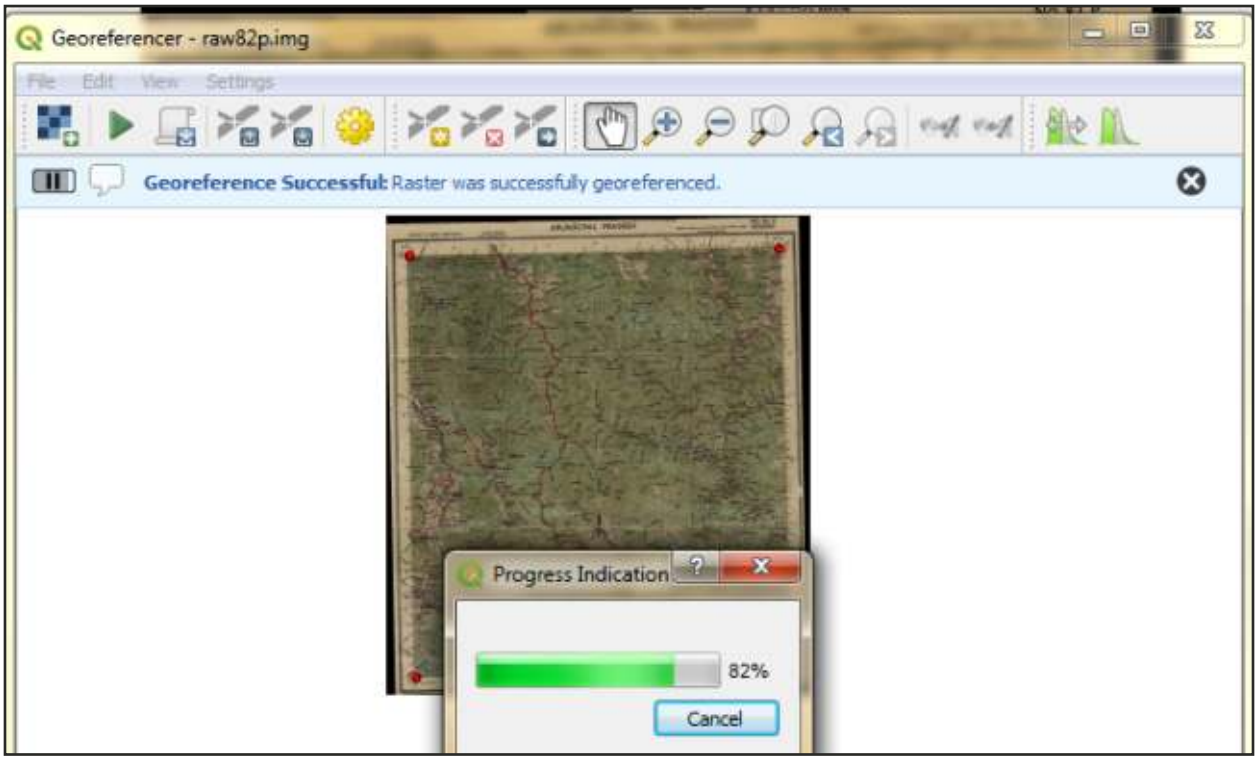
2.1a (iii) Define the Resampling method

The type of resampling you choose will likely depending on your input data and the ultimate objective of the exercise. If you don't want to change statistics of the image, you might want to choose 'Nearest neighbour', whereas a 'Cubic resampling' will likely provide a more smoothed result.



2.1a (iv) Running the transformation

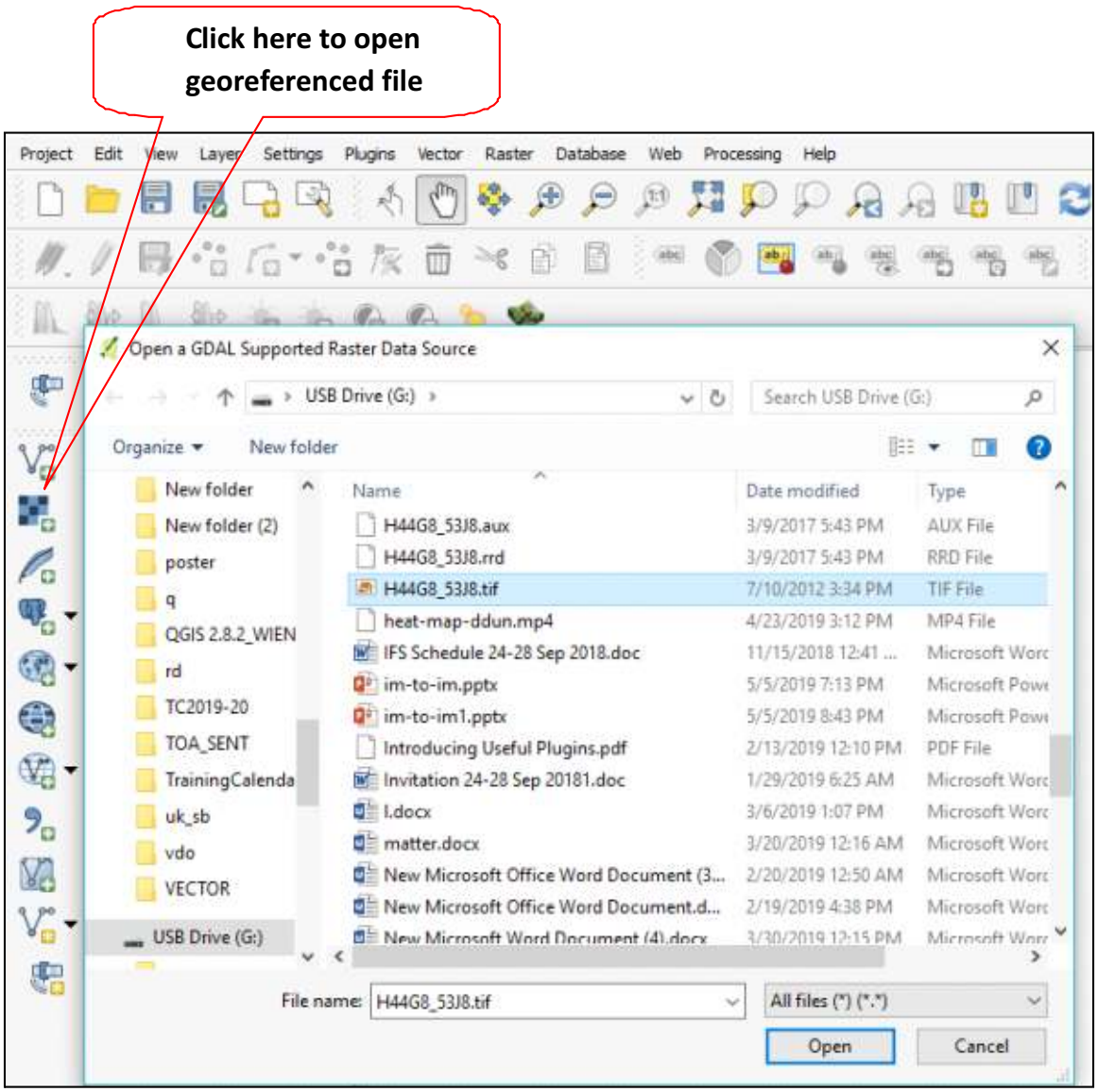
After all GCPs have been collected and all transformation settings are defined, just press the Start georeferencing button to create the new georeferenced raster.



2.2 Assigning GCP's by using georeferenced layer

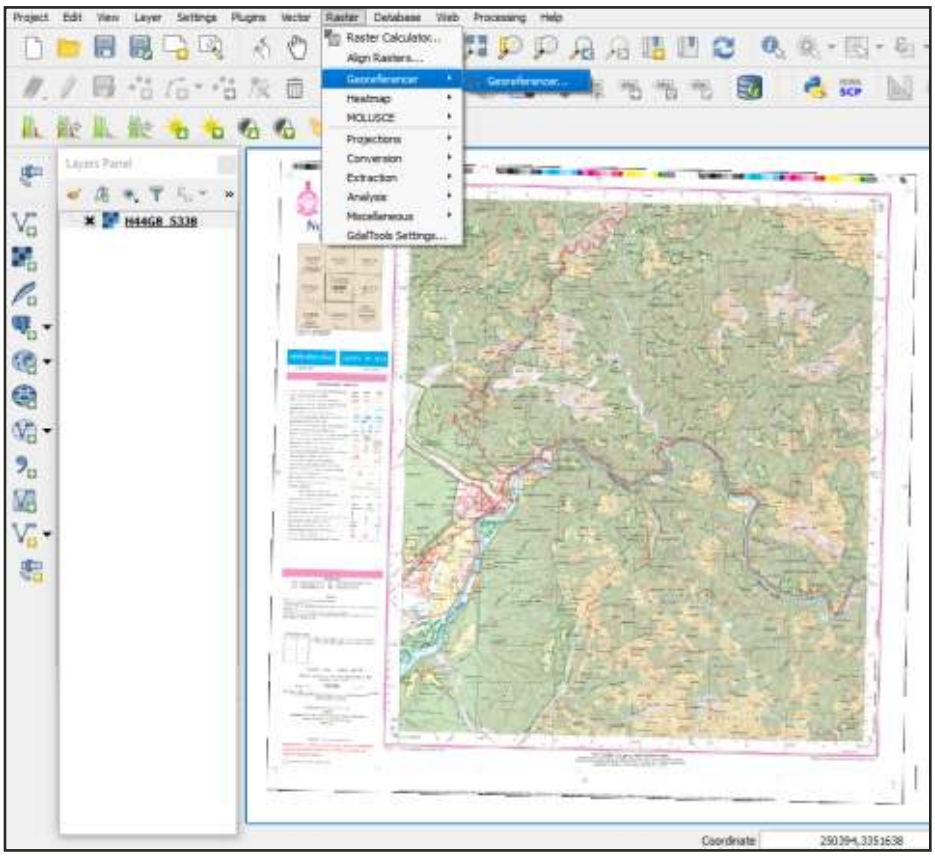
Georeferencing is the process of assigning real-world coordinates to each pixel of the raster. The method involved reading the coordinates from reference (already defined map projection) or scanned map and inputting it manually by identifying similar features in input and reference image as well.

- To enable the Georeferencer for the first time, go to plugin from Plugins > Manage and install Plugins > Installed.
- Now, the plugin is installed in the Raster menu.
- First of all, open referenced image/base image (georeferenced toposheet) on map canvas.
- Go to open a GDAL supported Raster data source and browse for the georeferenced file.

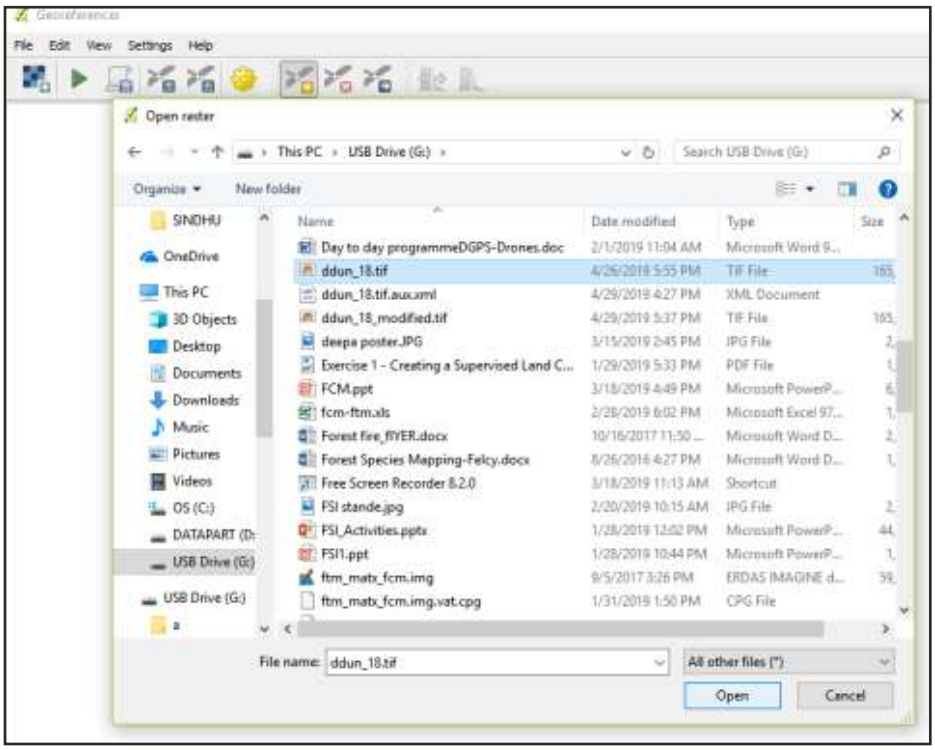


- To start georeferencing of input image (satellite imagery) by taking reference of already rectified image (SOI toposheet), launch the Georeferencer from Raster.

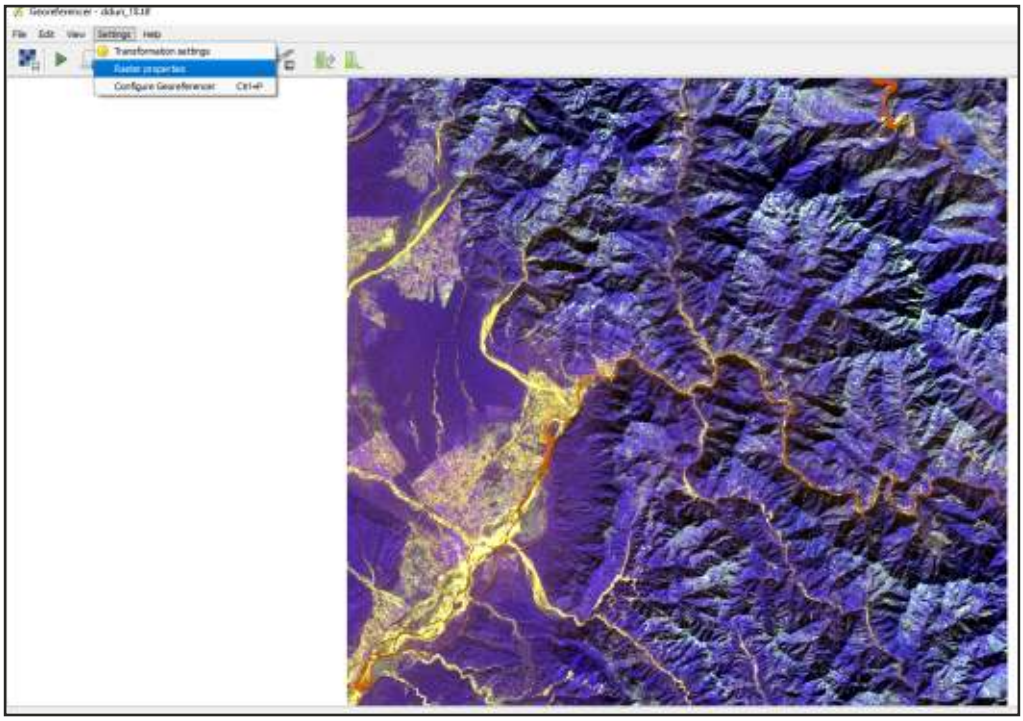
- Click on Raster > Georeferencer > Georeferencer to open the plugin.



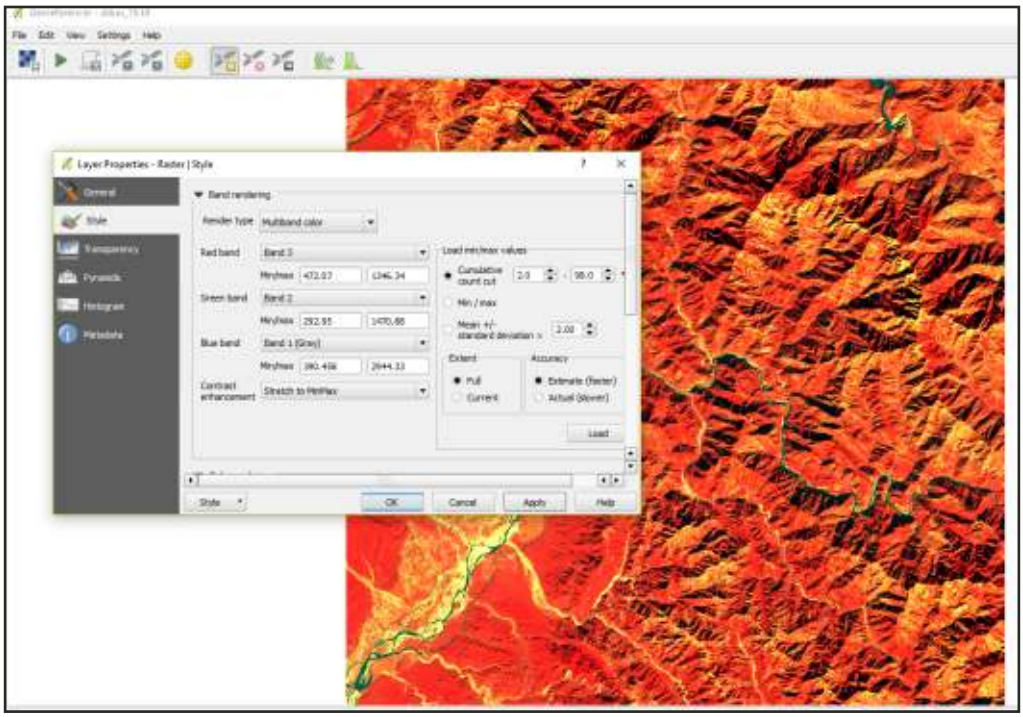
- Then georeferencer window will appear on map canvas as showing in Figure.



