

A Laboratory Manual for

Remote Sensing and GIS

(3150617)

B.E. Semester 5 (Civil)



Government Engineering College, Valsad



Directorate of Technical Education

Gandhinagar, Gujarat

Government Engineering College, Valsad

Government Engineering College, Valsad

Certificate

This is to certify that Mr./Ms. _____
_____ Enrollment No. _____ of B.E. Semester _____ Civil
Engineering of this Institute (GTU Code: _____) has satisfactorily
completed the Practical / Tutorial work for the subject Remote Sensing and
GIS (3150617) for the academic year 2023-24.

Place:

Date: _ _____

Name and Sign of Faculty member

Head of the Department

Preface

The basic aim of laboratory/practical/field work is to enhance the required skills as well as creating ability amongst students to solve real time problem by developing relevant competencies in psychomotor domain. By keeping this in view, GTU has designed competency focused outcome-based curriculum for engineering degree programs where sufficient focus is given to the practical work. It shows importance of enhancement of skills amongst the students and pays attention to utilize every second of time allotted for practical amongst students, instructors, and faculty members to achieve relevant outcomes by performing the practical rather than having merely study type practical. It is must for effective implementation of competency focused outcome-based curriculum that every practical is keenly designed to serve as a tool to develop and enhance relevant competency required by the various industry among every student. These psychomotor skills are very difficult to develop through traditional chalk and board content delivery method in the classroom. Accordingly, this lab manual is designed to focus on the industry defined relevant outcomes, rather than old practice of conducting practical to prove concept and theory.

By using this lab manual students can go through the relevant theory and procedure in advance before the actual performance which creates interest and students can have basic idea prior to performance. This in turn enhances pre-determined outcomes amongst students. Each Practical in this manual begins with competency, industry relevant skills, course outcomes as well as practical outcomes (objectives). The students will also achieve safety and necessary precautions to be taken while performing practical.

This manual also provides guidelines to faculty members to facilitate student centric lab activities through each Practical by arranging and managing necessary resources in order that the students follow the procedures with required safety and necessary precautions to achieve the outcomes. It also gives an idea that how students will be assessed by providing rubrics.

Remote Sensing and GIS is Open Elective course which deals with the remotely sensed data sets and its analysis in GIS software to interpret existing information and to generate new type of data set for wide region/s.

Utmost care has been taken while preparing this lab manual however always there are chances of improvement. Therefore, we welcome constructive suggestions for improvement and removal of errors if any.

Industry Relevant Skills

The following industry relevant competencies are expected to be developed in the student by undertaking the practical work of this laboratory.

1. Student will get acquainted with different types of freely available remote sensing data types and GIS software. And will be able to leverage such data types for use during his professional life.
2. Student will be able to visually analyze remotely sensed data and perform on screen digitization to generate different types of maps.
3. Student will be able to perform different types of geometric calculations, such as calculation of area, length, perimeter on the map features using tools available within the GIS software.

Guidelines for the Faculty members

1. Teacher should provide the guideline with demonstration of practical to the students with all features.
2. Teacher shall explain basic concepts/theory related to the practical to the students before starting of each practical.
3. Involve all the students in performance of each practical.
4. Teacher is expected to share the skills and competencies to be developed in the students and ensure that the respective skills and competencies are developed in the students after the completion of the experimentation.
5. Teachers should give opportunity to students for hands-on experience after the demonstration.
6. Teacher may provide additional knowledge and skills to the students even though not covered in the manual but are expected from the students by concerned industry.
7. Give practical assignment and assess the performance of students based on task assigned to check whether it is as per the instructions or not.
8. Teacher is expected to refer complete curriculum of the course and follow the guidelines for implementation.

Instructions for Students

1. Students are expected to carefully listen to all the theory classes delivered by the faculty members and understand the COs, content of the course, teaching and examination scheme, skill set to be developed etc.
2. Students shall organize the work in the group and make record of all observations.
3. Students shall develop maintenance skill as expected by industries.
4. Student shall attempt to develop related hand-on skills and build confidence.
5. Student shall develop the habits of evolving more ideas, innovations, skills etc. apart from those included in scope of manual.
6. Student shall refer technical magazines and data books.
7. Student should develop a habit of submitting the experimentation work as per the schedule and s/he should be well prepared for the same.

Common Safety Instructions:

Take break of at least 10 minutes, after 45 minutes continues screen viewing.

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(Progressive Assessment Sheet)

Sr. No.	Objective(s) of Practical	Page No.	Date of performance	Date of submission	Assessment Marks	Sign. of Teacher with date	Remarks
1	Practical No: 1						
2	Practical No: 2						
3	Practical No: 3						
4	Practical No: 4						
Total							

Practical No: 1

Leveraging freely available RS data and GIS Software (QGIS)

Date:

Competency and Practical Skills: Knowledge of Remote Sensing data formats.