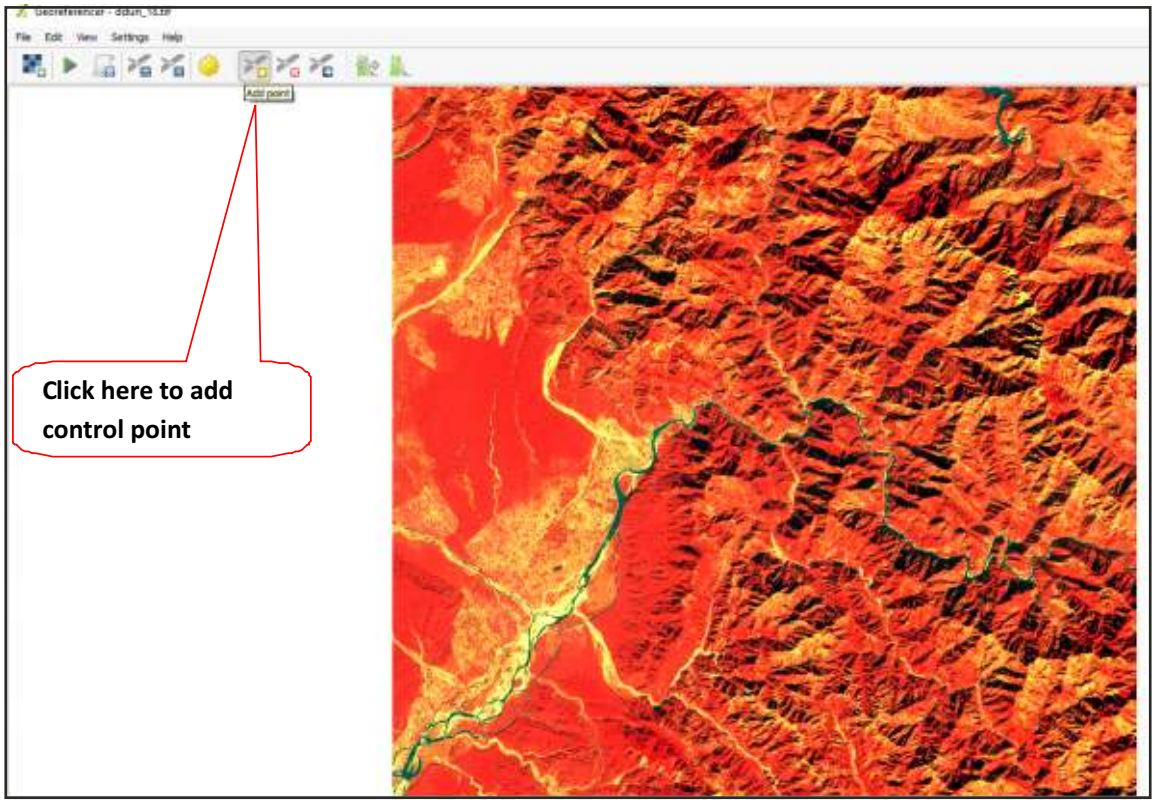
- In the Georeferencer window, go to File > Open raster > Navigate to the downloaded tif/jpg file and click Open.
- Input file will appear on georeferencer window as showing in figure.



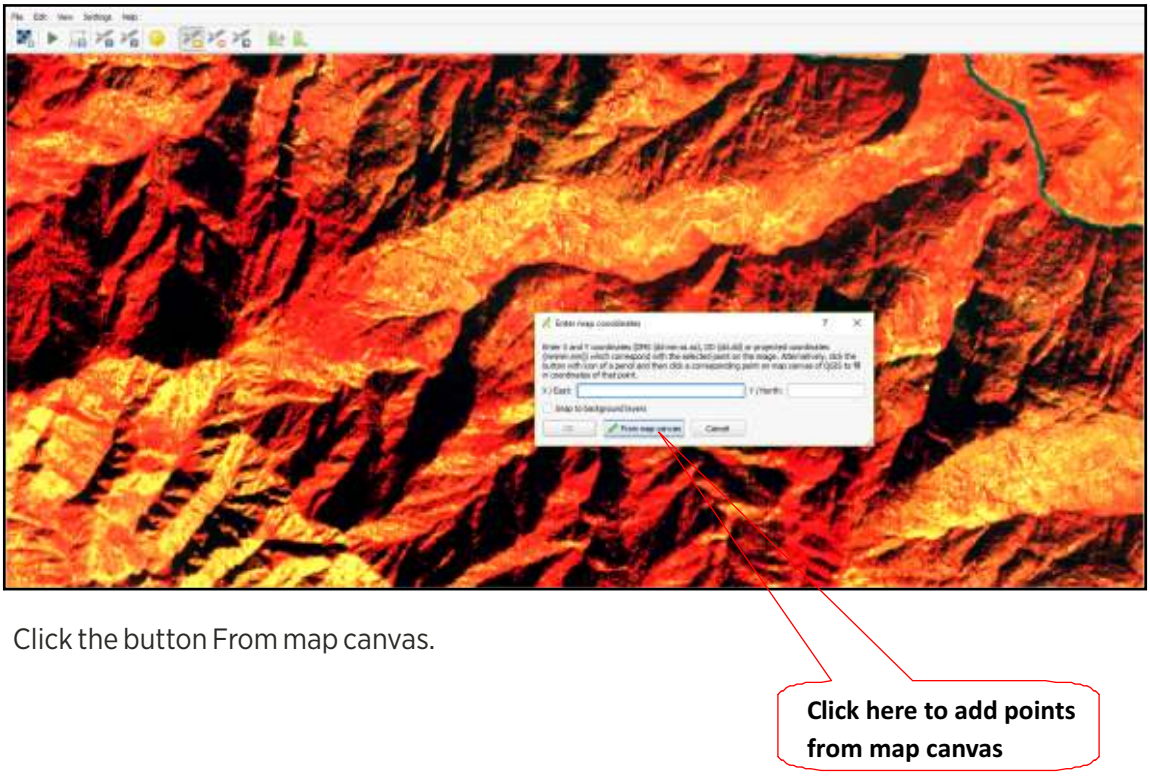
- We can display a color composite of bands in the Working toolbar, click the list RGB > and select the item 3-2-1 (corresponding to the band numbers in Band set).
- Go to layer properties/Style by going to settings > Raster properties > and put Band 3 in the Red band, Band 2 in the Green Band and Band 1 in the Blue band.



- Now click on the Add Point button on the toolbar and select an easily identifiable location such as junctions, corners, intersections, poles etc on the image to get good control points.

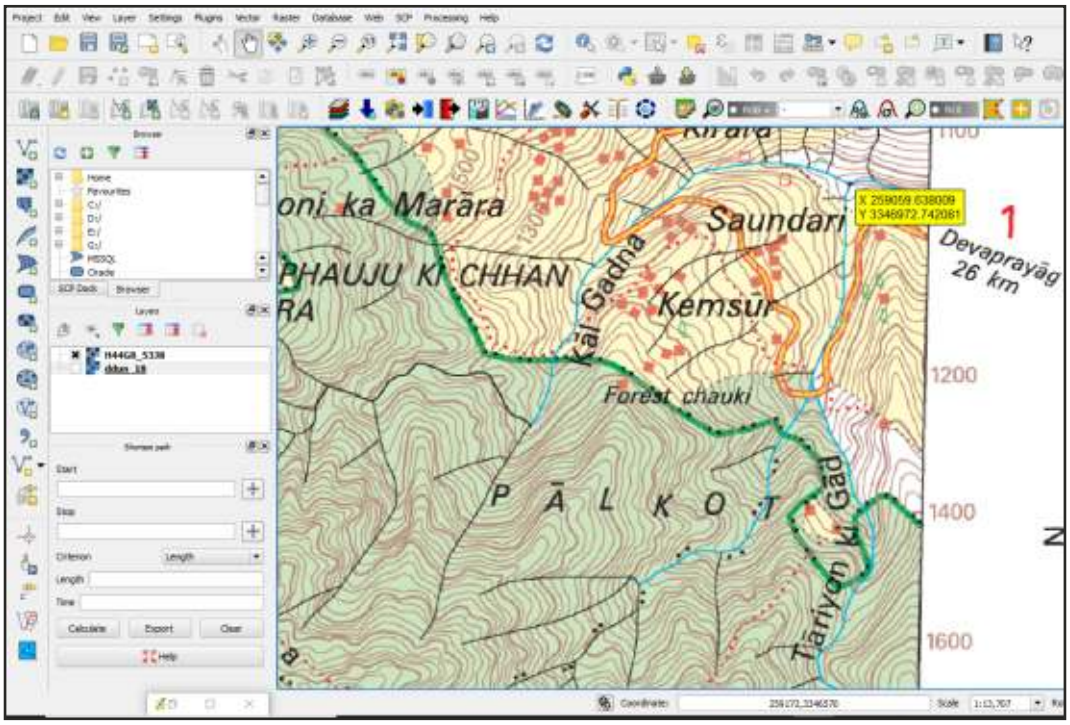


- Once click on the image at a control point location, we will see a pop-up asking about to enter map coordinates.

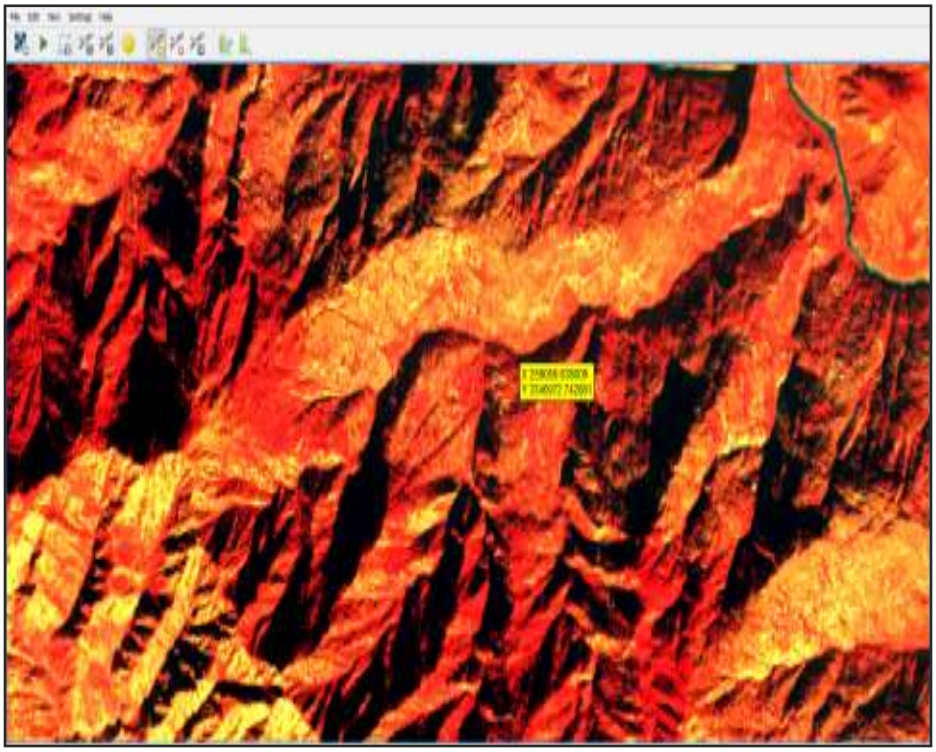


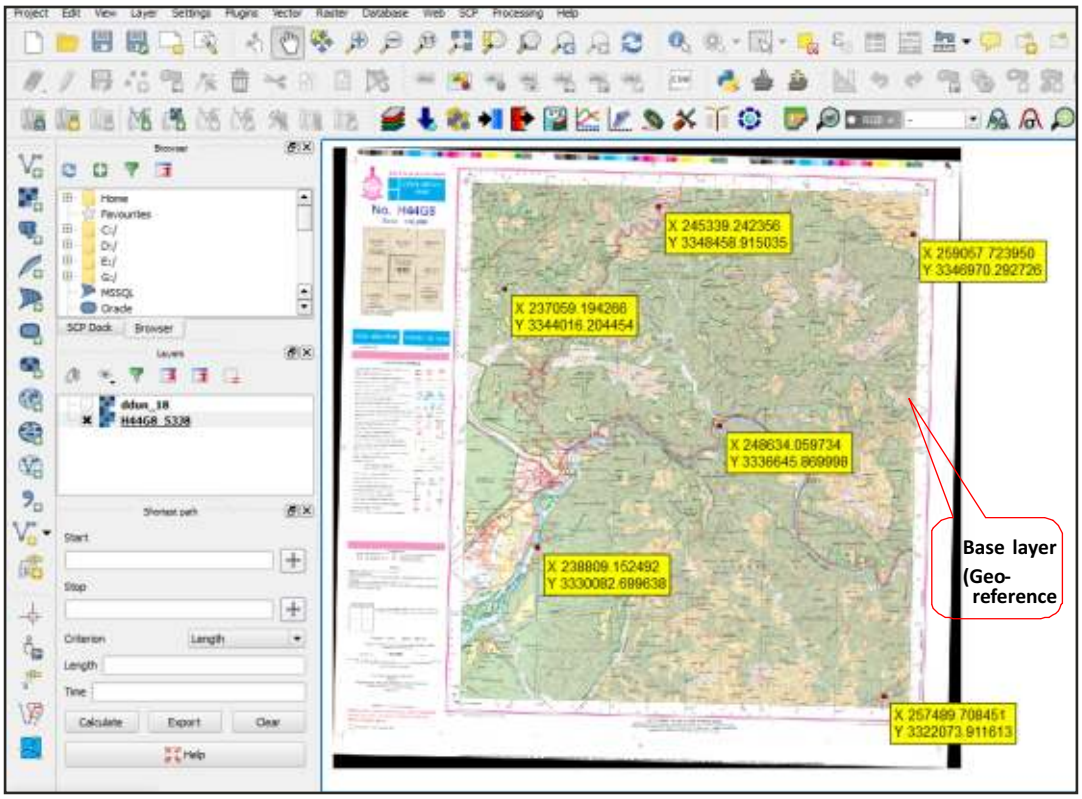
- Click the button From map canvas.

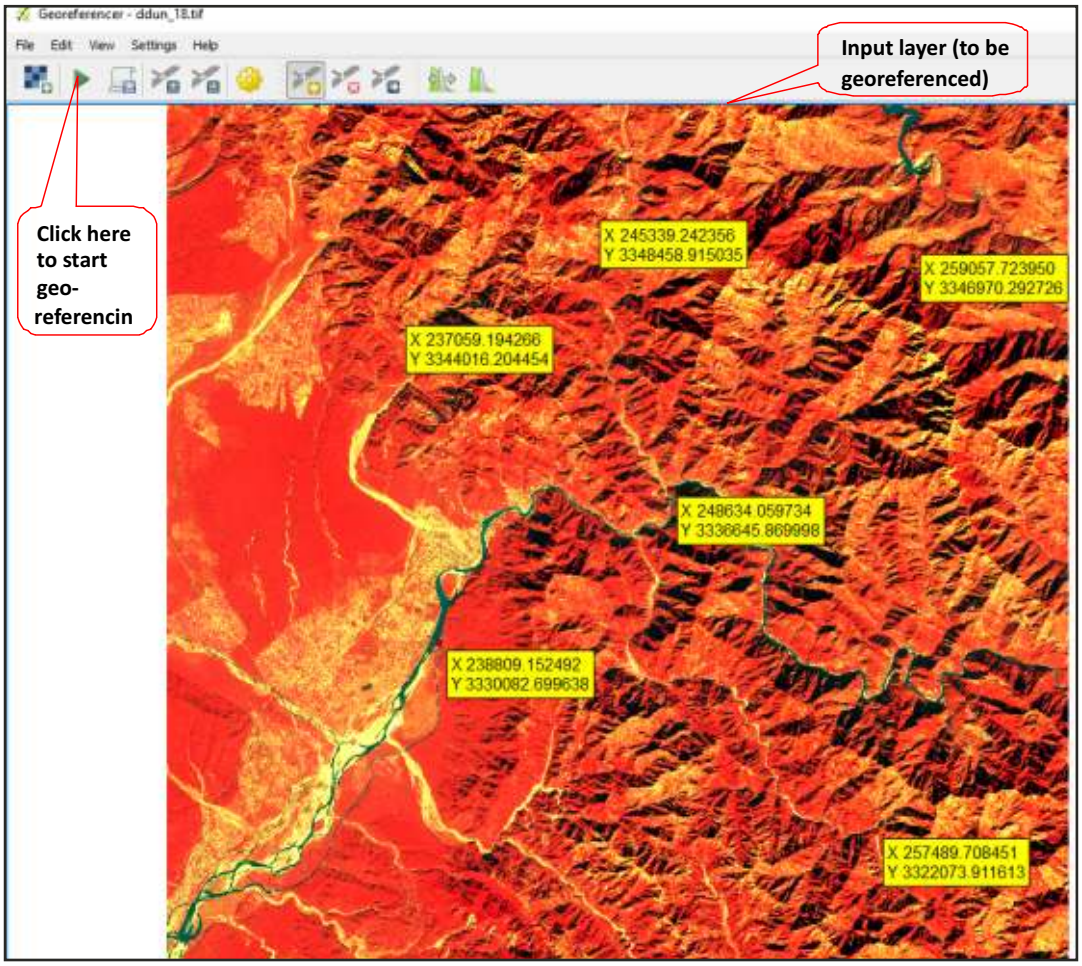
- Now, find the same location in your reference layer, i.e SOI toposheet in map canvas and place GCP by clicking on similar identified feature.
- The coordinates are automatically populated by clicking on the map canvas.



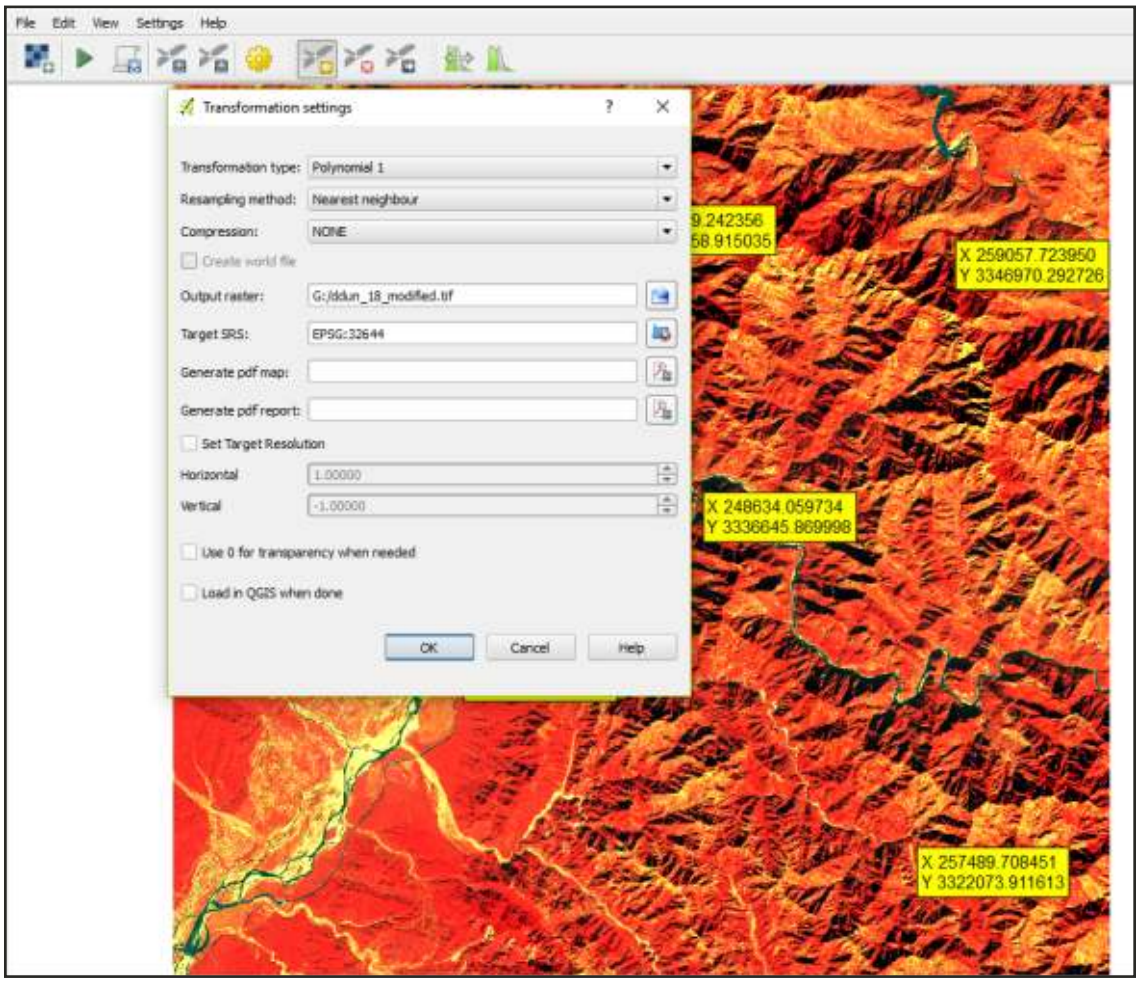
- Click Ok.
- Similarly, choose at least 4 points on the image and add their coordinates from the reference layer.



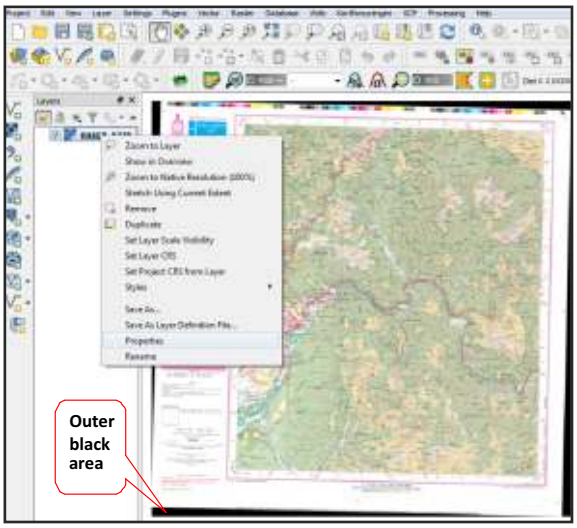

X 245339.242356
Y 3348458.915035
X 259057.723950
Y 3346970.292726
X 237059.194266
Y 3344016.204454
X 248634.059734
Y 3336645.869998
X 238809.152492
Y 3330082.699638
X 257489.708451
Y 3322073.911613
Base layer (Geo-reference


Georeferencer - ddun_18.tif
File Edit View Settings Help
Input layer (to be georeferenced)
Click here to start geo-referencin
X 245339.242356
Y 3348458.915035
X 259057.723950
Y 3346970.292726
X 237059.194266
Y 3344016.204454
X 248634.059734
Y 3336645.869998
X 238809.152492
Y 3330082.699638
X 257489.708451
Y 3322073.911613

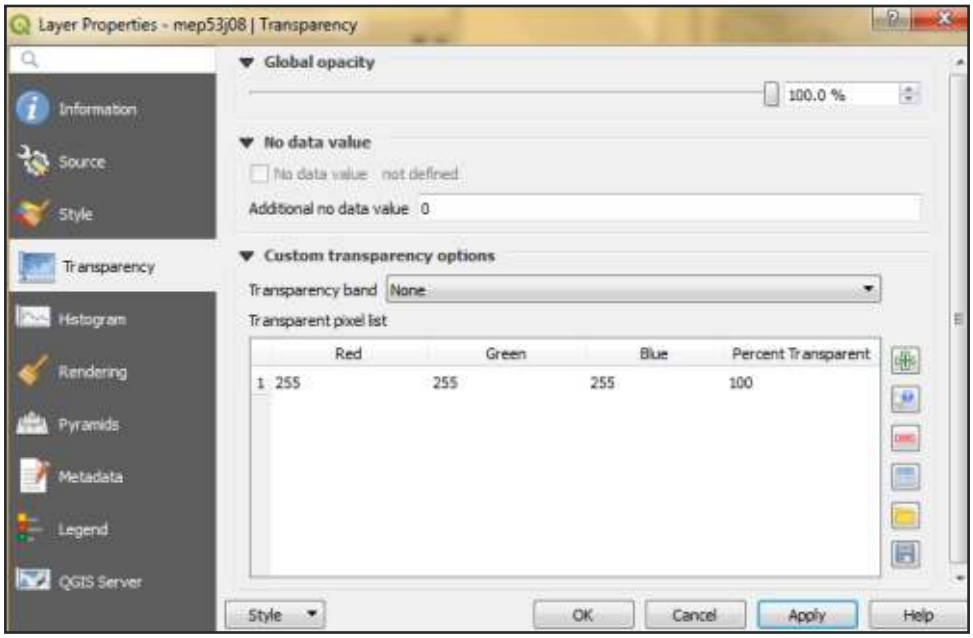
- Now go to Settings > Transformation settings > choose the settings as showing in Figure. Ensure to check Load in QGIS when done button to open the georeferenced layer by its own after running algorithm .



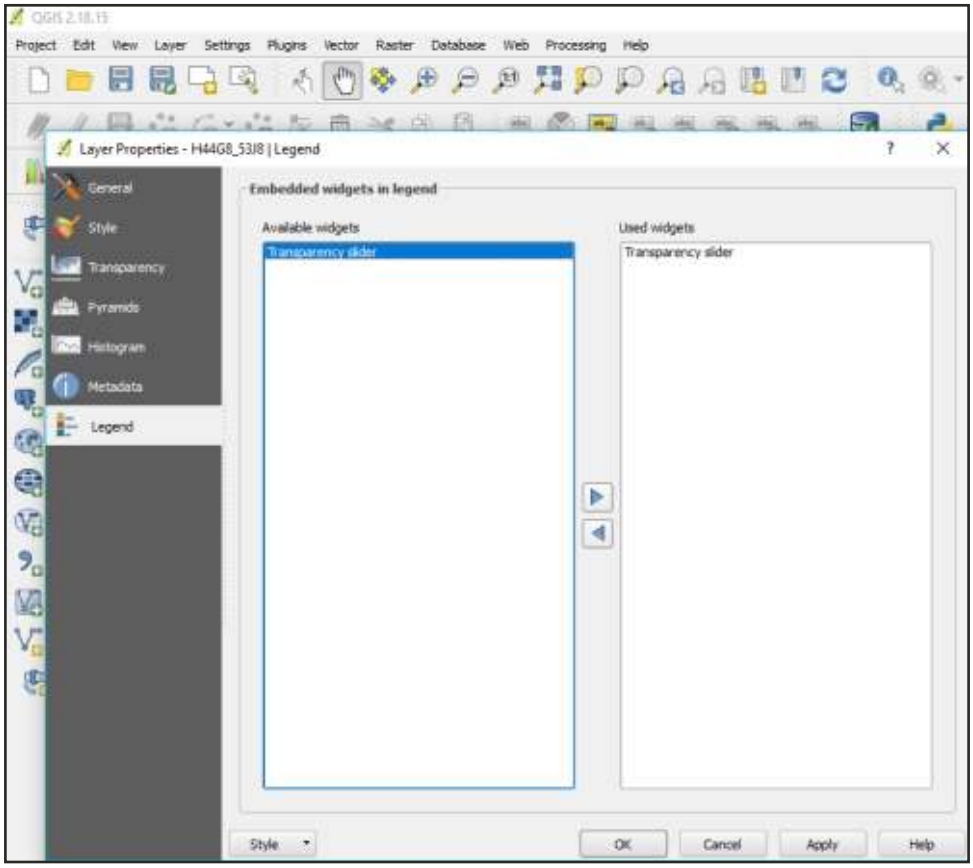
- To run the process, go to Georeferencer window > go to file > start georeferencing or directly click to ▶ start georeferencing button. This will start the process of warping the image using the GCPs and creating the georeferenced raster.
- Once the algorithm finishes, the georeferenced layer loaded in map canvas of QGIS.
- To validate the accuracy of georeferenced file, load and overlay the referenced file on created georeferenced file.
- To remove the black and white, (black or white pixels in the image are no-data values and should be made transparent). Right click on the image layer > choose Properties > Switch to the Transparency tab.



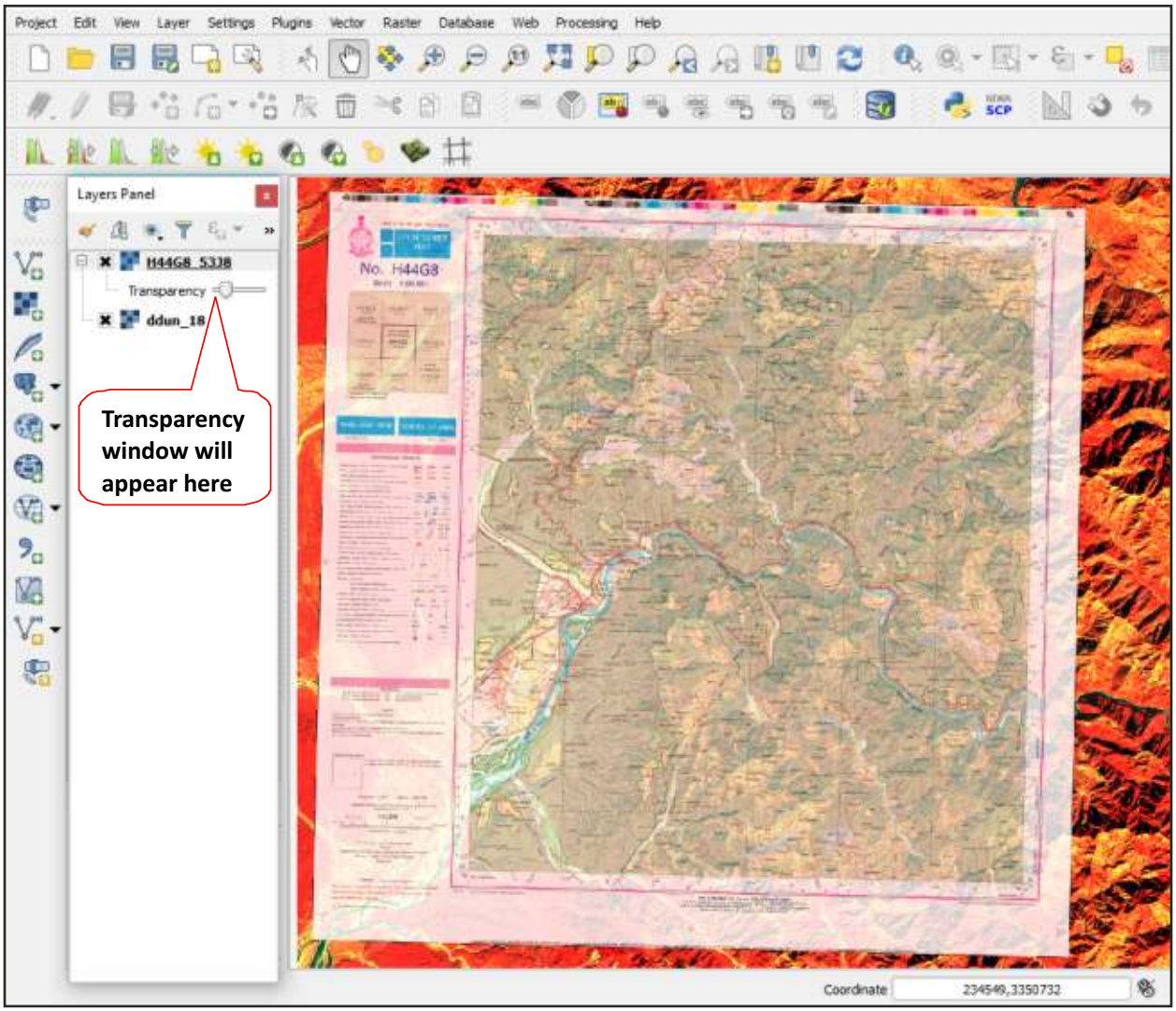
- Specify Input 0 as the No data value in additional no data value. Now in the Custom transparency options > click the + button > and add 255 as the transparent pixels for each band > and enter 100 as the Percent transparent > Click OK. Now it will remove the outer black area from the image.



- To open Transparency slider in layer panel again Right click on top layer > properties > legend > select Transparency slider > select button 



- Now the transparency slider will appear in Layer panel and accordingly by sliding we can set transparency and validate the results, if georeferenced layer is overlapping properly on base/referenced layer.
- In the given Figure, we will see that georeferenced image accurately overlaid on the base layer.



NOTE: If in case the output is not satisfying, it can be further improved by taking more number of control points.

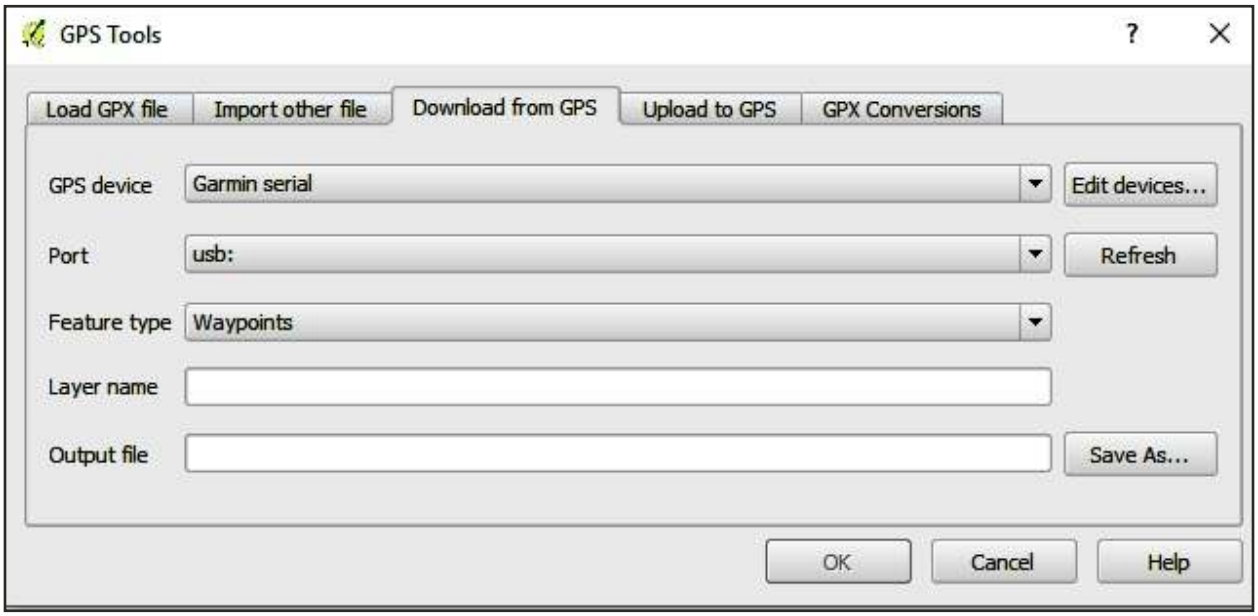
CHAPTER 3:
DOWNLOADING GPS DATA IN QGIS

3. (a) After installing QGIS software (refer to the base at the bottom) in the computer, open QGIS software.

3. (b) In the Menu Toolbar, click **Vector** menu > click on **GPS**>choose **GPS** tools.

3. (c) When GPS tool is activated small box will appear in the Map Canvas

3. (d) In the GPS tool box >click **download from GPS** option



3. (e) In the GPS device select >**Garmin serial**.

3. (f) In the port option select **usb**.

3. (g) In the features type option select **waypoint, track, routes** (choose any feature you want to transfer).

3.(h) In the layer name > specify or type any name.

3.(i) In the output file option > specify the drive and folder to save the output> click ok.

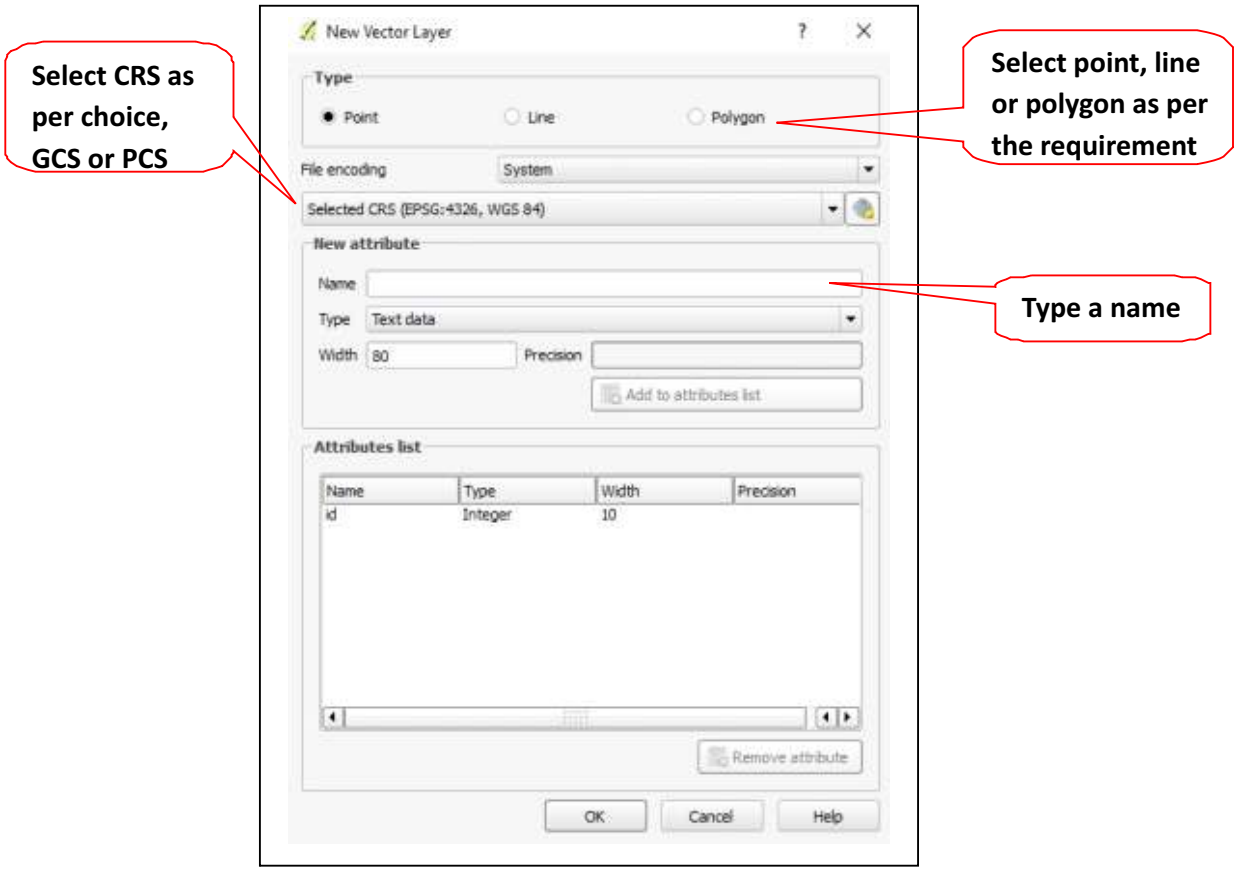
(After the transfer is done GPS data will automatically display in the map canvas of QGIS).