Relevant CO: CO1, CO2, CO3

Objectives:

- a) Introduction to Bhuvan Portal and Earth-Explorer Portal.
- b) Introduction to various types of remote sensing data available on these portals (in particular DEM data sets and LandSAT data).
- c) To leverage freely available remote sensing data. Specially DEMs on Bhuvan Portal and Earth-Explorer Portal.

Equipment/Instruments: Computer with internet connection.

Theory:

Introduction to Bhuvan Portal:

Bhuvan Portal is a web-based platform developed by the Indian Space Research Organization (ISRO) to provide geospatial data and services to users in India. The portal was launched in 2009 and has since then been providing a variety of data sets, tools, and applications to support various applications such as disaster management, urban planning, agriculture, water resource management, and many others.

Bhuvan Portal offers a range of data sets including satellite imagery, topographic maps, and weather data. Users can access these data sets through the portal's user-friendly interface, which allows for easy navigation and customization. The platform also includes several tools and applications such as the Bhuvan Geoportal, Bhuvan Panchayat, and Bhuvan Mobile App that enable users to view, analyze, and download geospatial data.

One of the unique features of the Bhuvan Portal is its ability to provide real-time data, such as weather and rainfall information, which can be particularly useful for disaster management and emergency response. The portal also provides 3D visualization capabilities, allowing users to view and analyze geospatial data in three dimensions.

Overall, Bhuvan Portal is an important resource for geospatial data and services in India, helping to support a wide range of applications and activities that require accurate and up-to-date information about the Earth's surface and environment.

Introduction to Earth Explorer by USGS:

The Earth Explorer portal is a web-based platform developed by the United States Geological Survey (USGS) that provides access to a wide range of remote sensing and geospatial data related to the Earth's surface. Launched in 2008, the platform allows users to search, preview, and download data from a variety of satellite, aerial, and ground-based sources.

The Earth Explorer portal offers access to a range of data sets, including aerial photographs, satellite imagery, topographic maps, and land cover data. Users can search for data based on location, data type, time period, and other parameters, and can preview the data before downloading it. The platform also includes tools for processing and analyzing the data, as well as for visualizing it in different formats.

One of the key features of the Earth Explorer portal is its comprehensive coverage of the United States and other parts of the world. The platform provides access to data from a range of satellite missions, including Landsat, MODIS, and Sentinel, as well as from ground-based sensors such as the USGS National Land Cover Database and the Global Land Cover Facility.

The Earth Explorer portal is used by a wide range of users, including scientists, researchers, government agencies, and private companies. It is particularly useful for applications such as land use planning, natural resource management, and environmental monitoring. Overall, the platform plays a critical role in providing access to high-quality geospatial data and supporting a range of important applications related to the Earth's surface.

DEM:

A Digital Elevation Model (DEM) is a digital representation of the Earth's surface terrain that uses height data to represent the elevation of the terrain. It is a commonly used type of digital map that provides a 3D representation of the Earth's surface.

DEM data is typically collected using remote sensing technologies such as LiDAR (Light Detection and Ranging) or satellite-based radar interferometry. These technologies use lasers or radar signals to bounce off the Earth's surface and measure the time it takes for the signal to return, which provides information about the elevation of the terrain.

DEM data is stored in a grid format, with each grid cell representing a small area of the Earth's surface and containing a height value for that area. The height values can be used to create a 3D representation of the terrain, which can be useful for a wide range of applications such as environmental modeling, urban planning, and disaster management.

DEM data can also be used to create other types of maps, such as slope and aspect maps, which provide information about the steepness and orientation of the terrain. Additionally,

DEM data can be combined with other types of data such as aerial photographs and land cover data to create more detailed and informative maps.

Overall, Digital Elevation Models are an important tool for understanding and visualizing the Earth's surface terrain, and they play a critical role in many fields including geology, geography, and environmental science.

CartoDEM:

CartoDEM is a digital elevation model (DEM) available on the Bhuvan Portal, developed by the Indian Space Research Organization (ISRO). It is a high-quality DEM that covers the entire land area of India, providing fairly accurate elevation data for a wide range of applications, including natural resource management, environmental modeling, and disaster management.

CartoDEM is based on a 30-meter grid and is derived from CARTOSAT satellite imagery. It is a detailed representation of the terrain, providing users with the ability to create 3D visualizations of the Earth's surface terrain.

SRTM DEM:

The Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) is a high-resolution digital elevation model of the Earth's surface that covers nearly the entire land surface of the Earth between 60 degrees north and 56 degrees south latitude. The SRTM mission was conducted by NASA in 2000 using the Space Shuttle Endeavour and the SRTM radar system.