CHAPTER 4:

CREATION OF NEW SHAPEFILE IN QGIS

4. (a) To create a new layer for editing choose **new layer vector** from **Layer** menu > Click on **new shapefile layer.**

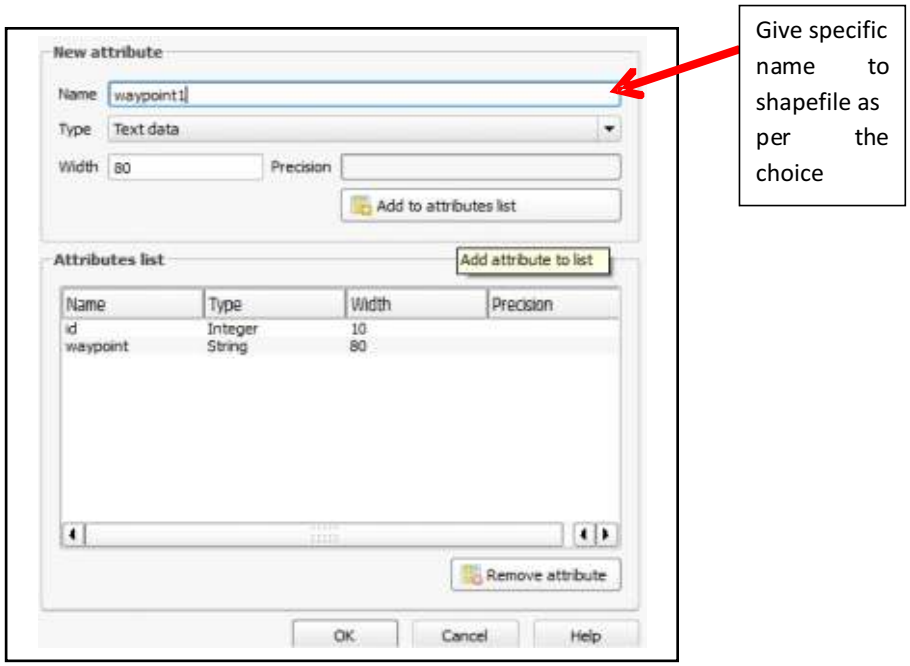
4. (b) The new vector layer dialog box will be displayed as shown in figure below.



4. b (i) Choose any feature type i.e. point/line/polygon as the case may be.

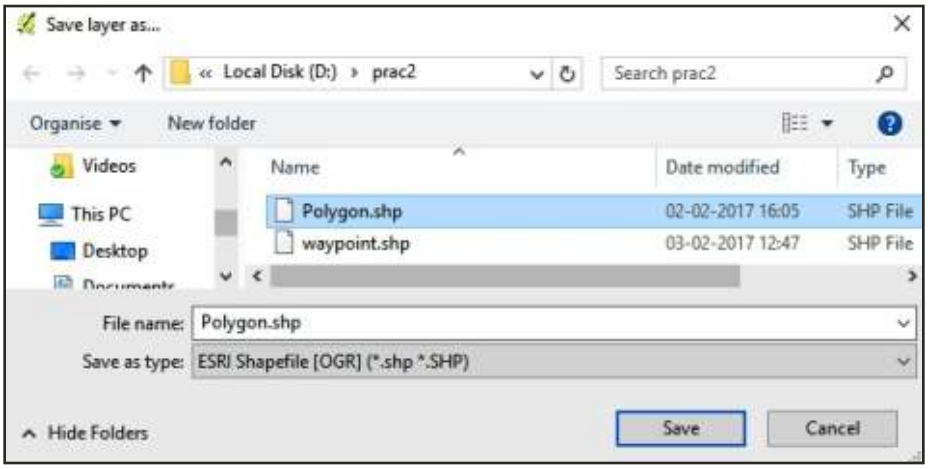
4. b (ii) Select and specify the **Coordinates Reference System (CRS)**.

4.b (iii) To complete the creation of New shapefile layer > go to **New attribute** field > specify any **name**>**type** (choose text ,decimal,whole number ,date) > then click **add to attribute list**> click **OK**.



Give specific name to shapefile as per the choice

4. (c) After clicking ok option >**save layer as** dialog box will appear > then specify the Drive and folder to save the output file>Give name to output file> click save.



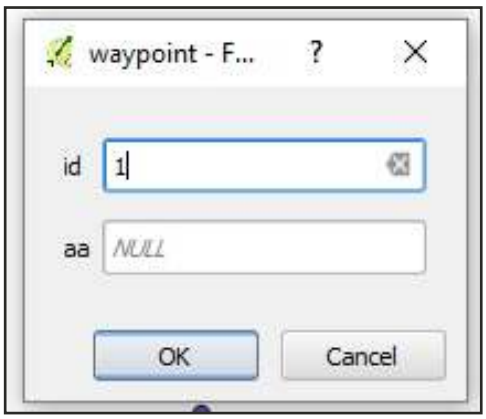
CHAPTER 5:

DIGITIZING A NEW OR EDITING AN EXISTING LAYER

5. (a) All editing session start by choosing the toggle editing option

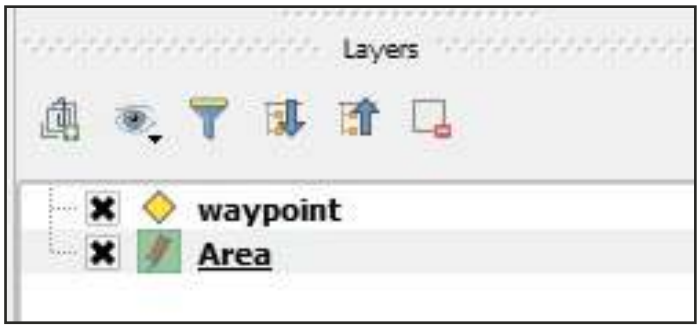
5. (b) Use the add features icon on the toolbar to add new features (point, line or polygon).

5. (c) Next start digitise the feature i.e. point, line or polygon, left-click on the map area to create the first point of your new feature >then enter its attributes (same way with both line and polygon).

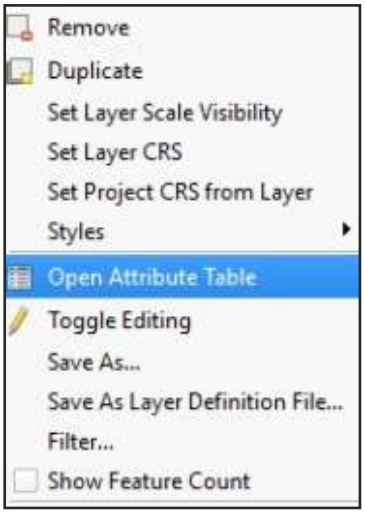


5. (d) After digitizing click on save layer edits

5. (e) To calculate area, length and perimeter > go to layer option > click on polygon features > right click.



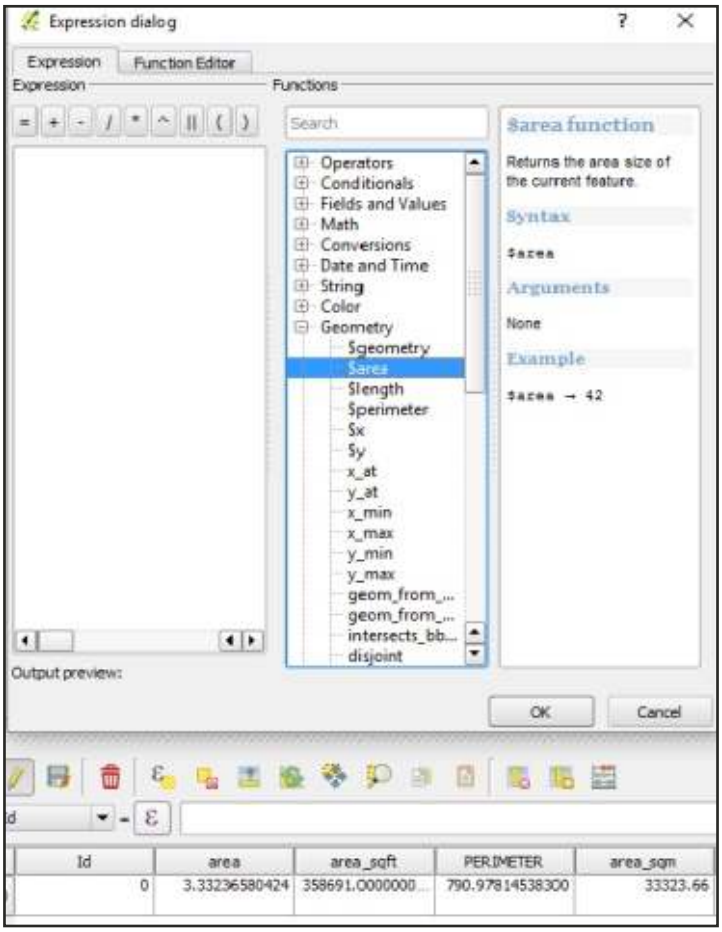
5. (f) Select Open Attribute Table.



5. (g) One dialog box will appear> then click on toggling editing mode to start Calculating area, length or perimeter.

5.(h) Then click on **expression** (for calculating the length, perimeter and area).

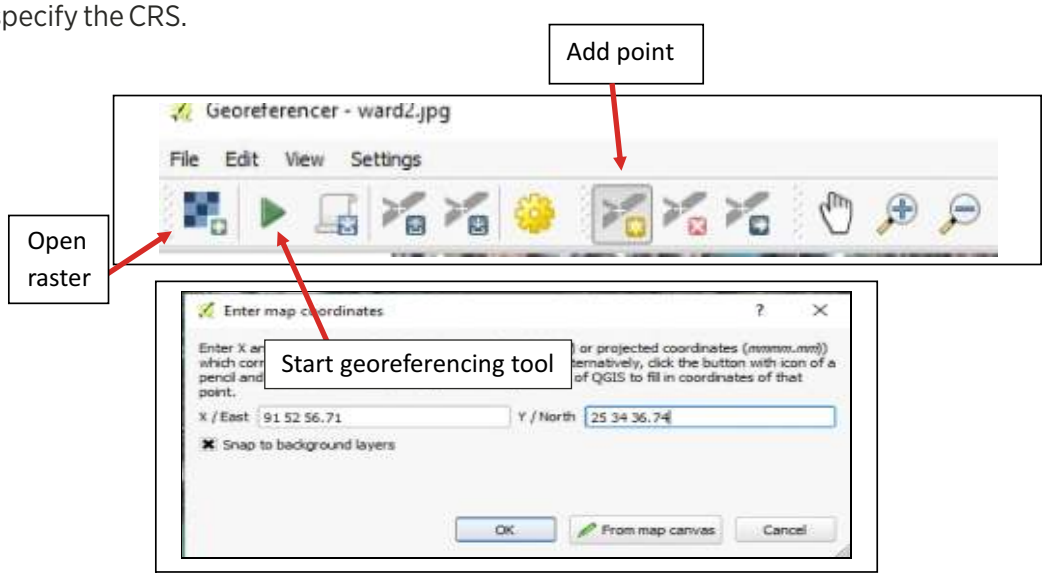
5. (i) Expression dialog box will appear >in the **function** option >select **geometry** >click on $area, $perimeter, $length (to calculate area/perimeter/length) > click ok> then click **update all** option (the software will automatically calculate the Area/length/perimeter as shown in figure below).



CHAPTER 6:

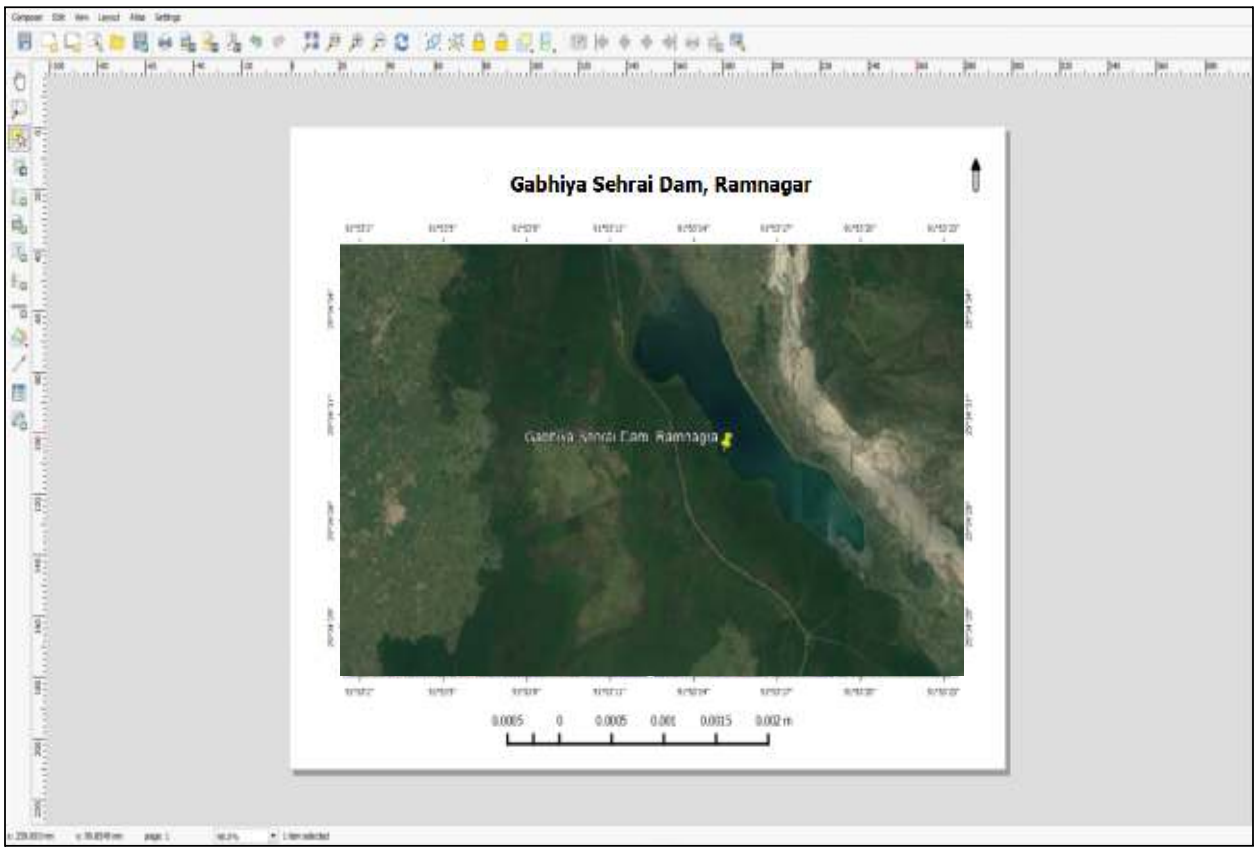
GEOREFERENCE A DOWNLOADED GOOGLE EARTH IMAGE

6. (a) To georeference the Google earth image > Go to menu bar >select **Raster**>select **Georeference**> open raster option > add the save Google earth image to Georeference > specify the CRS.



6. (b) After adding four points >go to **setting>transformation setting**> in the target SRS select the coordinate reference system (CRS) > specify the output file> click Ok **Run** (start georeferencing tool).

6. (c) To compose the georeference image you have to follow steps 11a-d (pg. 37).



CHAPTER 7:

HOW TO OPEN SATELLITE IMAGE (RASTER DATA) IN QGIS

7. a (i) Open QGIS software > go to add raster layer icon and click in the icon.

7. a (ii) Immediately one dialog box will appear in the frame > then click on the specific image> click open to add the image in the map canvas or frame.

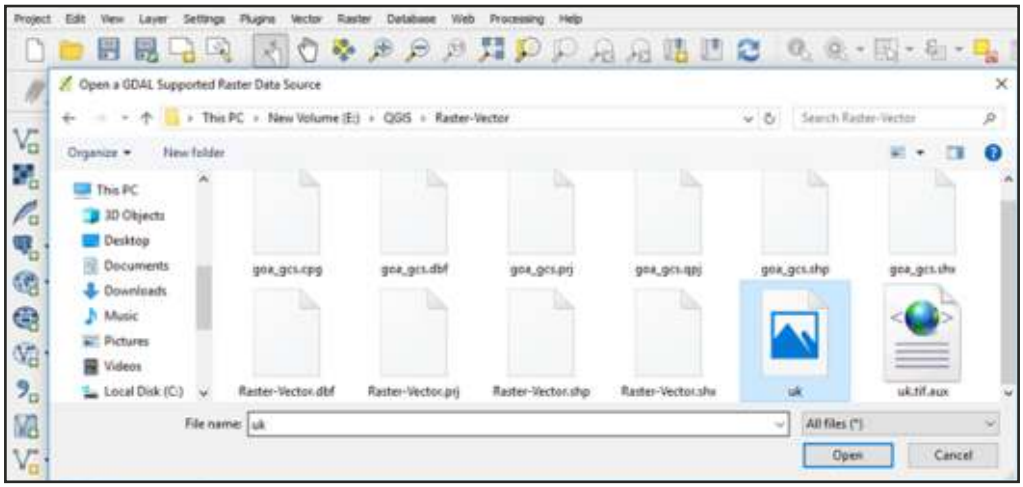
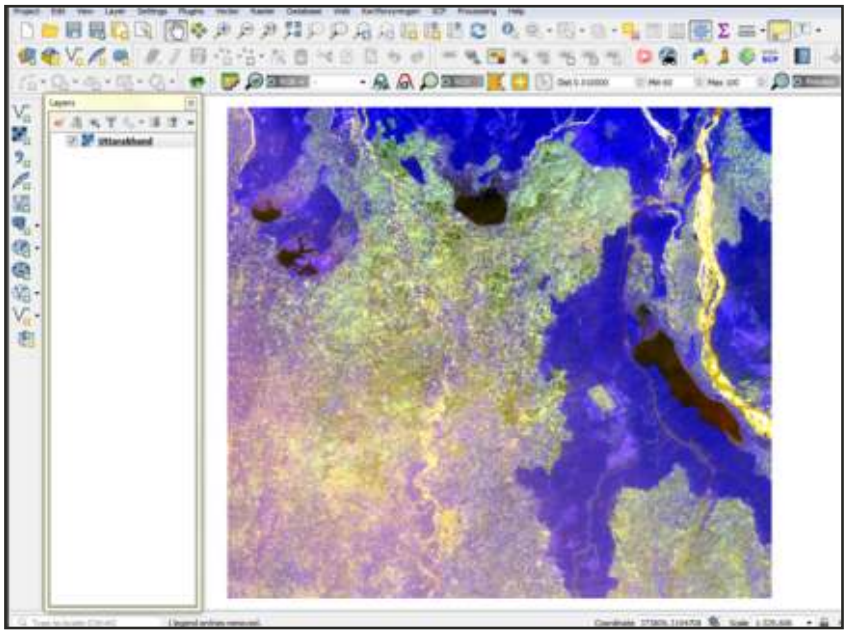


Image will appear as showing in Figure



7. a (iii) Go to layer > click in the image > right click > go to properties > go to style option to change the band combination (for red band 3,green band 2 and blue band 1) >click apply then ok.

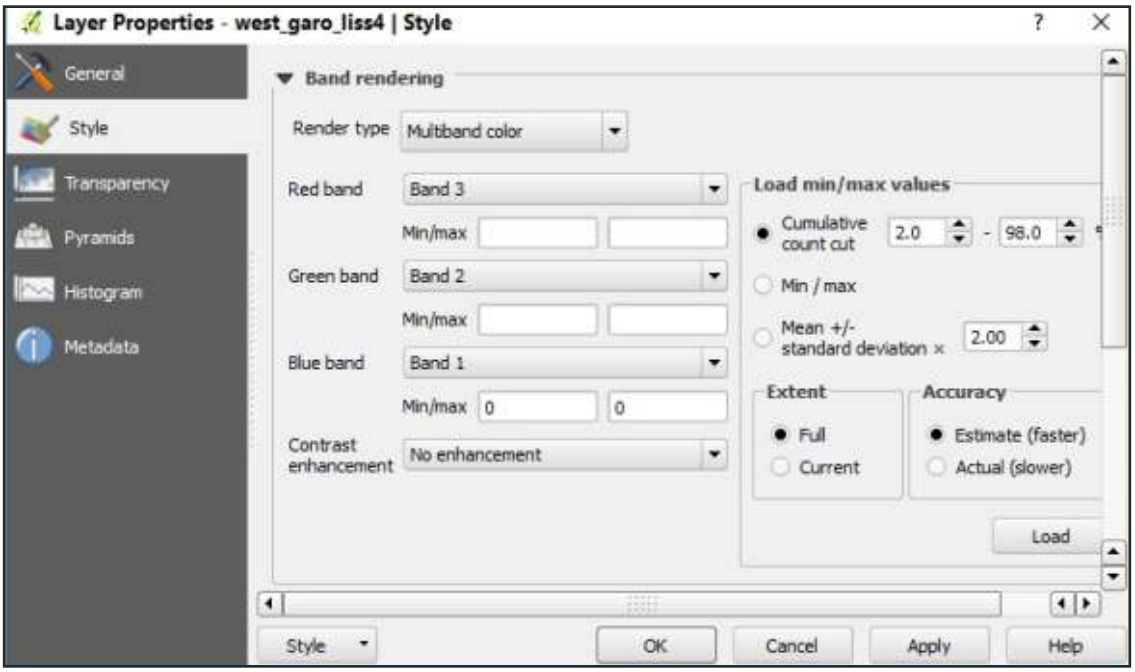
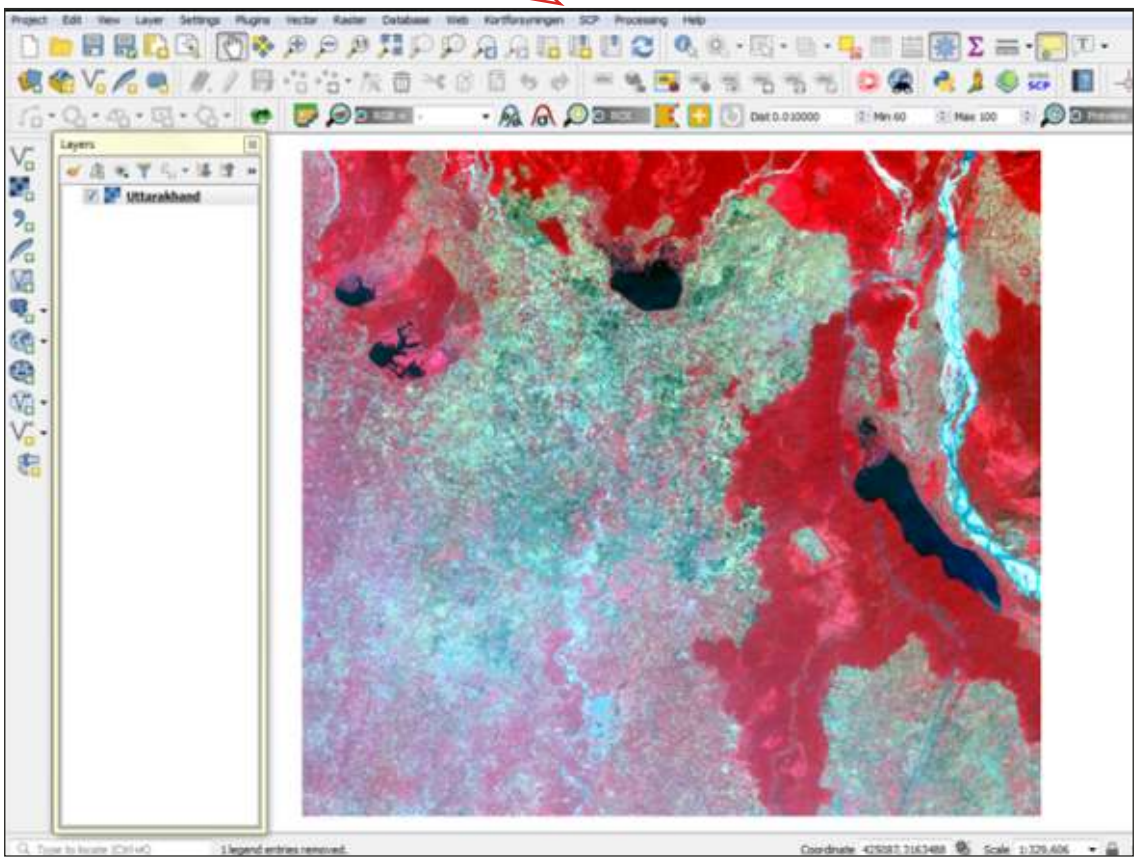


Image will appear as showing in Figure

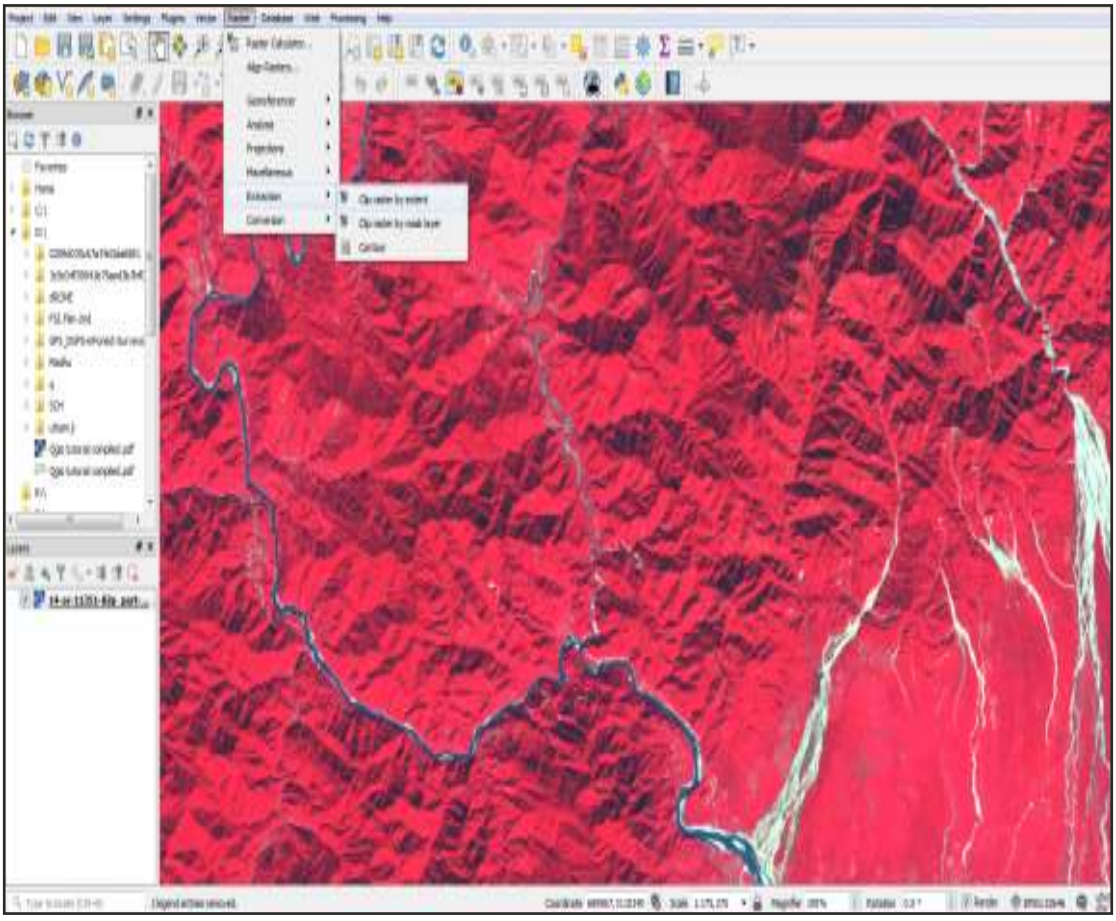


CHAPTER 8:

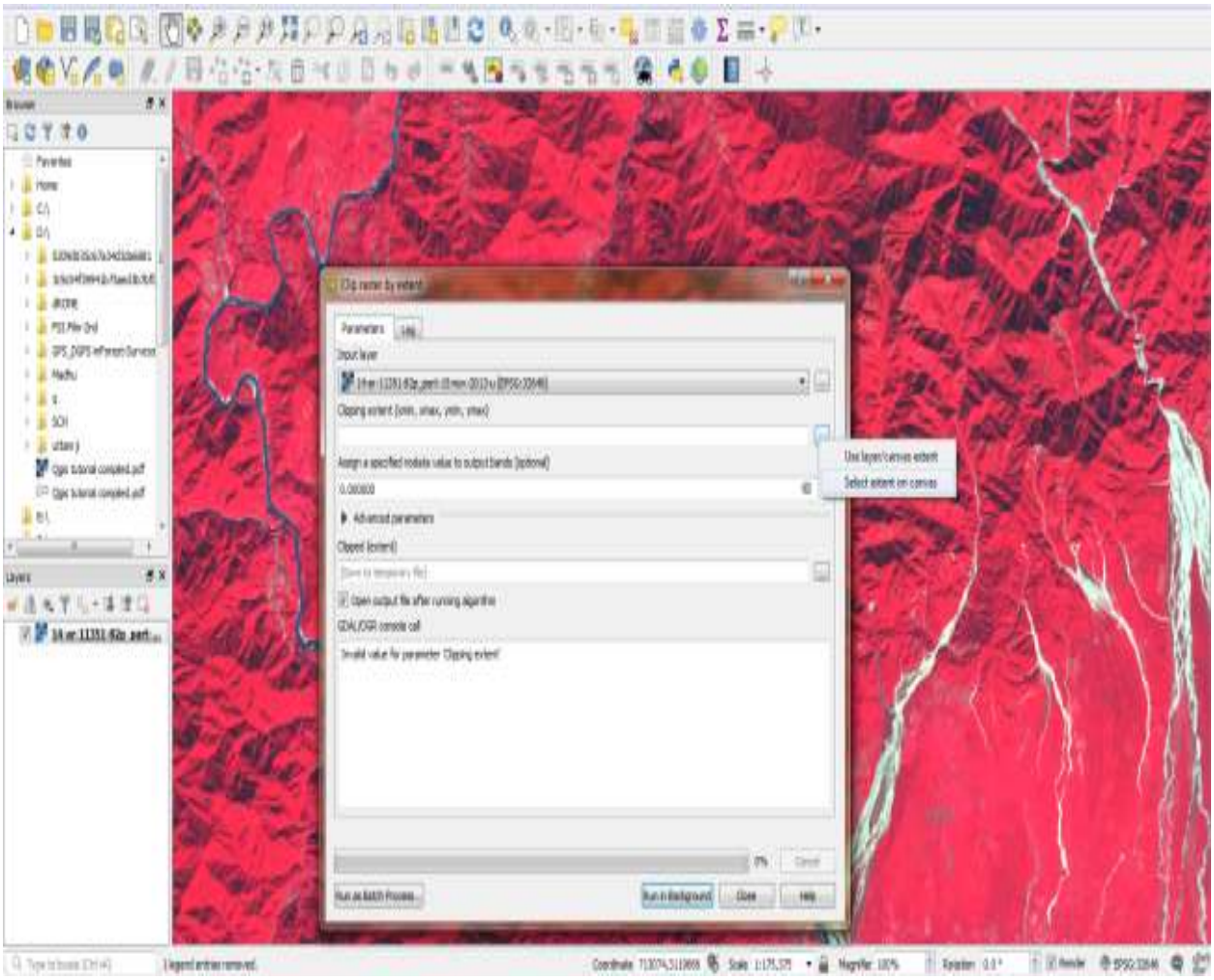
CLIP

Clipping is the process by which a subset of the raster as well as vector dataset is created. Clipping removes data outside the area of interest reducing the file size and improving the processing time for many operations.

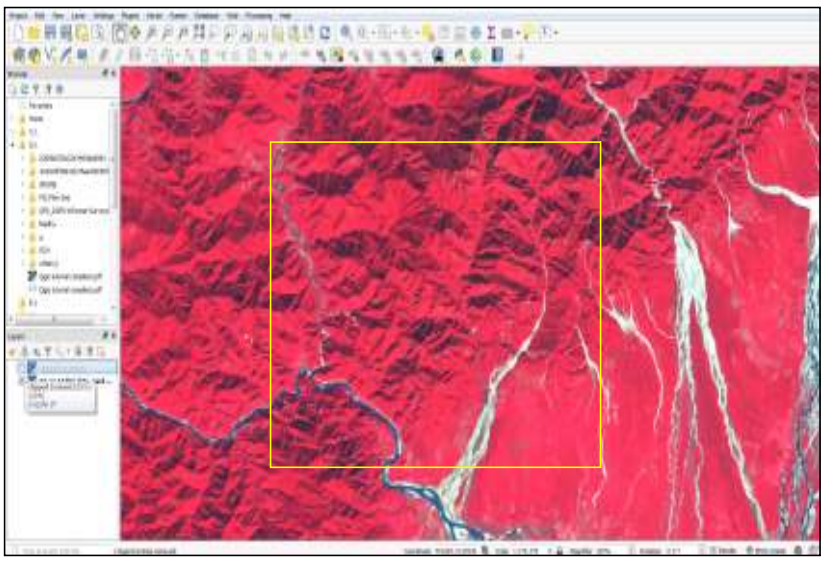
- The Clip tool allows you to extract a portion of a raster dataset based on a template extent. The clip output will include any pixels that intersect the template extent.
- The clipped area is specified either by a rectangular envelope using minimum and maximum x- and y-coordinates or by using a output extent file. If the clip extent specified is not aligned with the input raster dataset, this tool will make sure that the proper alignment is used. This may cause the output to have a slightly different extent than specified in the tool.
- Go to Raster > Extraction > Clip Raster by Extent.



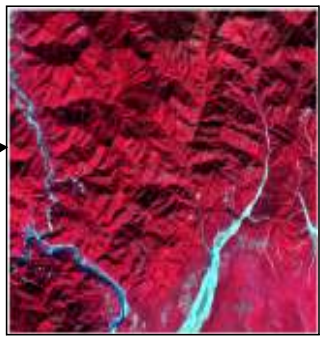
- Give clipping extent by selecting extent (through dragging to selected area) on canvas or use layer/ canvas as extent as per the availability and run the process.



Subset/Clip of Raster Dataset



Input

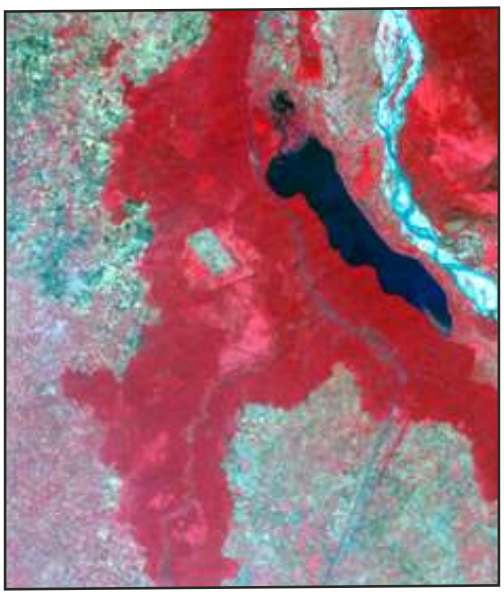


Final Output

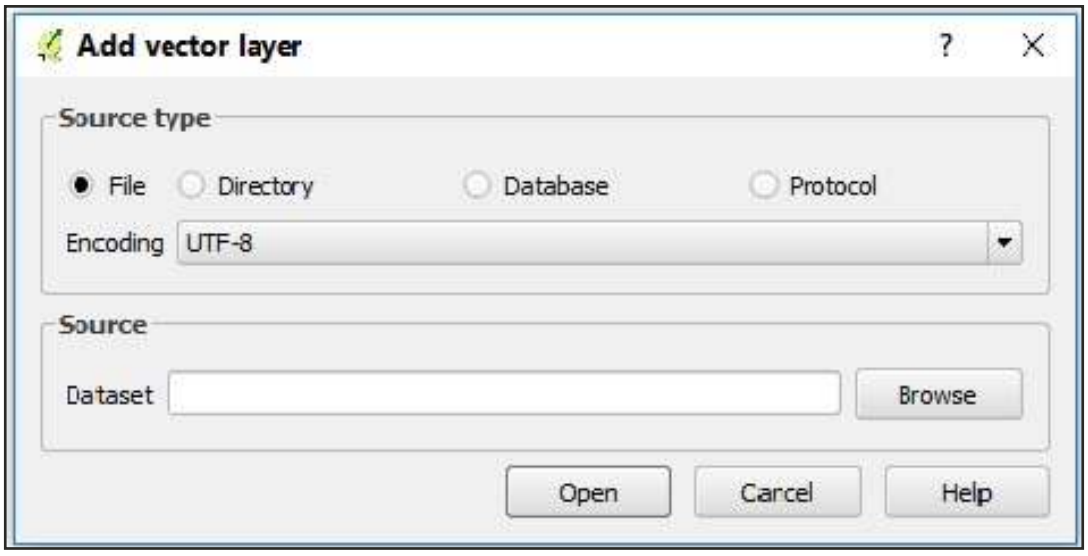
CHAPTER 9:

SUPERIMPOSED A SHAPEFILE ON SATELLITE IMAGE

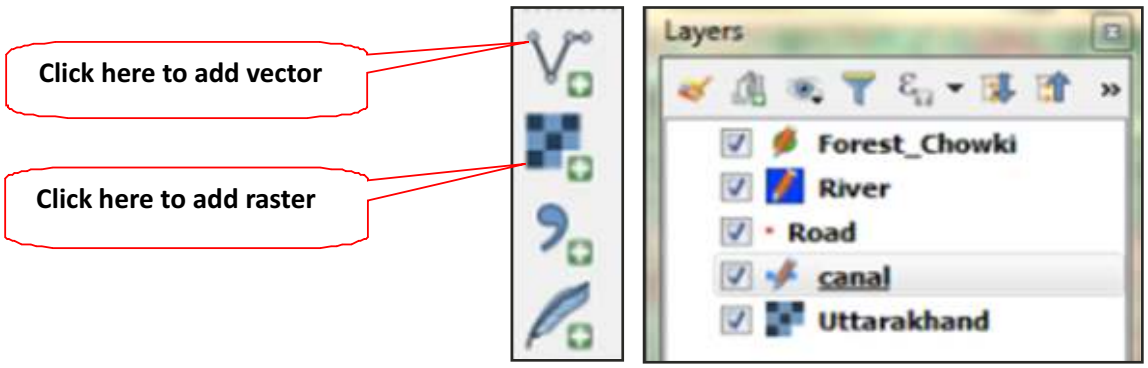
9. a (i) Open the raster data or satellite image.