The SRTM DEM has a spatial resolution of 1 arc-second (approximately 30 meters) and is based on radar signals that were transmitted from the Space Shuttle and bounced off the Earth's surface. These radar signals provided elevation measurements that were used to create a detailed digital elevation model of the Earth's surface terrain.

The SRTM DEM has many applications, including geological and environmental modeling, hydrological modeling, and disaster management. It has been widely used by government agencies, researchers, and businesses for a range of purposes, including urban planning, natural resource management, and military operations.

Overall, the SRTM DEM is a valuable resource for understanding the Earth's surface terrain and has played a significant role in advancing our understanding of the planet.

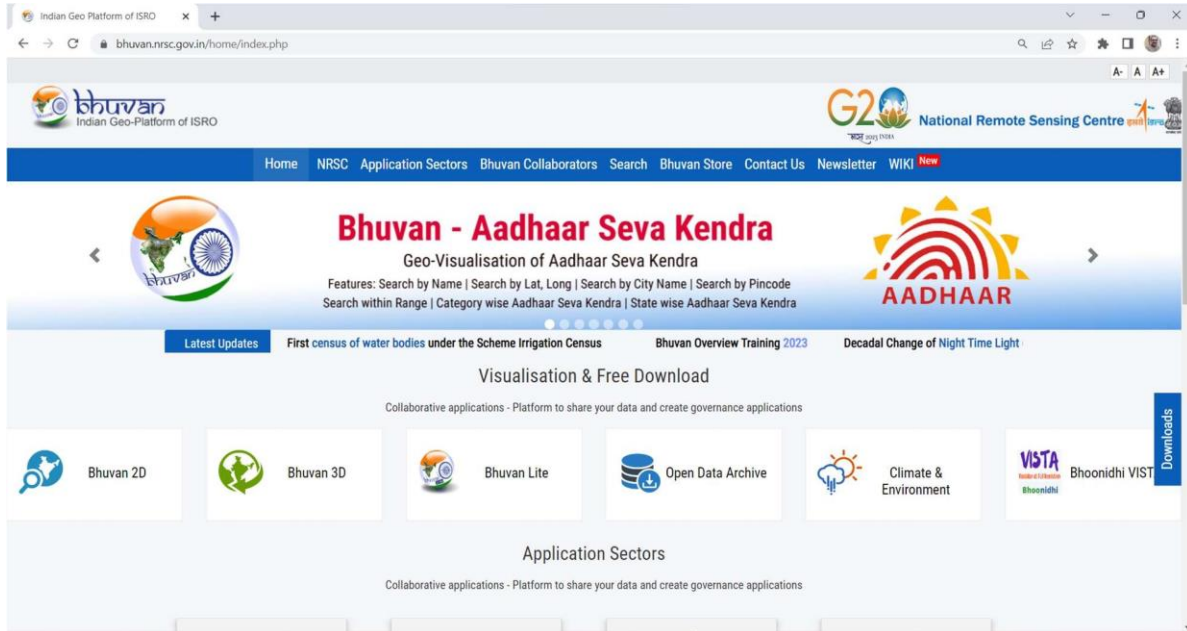
Safety and necessary Precautions:

Take break of at least 10 minutes, after 45 minutes continues screen viewing.

Procedure-1: Creating login ID on ISRO Bhuvan Portal and downloading CartoDEM Data

Remote Sensing and GIS

- 1) Open <https://bhuvan.nrsc.gov.in/home/index.php> and click Open Data Archive tab.

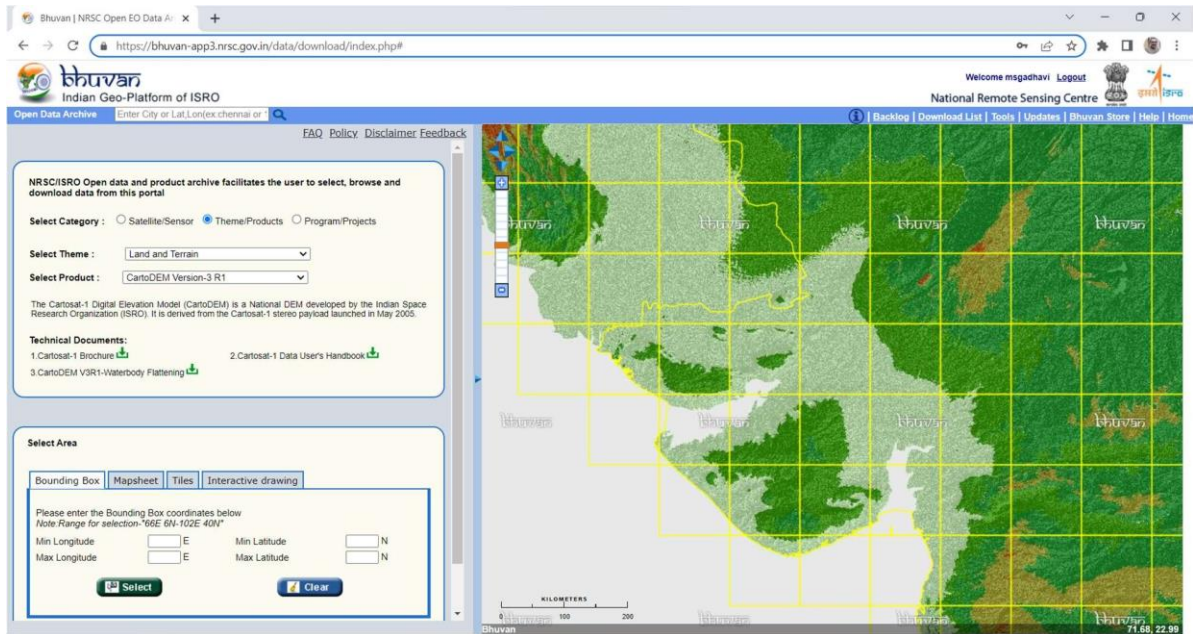


- 2) Create login on the <https://bhuvan-app3.nrsc.gov.in/data/download/index.php#>

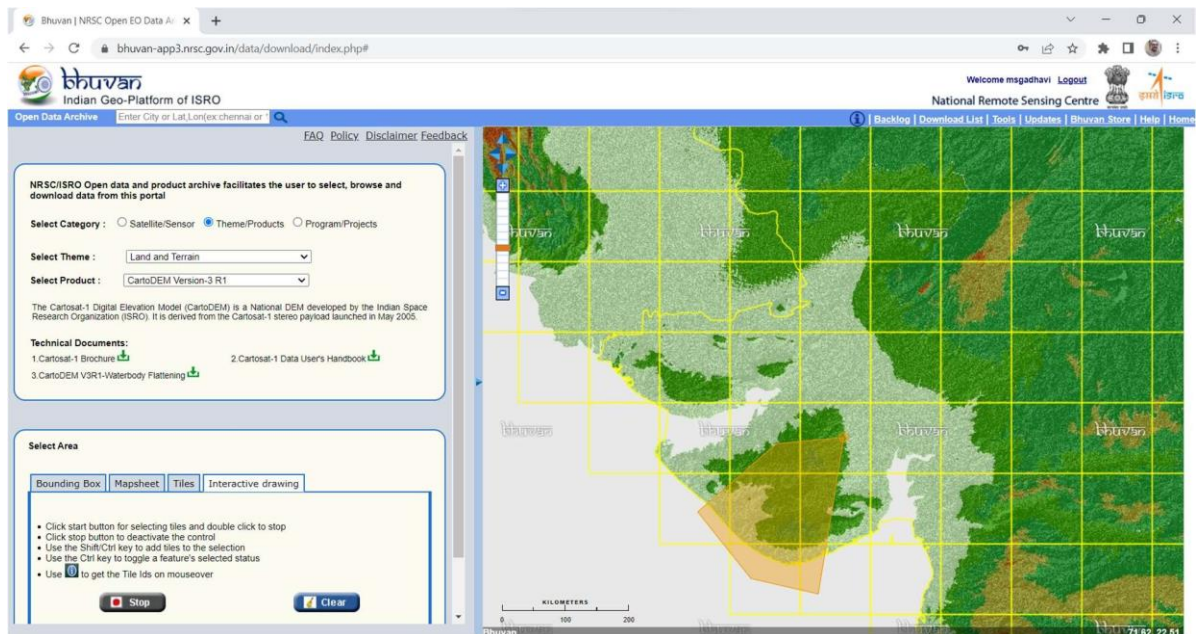
The screenshot shows the Bhuvan login and registration form. The form is titled "Account and Profile Information" and includes a "Subscribe" section for Bhuvan NewsLetters. The "Account" section contains fields for User Name, Email, Country (set to India), Telephone, Organization (set to Government), and Organization details. The "Profile" section contains fields for First Name, Last Name, Gender (set to Select), Pincode, and Purpose. A "Submit" button is located at the bottom of the form. A "Click here to Login" link is also present. A "Cancel" button is visible at the bottom of the page.