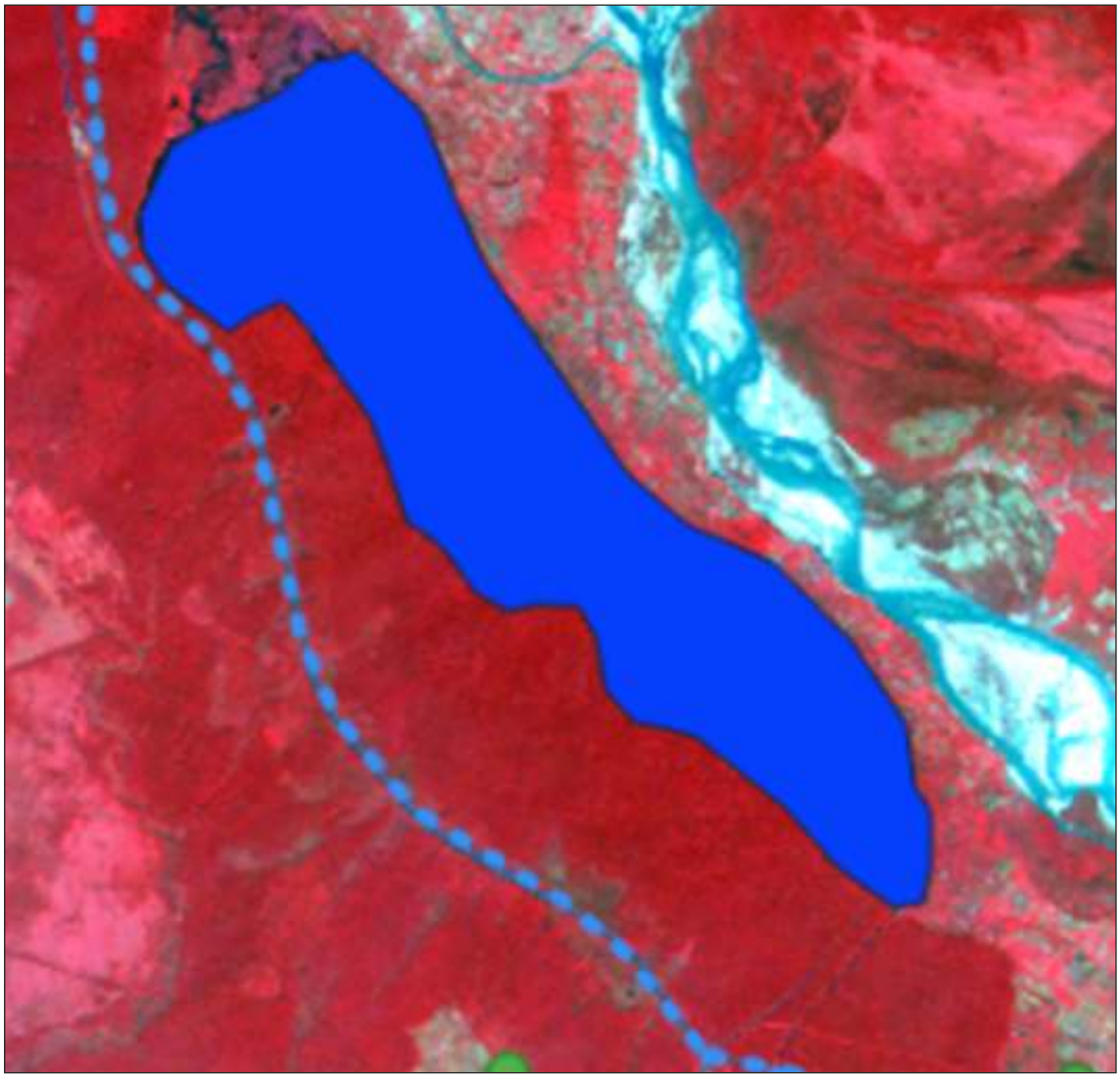


9. a (ii) Open the vector data (shapefile of point, line or polygon).



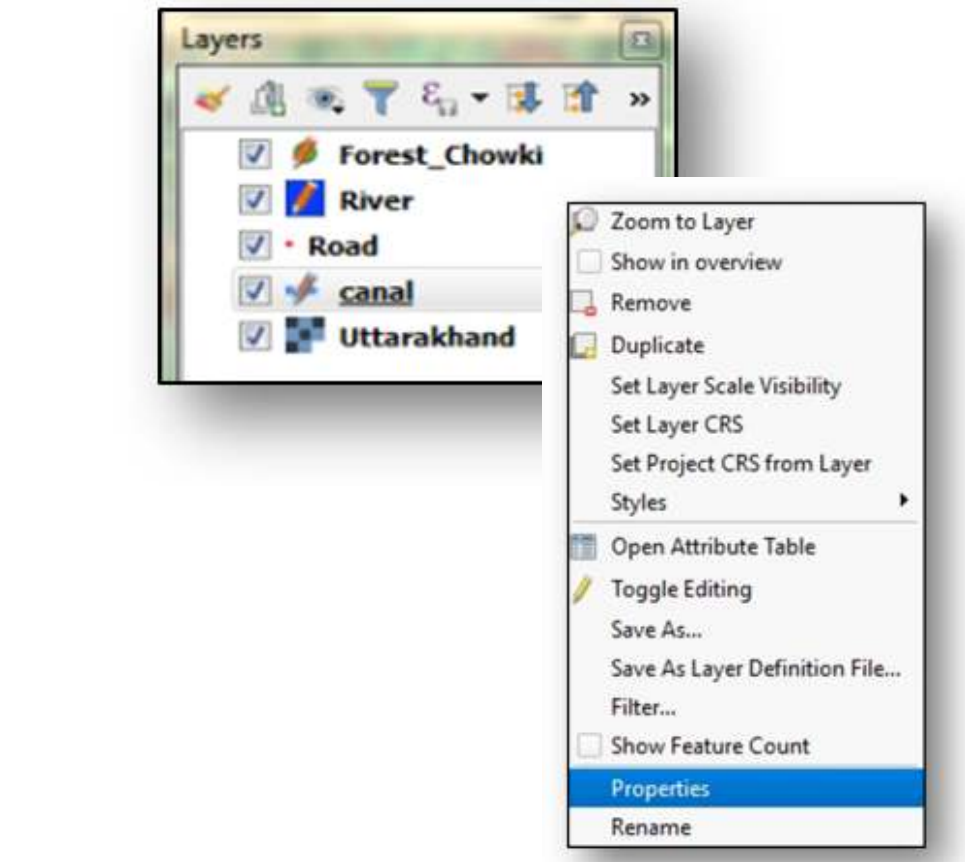
9. a (iii) Add the vector data (i.e. shapefile of point,line and polygon) from add vector layer icon.

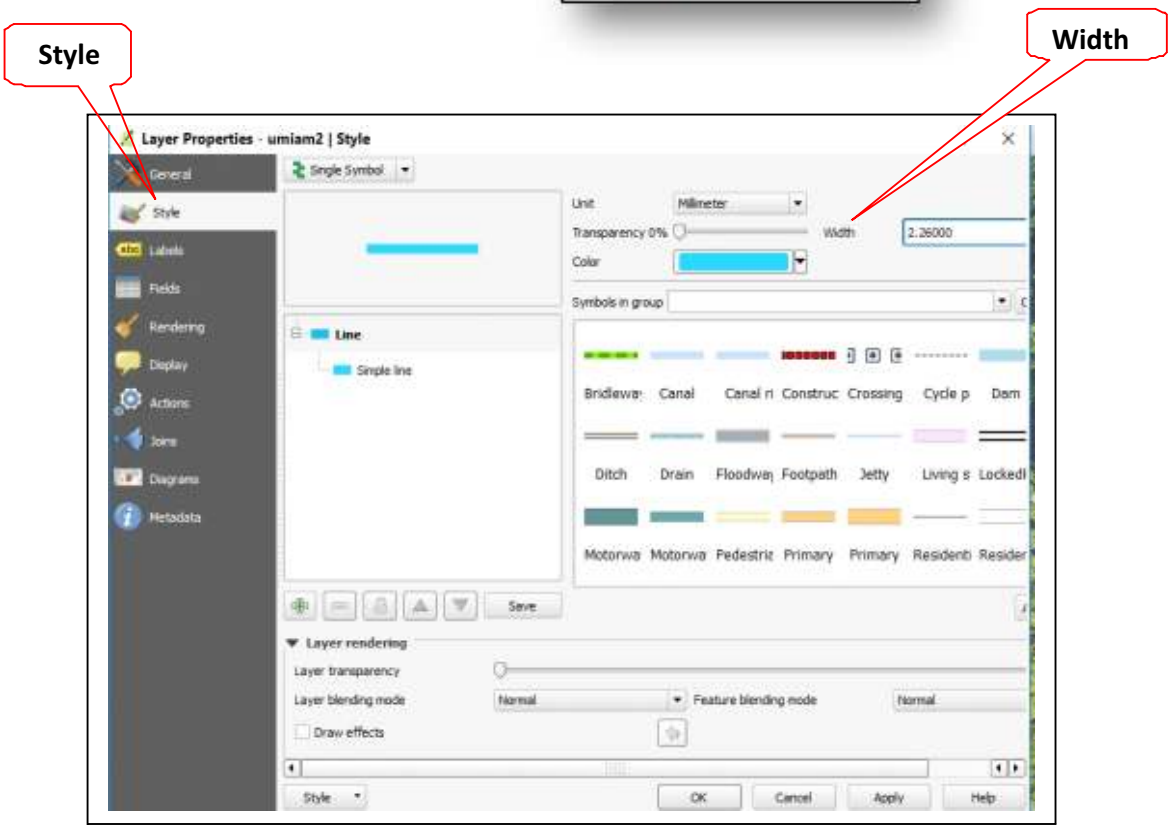




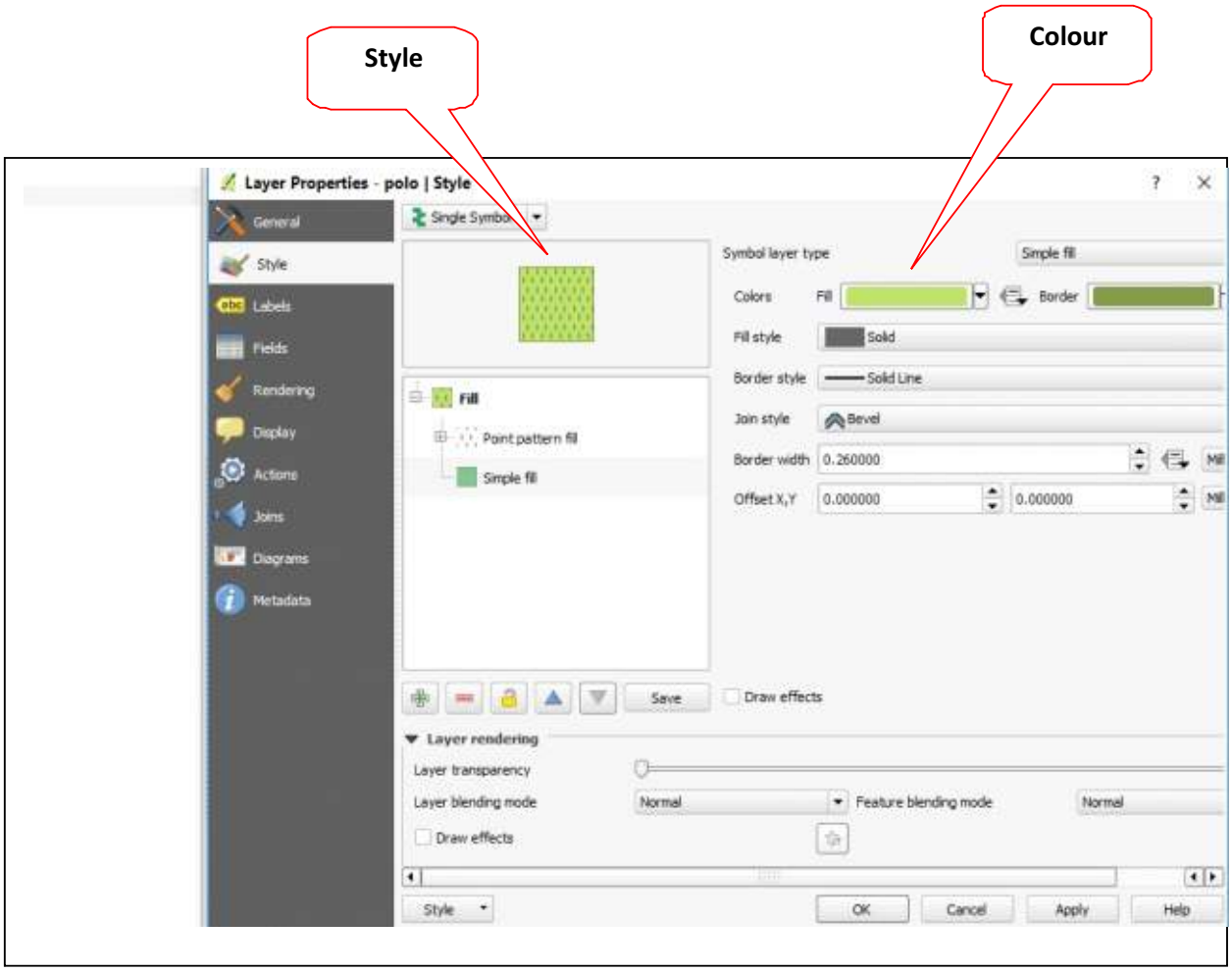
9.b (i) To change weight (width) of point, line go to layers >select the point or line layer >right click on it> go to properties option (a layer properties dialog will appear).

9. b (ii) Select style >go to width option and change the width of point or line as the case may be.





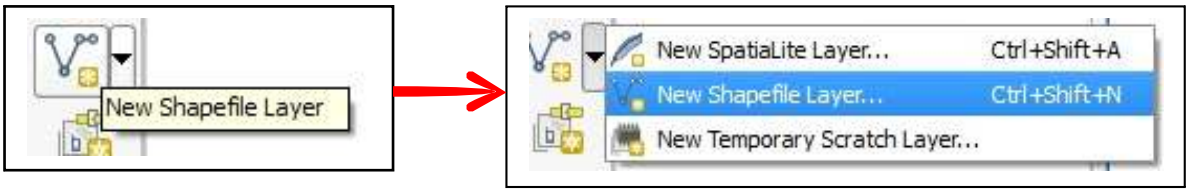
9. c (i) To change colour of the point, line and polygon go to layer >double click on the point polyline or polygon shapefile> a layer properties dialog box will appear > click on style option >change the colour of the shapefile.



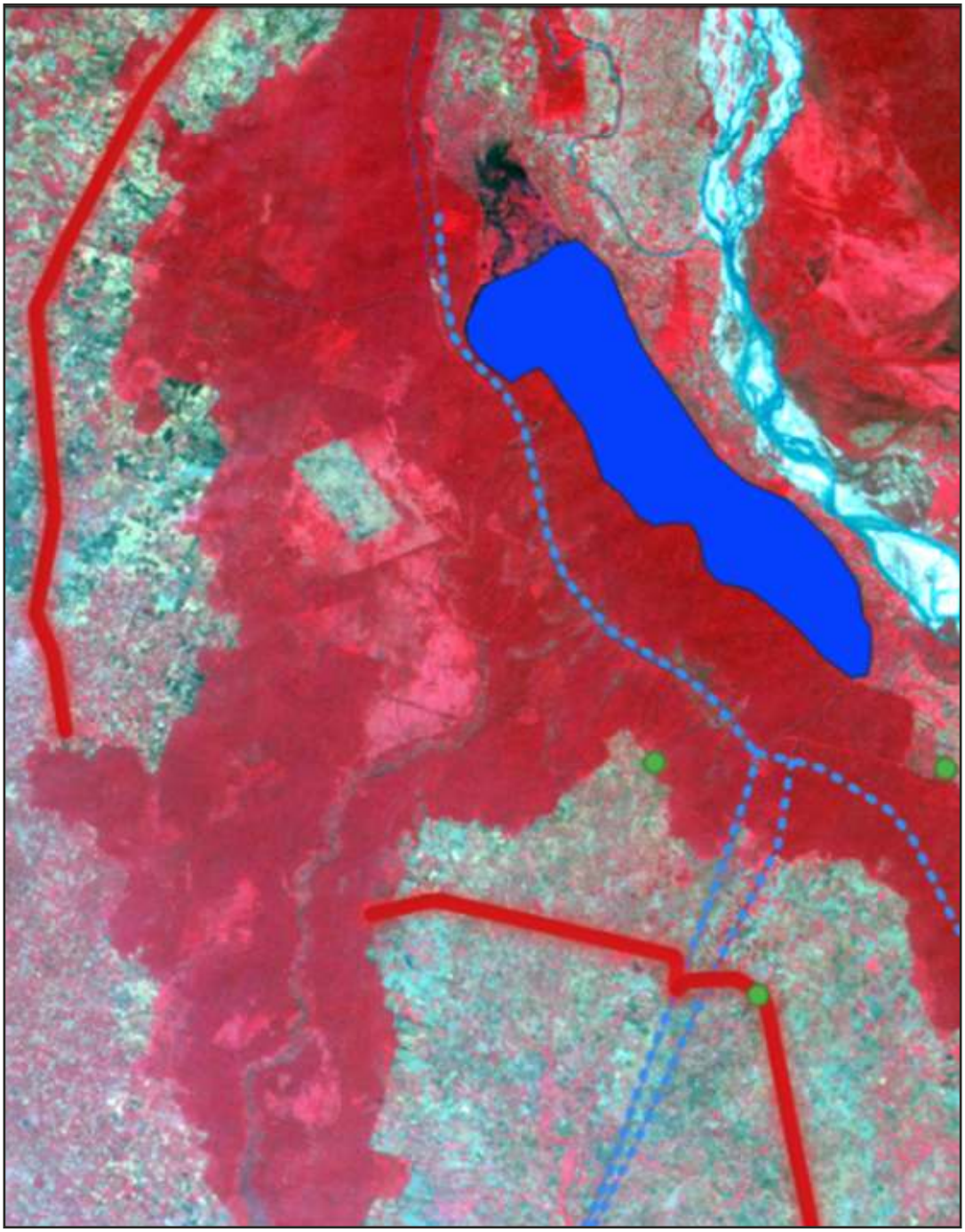
CHAPTER 10:
DIGITIZATION OF VECTOR FEATURE (POINT, LINE AND POLYGON) ON SATELLITE IMAGE

10. a Add a satellite image in QGIS layer.