Remote Sensing and GIS

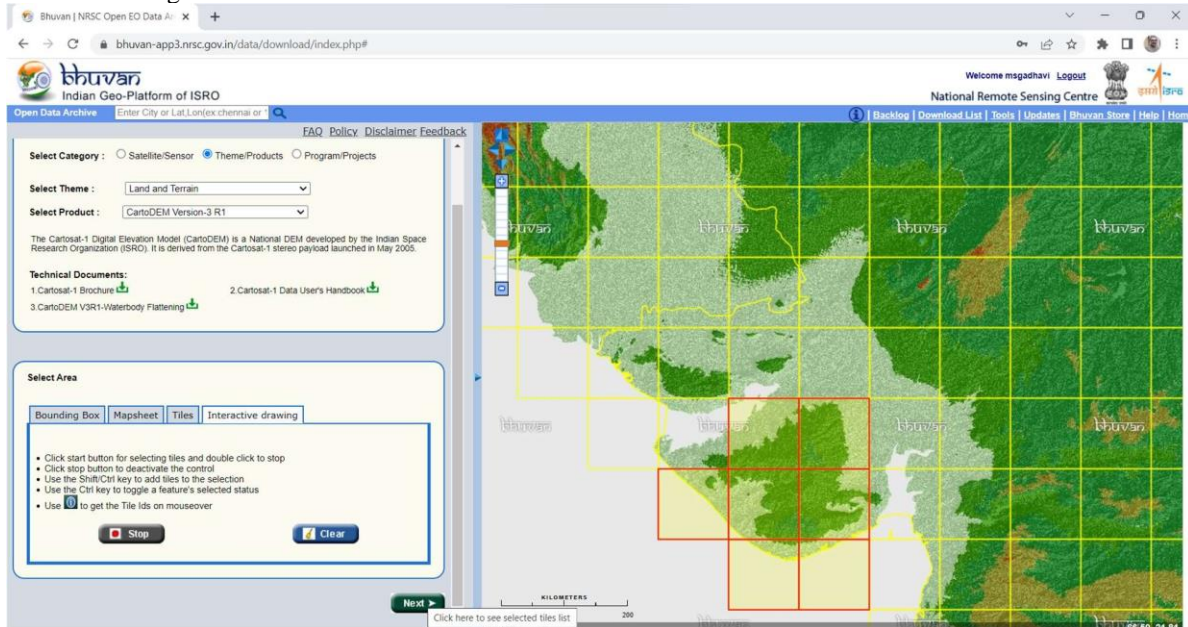
- 3) After logging on the Bhuvan Portal, as shown in the previous step, data selection should be done from the available options as shown below:



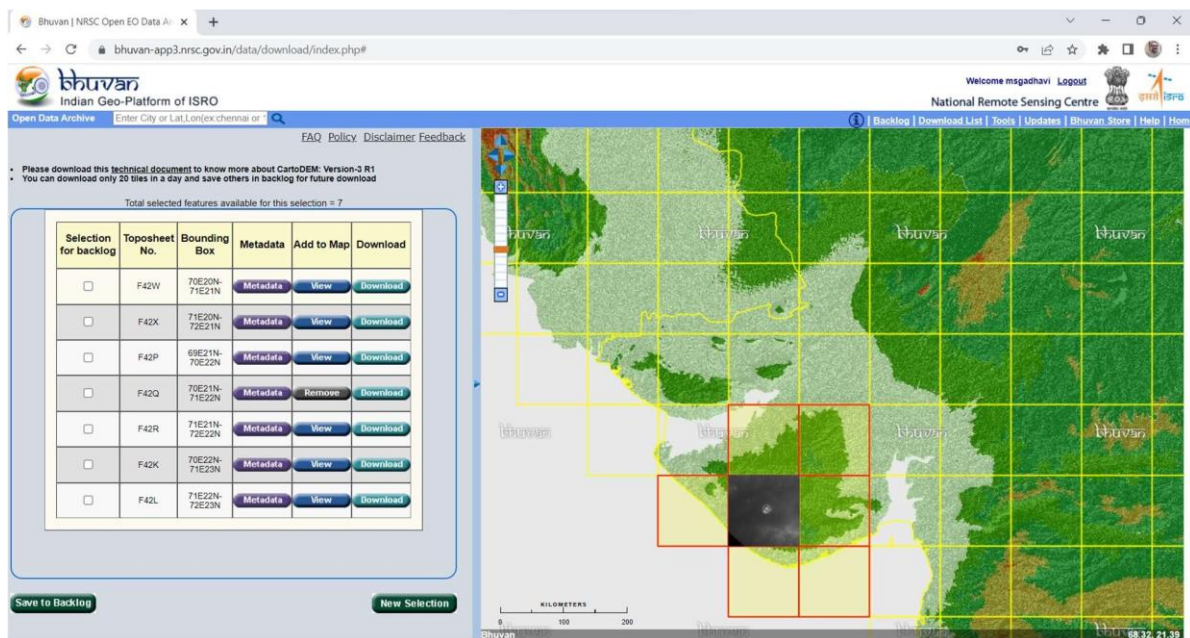
- 4) Tik the radio button for Theme/Product > Select Theme: Land and Terrain > Select Product: CartoDEM Version- (any version as per your requirement).
- 5) In Select area tab click: 'Interactive drawing' and click 'Start'.
- 6) Select the tiles by clicking left mouse button that cover the area of your interest as shown below. Finish the selection by double clicking left mouse button.



Remote Sensing and GIS



- 7) After tile selection as shown in the image above Click 'Next' and a list of different scenes will appear on the left side. To preview any tile, click 'View' tab and a preview of that particular dataset will be available as shown below:

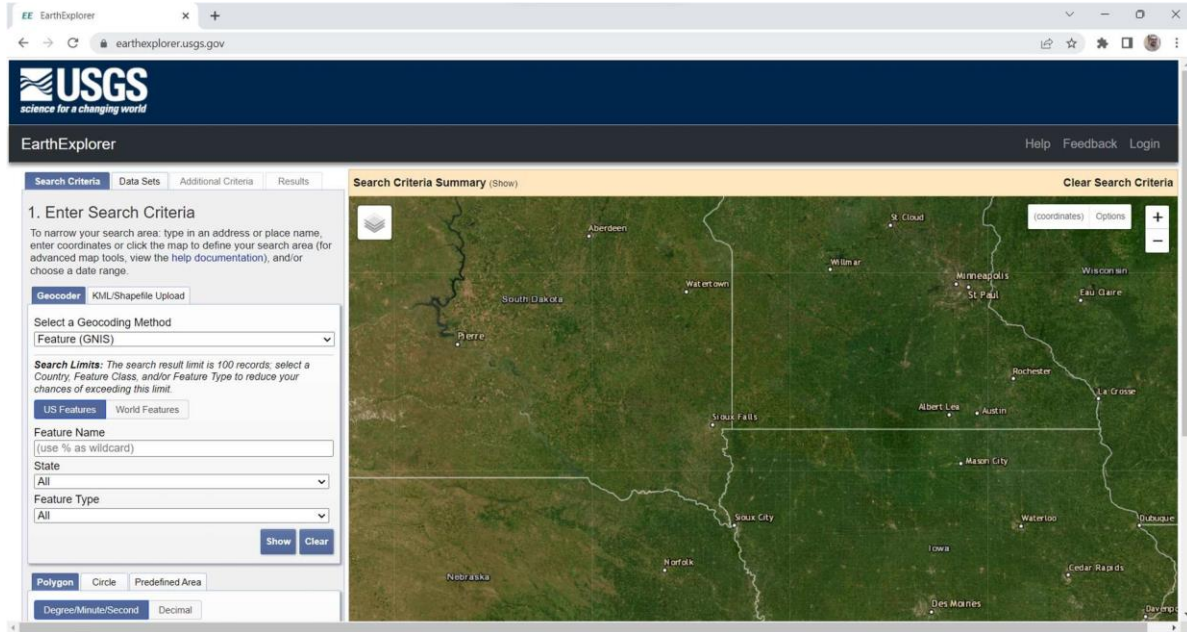


- 8) By clicking 'Download' tab the particular data tile (Image/scene) can be downloaded and saved on the computer. Which will be available in form of a ZIP folder, containing different a TIF file along with other supporting files. This TIF file can be opened later in the QGIS software.