10. b (i) To create a shapefile of point, line and polygon go to new shapefile layer menu > click in the option new shapefile (refer Chapter 4 for creation of new shapefile).



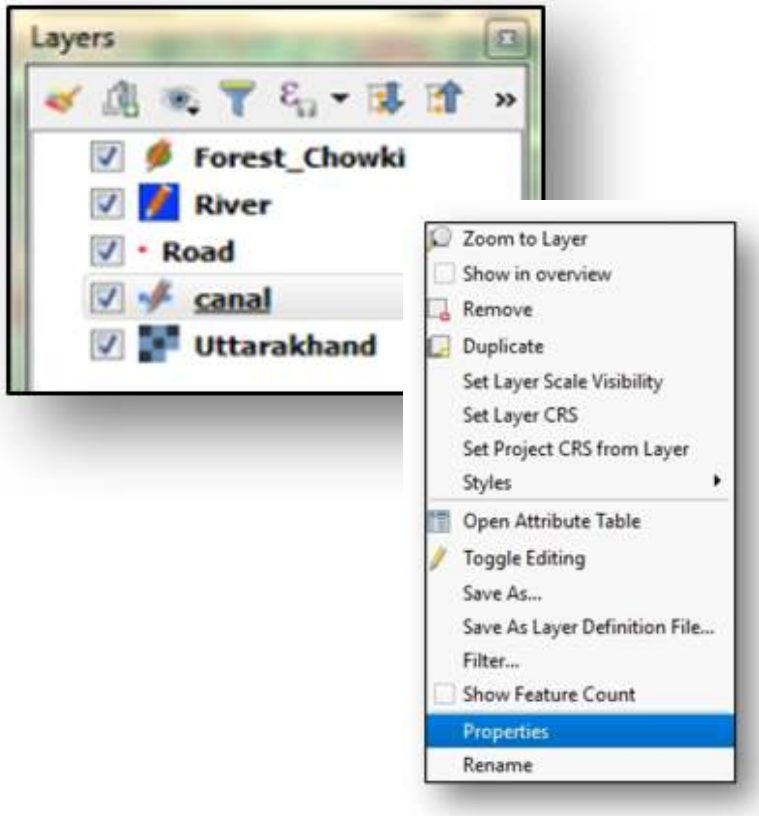
10. b (ii) Start digitise the point feature, line feature and polygon with reference to the satellite image (villages or locality as point features, river and road network as line features, open forest as polygon) .

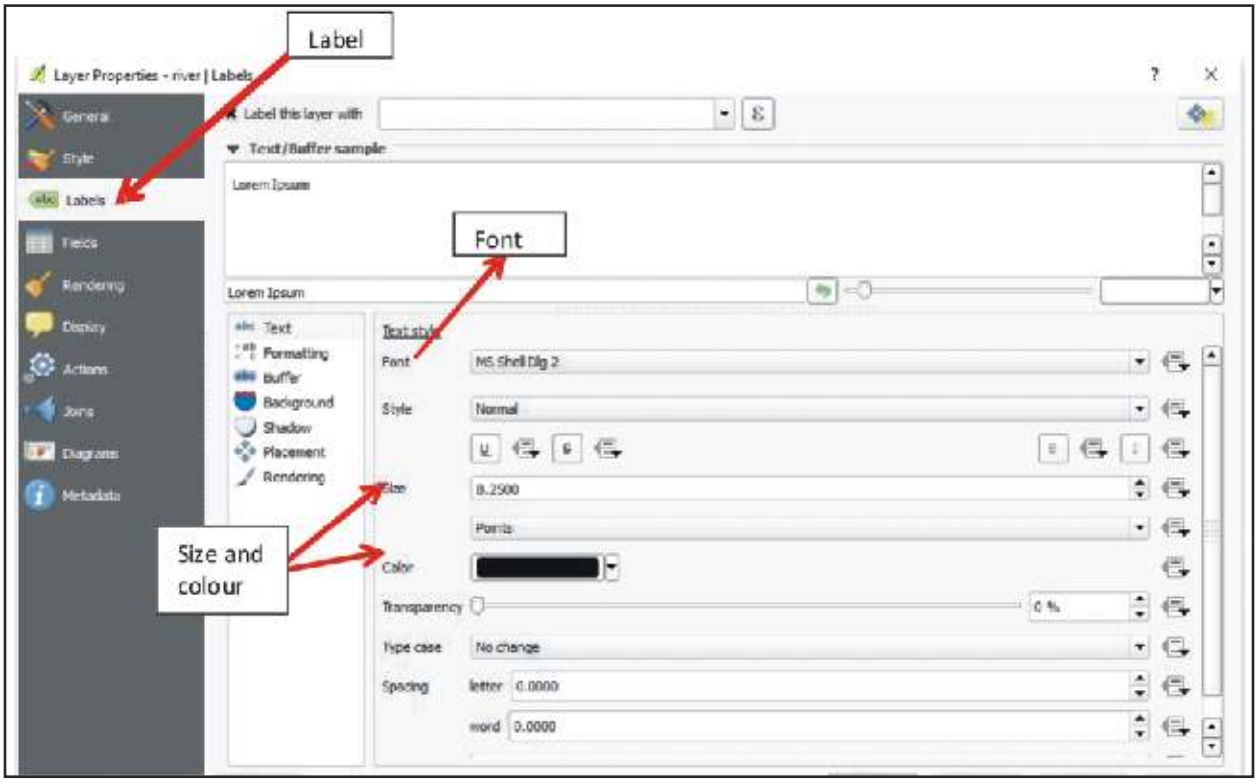


10. b (iii) After digitising all the features > save and stop the layer.

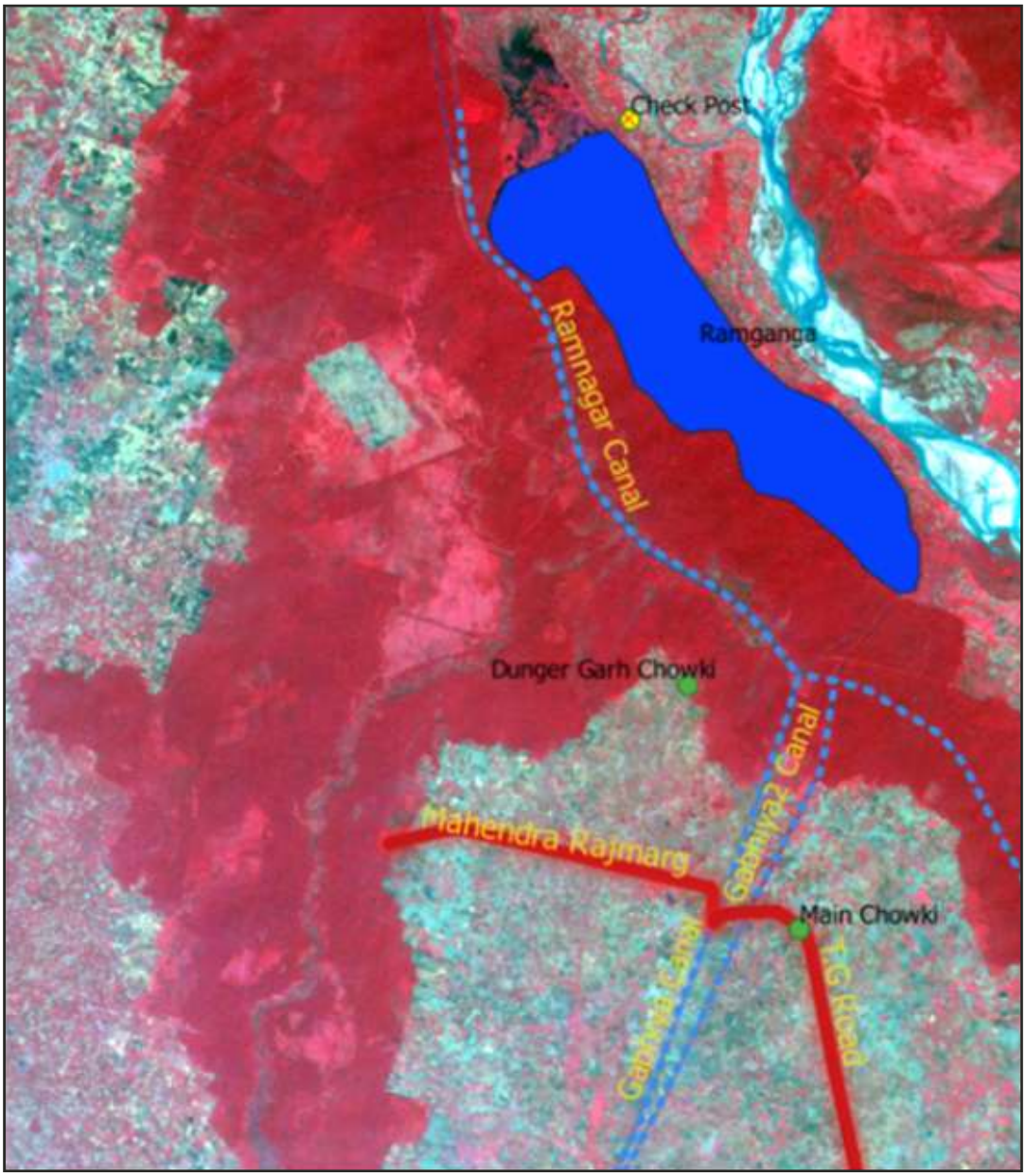
10.c (i) To name the features > select any features (either point, line or polygon) > right click on it > select properties.

10. c (ii) Layer properties table will appear > select Labels > select the option Label this layer.





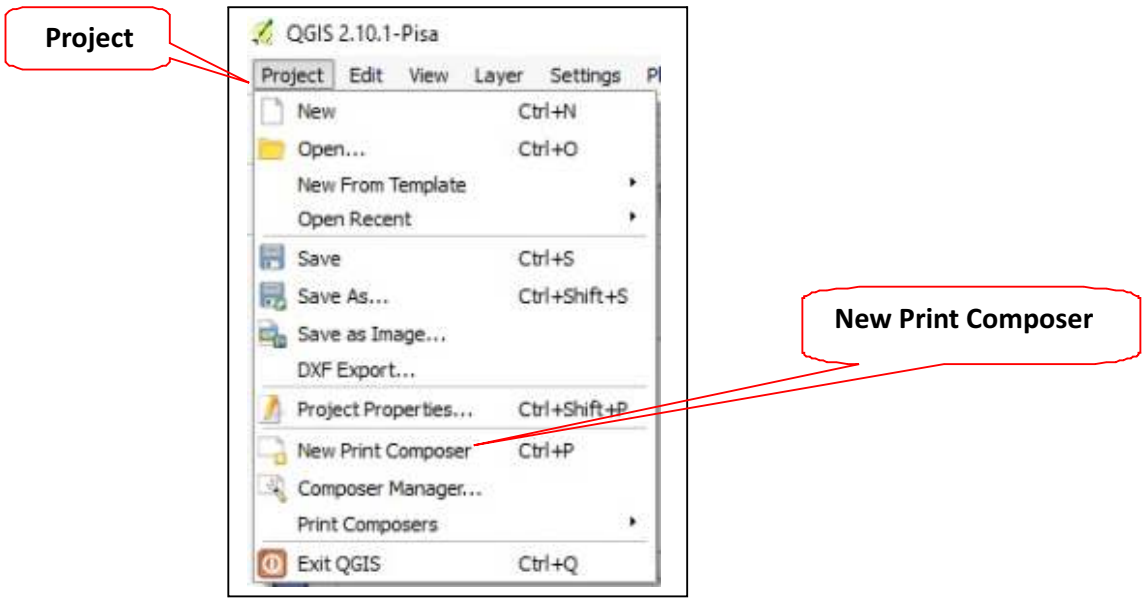
10. c (iii) Select the name of features > adjust colour of text, size and font format from the table > click apply then ok.



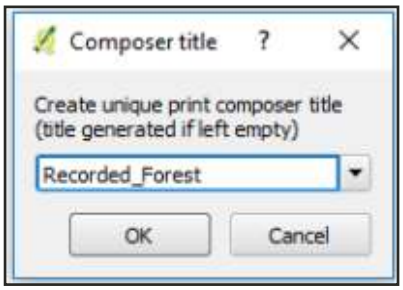
CHAPTER 11:

MAP COMPOSITION IN QGIS

11. (a) To compose a map in QGIS >go to menu toolbar > click **project**> select **new Print Composer.**

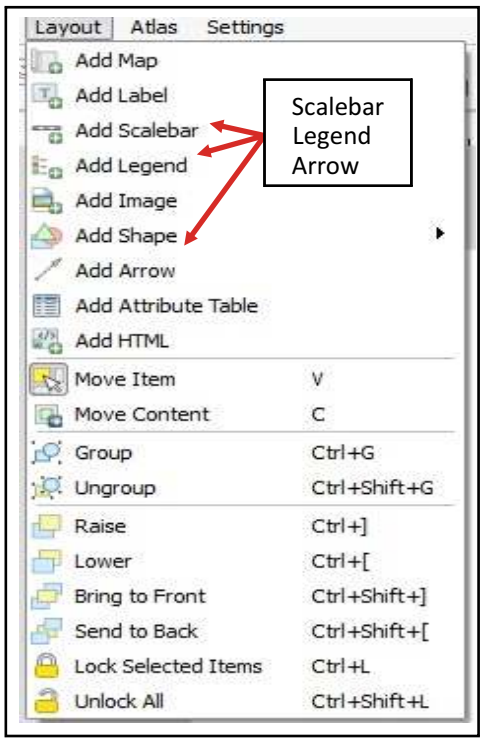


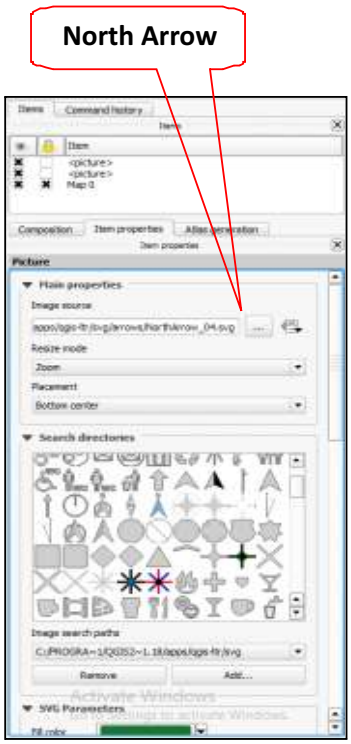
11. (b) After clicking on the new print composer one dialog box will appear >compose title > name the composer title.

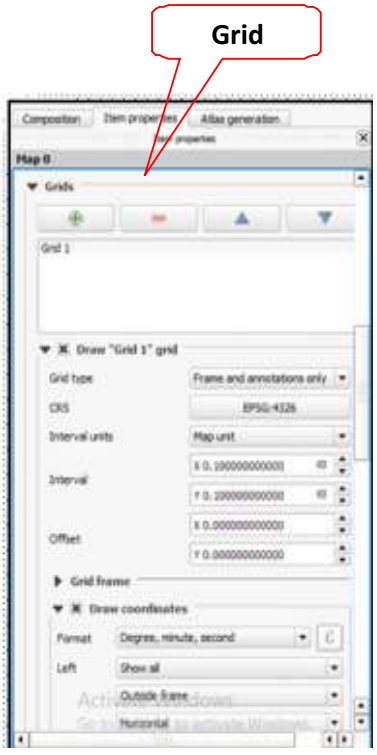


11. (c) Opening the Print Composer provides you with a blank canvas that represents the paper surface when using the print option> click on add new map>drag it in the map canvas.

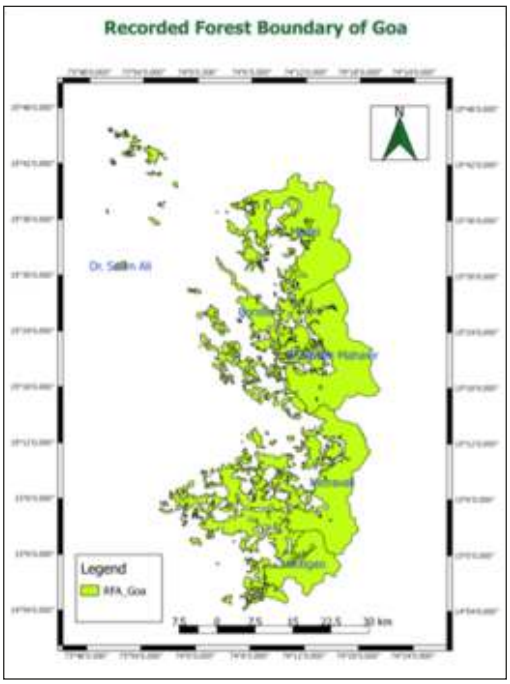
11. (d) Go to layout toolbar to add label, scale bar, legend and north arrow >to generate or add grid > click on item properties on the left side of map canvas > click on grid > add grid (+) > specify the CRS >adjust the interval > select the draw coordinates option > change the format into degree decimal or degree minute second.