Procedure-2: Creating login ID on USGS Earth Explorer and downloading SRTM Data

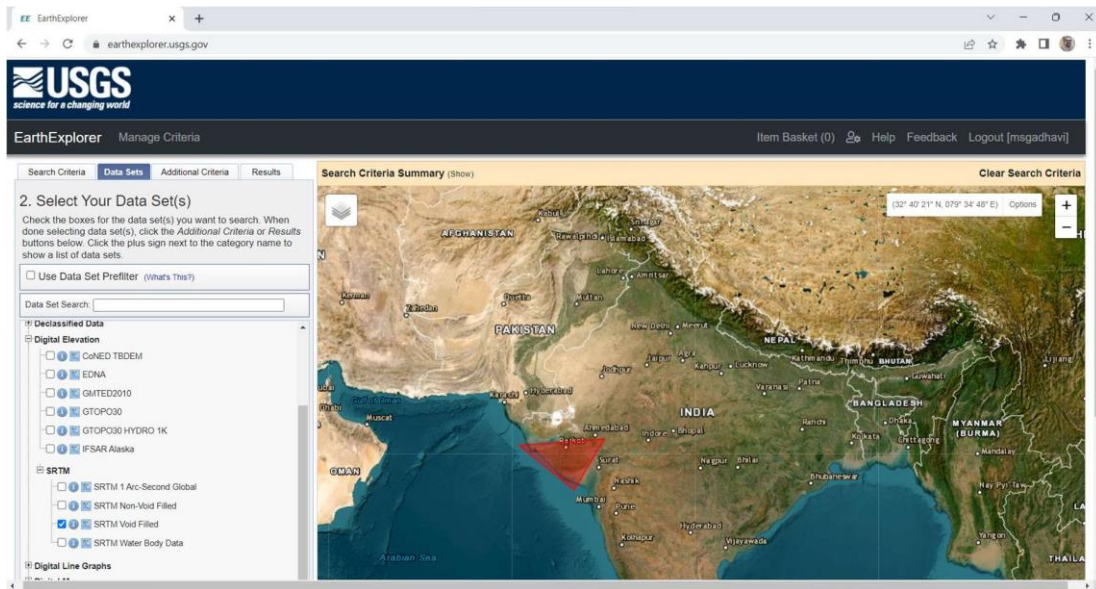
Remote Sensing and GIS

1) Open <https://earthexplorer.usgs.gov/> and create login.

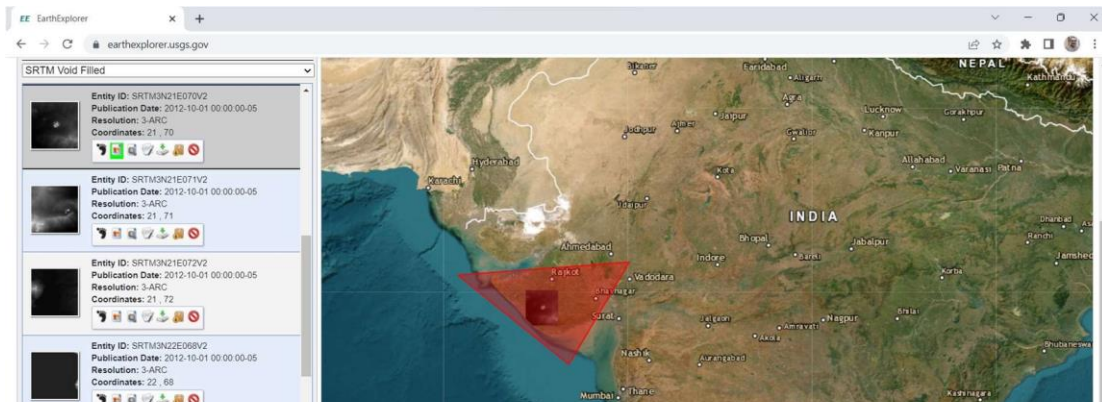


2) Pan to your area of interest in the map > left click on the map to select your area of interest

> on 'data sets' tab select > 'Digital Elevation' > 'SRTM' > 'SRTM Void Filled'.

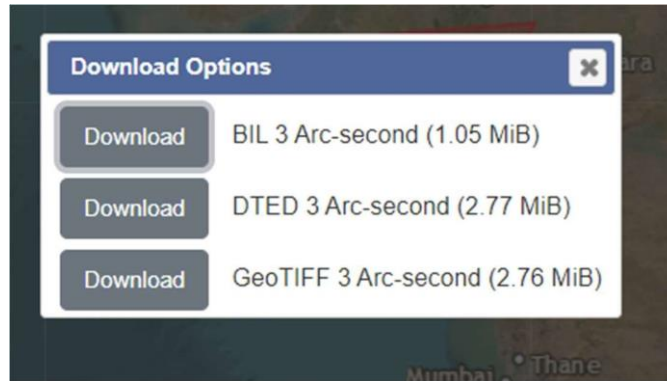


3) Click on 'Results' and preview of particular data scene (or image) can be viewed as shown below.



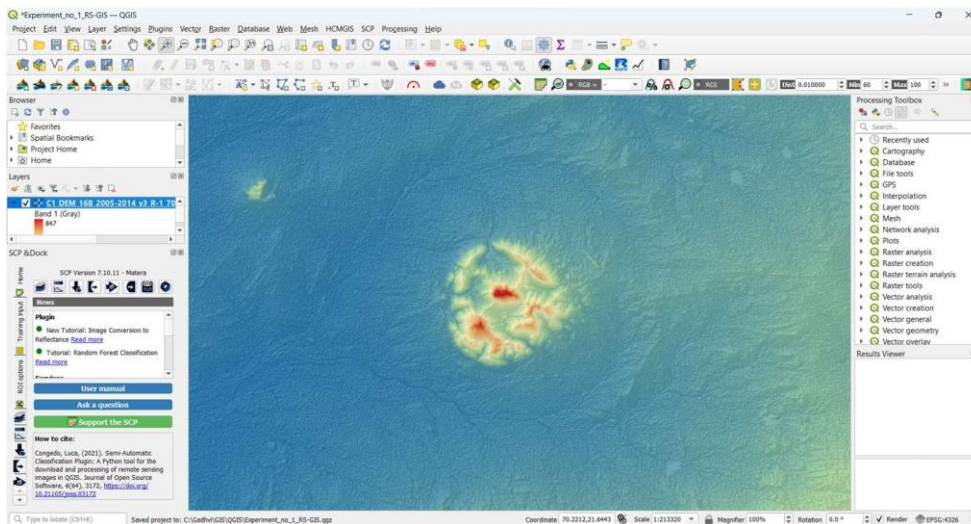
Remote Sensing and GIS

- 4) By clicking download option data can be downloaded in three different file formats as shown below.