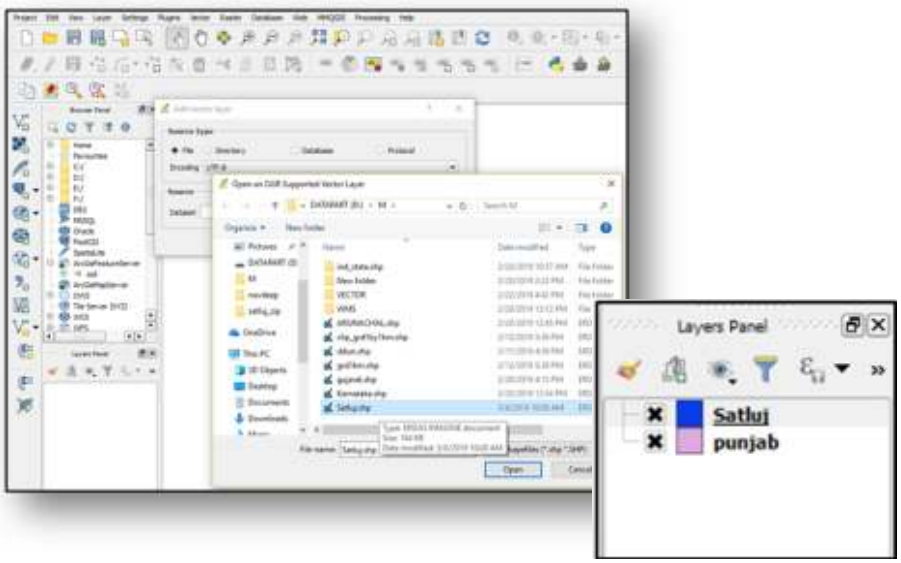
Composed Map of Goa

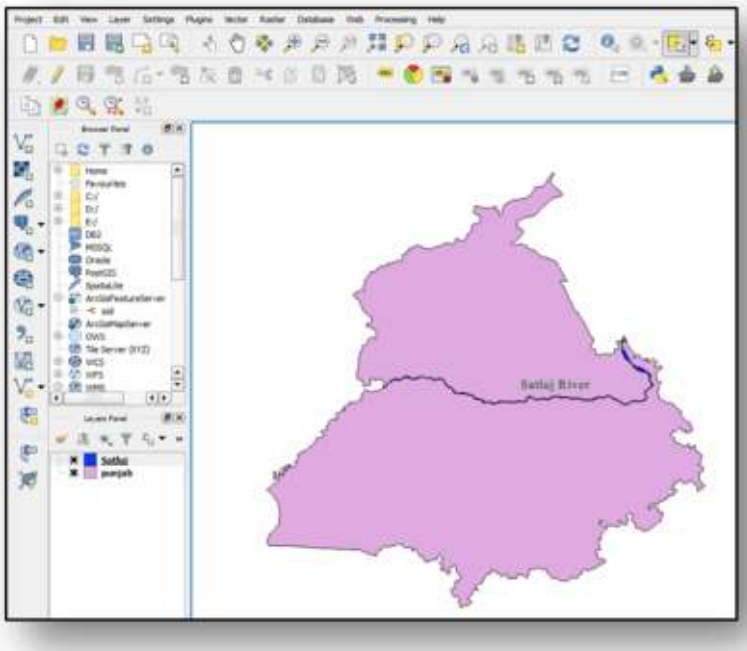


CHAPTER 12:

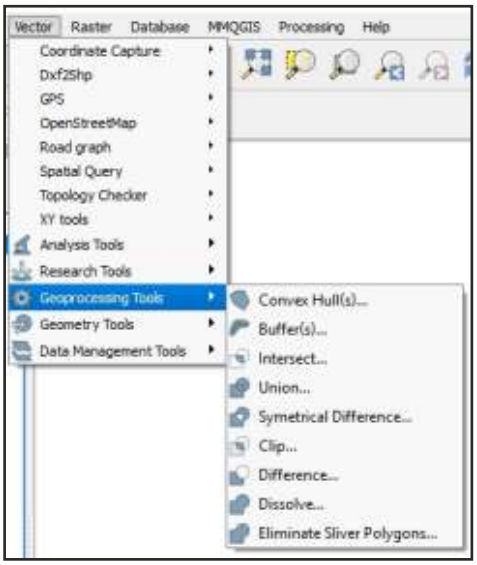
CREATION OF BUFFER

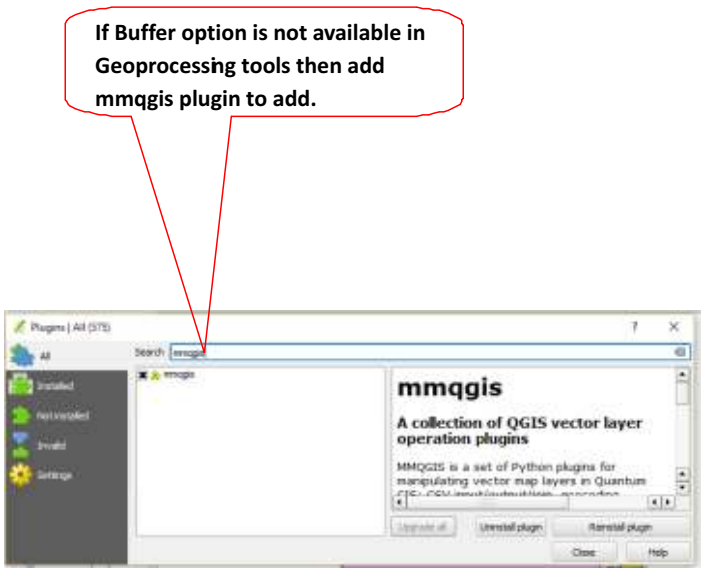
12. a (i) Open QGIS software > add vector data or shapefile of point, polyline and polygon.



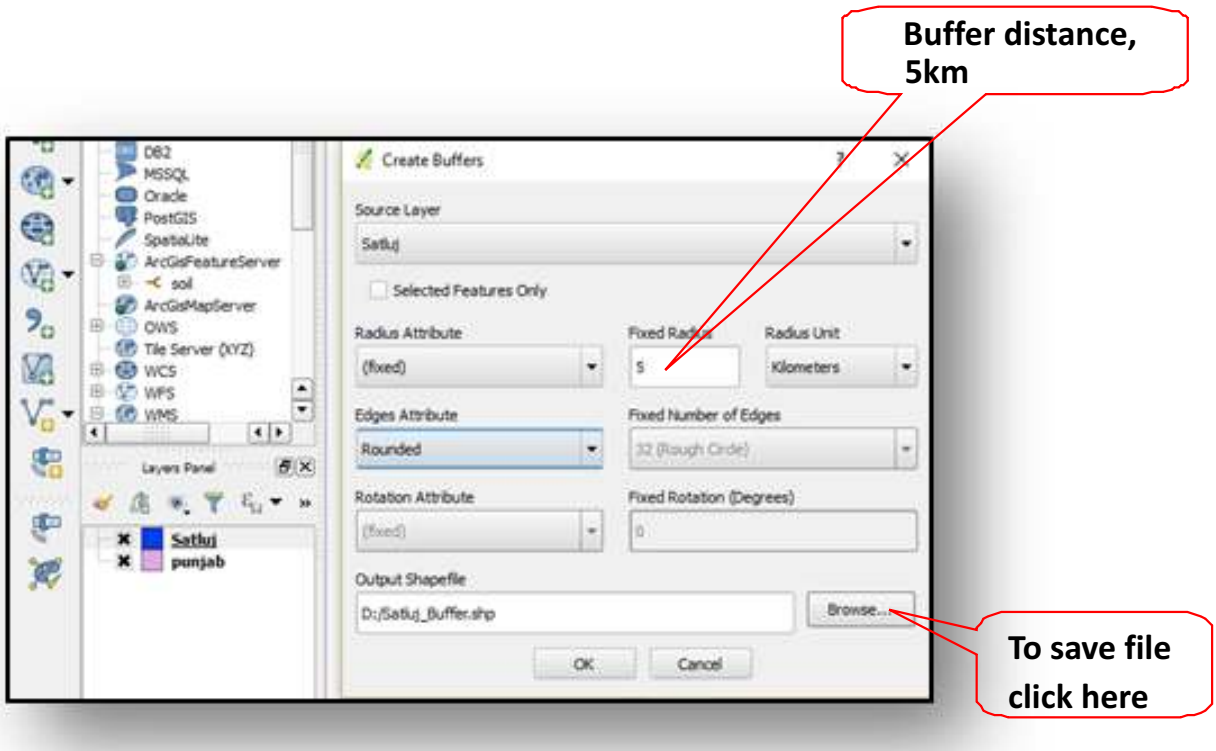


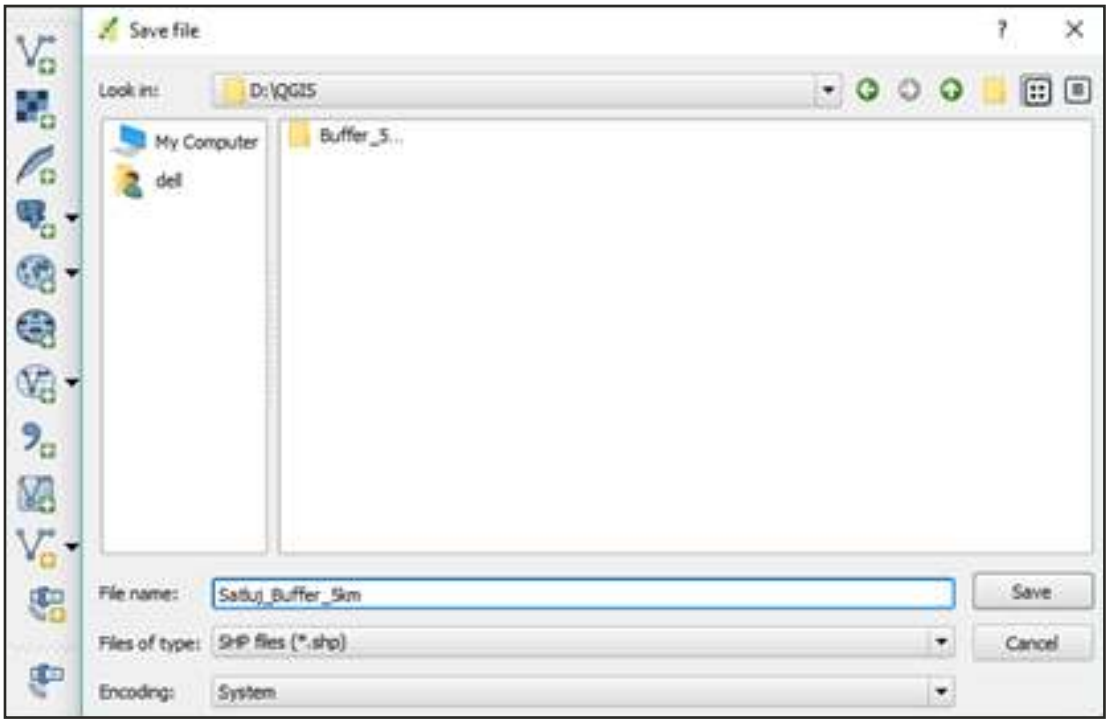
12. a (ii) Go to vector menu click on it > go to Geoprocessing tools > select buffer.

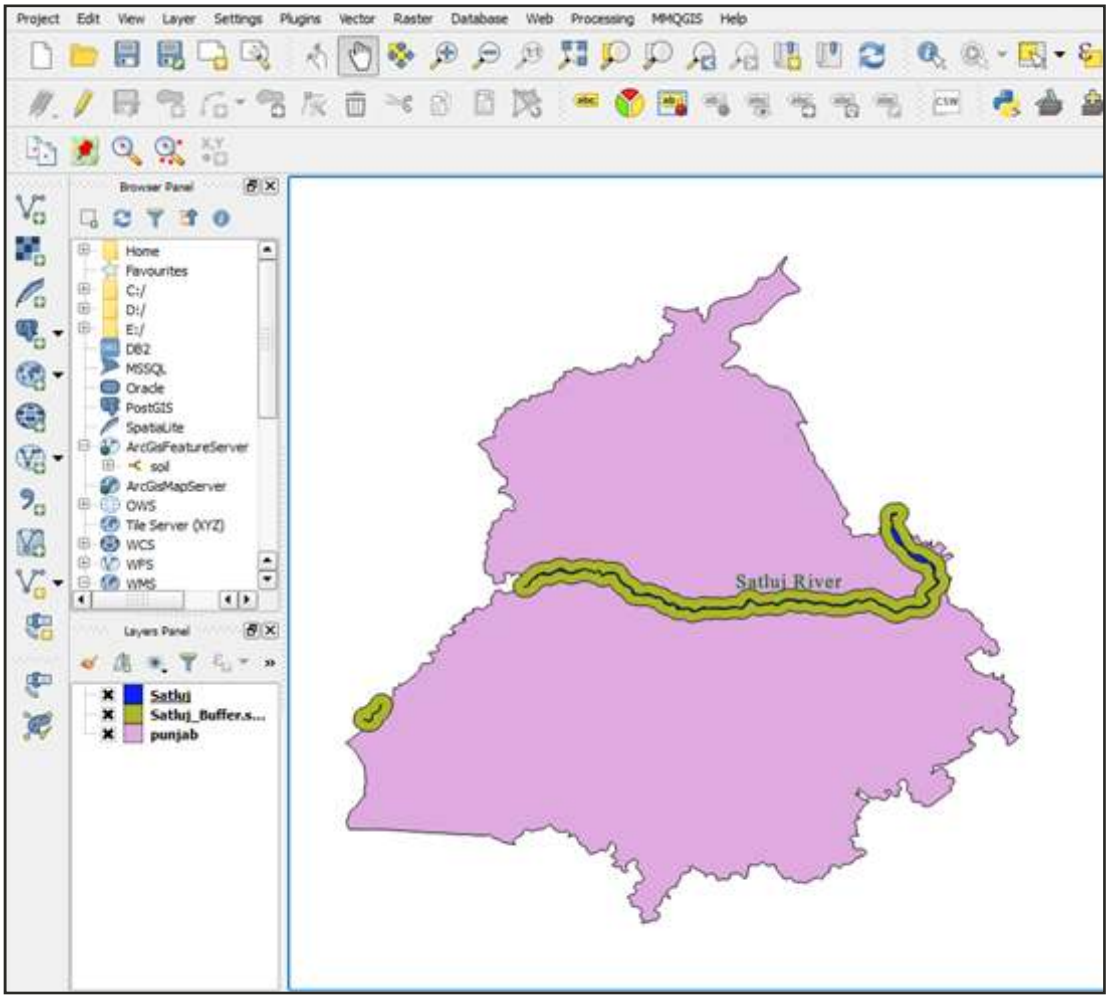




12. a (iii) After clicking on buffer option one dialog box will appear > specify or select the input vector layer > next specify the buffer distance (in km) > then go to browse option > select a folder to save the output file > click ok (the software will automatically process and calculate the buffer).




Save file
Look in:
D:\QGIS
My Computer
dell
Buffer_5...
File name:
Satluj_Buffer_5km
Save
Files of type:
SHP files (*.shp)
Cancel
Encoding:
System


Project Edit View Layer Settings Plugins Vector Raster Database Web Processing MMQGIS Help
Browser Panel
Home
Favourites
C:/
D:/
E:/
DB2
MSSQL
Oracle
PostGIS
SpatiaLite
ArcGisFeatureServer
soil
ArcGisMapServer
OWS
Tile Server (XYZ)
WCS
WPS
WMS
Layers Panel
Satluj
Satluj_Buffer.s...
punjab
Satluj River

ANNEXURE

GLOSSARY AND ABBREVIATION

Geographic Information Systems (GIS)

GIS is a computer-based tool that analyzes, stores, manipulates and visualizes geographic information on a map.

Open Source Software (OSS)

OSS is a computer software with its source code made available with a license in which the copyright holder provides the rights to study, change and distribute the software for any purpose. Open source software is developed in a collaborative public manner.

Open Source Geospatial Foundation (OSGeo)

It is a non-profit and non-governmental organization whose mission is to support and promote the collaborative development of open geospatial technologies, data, education and training. QGIS, GRASS, PostGIS, GDAL and GeoServer are projects of OSGeo (osgeo.org).

General Public License (GPL)

GPL is a free and widely used software license standard, which guarantees end users the freedom to run, study, share and modify the software. The license was originally written by the Free Software Foundation (FSF) for the GNU Project and grants the recipients of a computer program the rights of the Free Software Definition. The GPL is a copy left license, which means that derivative work can only be distributed under the same license terms.

Raster

Raster data in GIS are matrices of discrete cells that represent features of the earth's surface. Usually satellite or a real imagery is represented in Raster data format like GeoTIFF, img, pix, hdf (Hierarchical Data Format) etc.

Vector

Vector data is a coordinate-based data structure commonly used to represent point, linear and enclosed map features. Each linear feature is represented as x, y coordinates. Attributes stored in a database are associated with the features. Vector data includes:

1. Point features (Temple, Monuments, Forest Chowkies, Forest Fire Point, etc.)
2. Line features (Roads, Railways, Fences, Cart-tracks, Pack-Tracks, etc.)
3. Polygon features (Land Parcels, wetlands, forests, etc.)

Ground control points (GCPs

Control points are precise points with specific lat/long coordinates to add manually so the georeferencing tool can accurately generate georeferenced layer.

Coordinate reference system (CRS)

A CRS is a system corresponding to a certain projection and algorithm. Some of them are based on a latitude / longitude base while others may respond to different algorithms. Usually, each geographic entity has one or several CRS which represents its best. The most common CRS used for global projections is WGS 84.

Buffer

The buffer tool is a proximity function that creates a polygon at a set distance surrounding a selected feature or features.

Clip

A clip is an overlay tool that involves clipping an input layer with the extent of a defined feature boundary. The result of this tool is a new clipped output layer.

Coordinates

Coordinates are sets of values representing one particular geographical point. They are usually composed of two (x, y) or three (x, y, z) dimensions, x representing a horizontal value, y a vertical one, and z elevation.

Attribute table

An attribute table stores non-spatial information in columns and rows about geographic data.

Feature

A feature is a cartographic point, line or polygon object with a spatial location in the real-world landscape that can be used in a GIS for storage, visualization and analysis.

Latitude

The latitude is a vertical coordinate, ranging from 0° (at the Equator) to 90° (North Pole) or -90° (South Pole). It corresponds to the y field in coordinates.

Longitude

The longitude is a horizontal coordinate ranging from 0° at the Greenwich Meridian to 180° (East) and -180° (West). It corresponds to the x field in coordinates.

Note: The latest release of QGIS is always available web page
https://www.qgis.org/en/site/forusers/download.html

For further queries can connect m.bist83@gmail.com
Website: http://www.fsi.nic.in

"The cutting of a green tree is an offence punishable in hell !!!!"
Padma Puran (56.40-41)

9 788194 101826

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