- 5) GeoTIFF is widely used file format. Download the data in GeoTIFF format and save on the computer, which can be used in QGIS at later stage.

Result:



Quiz:

1. What is the Bhuvan Portal and what types of data sets are available on it?
2. What is the Earth Explorer portal and what types of remote sensing data are available on it?
3. What is a Digital Elevation Model (DEM) and how is it created?
4. What is CartoDEM and how is it different from other DEMs available on Earth Explorer?

Practical No: 2

Learning to upload DEM in QGIS and to change symbology of the DEM.

Date:

Competency and Practical Skills: Knowledge of Remote Sensing data formats.

Relevant CO: CO1, CO2, CO3

Objectives:

- a) Introduction to QGIS software.
- b) Loading DEM in QGIS and changing its symbology for better visualization.

Equipment/Instruments: Computer with internet connection.

Theory:

QGIS Software:

QGIS (short for Quantum Geographic Information System) is a free and open-source geographic information system (GIS) software. It was first released in 2002 and has since become a popular tool for viewing, editing, and analyzing geospatial data on Windows, Mac, and Linux operating systems.

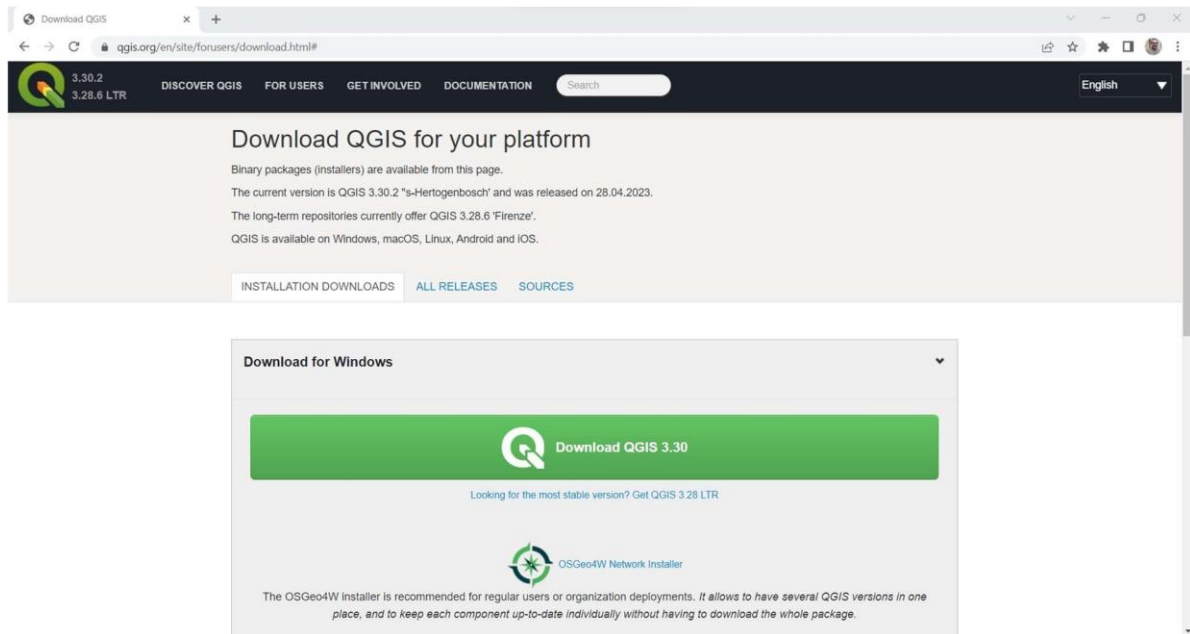
QGIS offers a range of features and capabilities for working with geospatial data. The software supports a wide range of file formats, including vector and raster data, and provides tools for importing and exporting data from various sources. The software also includes a variety of tools for editing and visualizing geospatial data, including the ability to create and edit shapefiles, perform geoprocessing tasks, and generate maps and charts.

One of the key advantages of QGIS is its plugin architecture, which allows users to extend the software's functionality through the use of third-party plugins. There are hundreds of plugins available for QGIS, ranging from tools for spatial analysis and data management to more specialized applications for specific industries or applications.

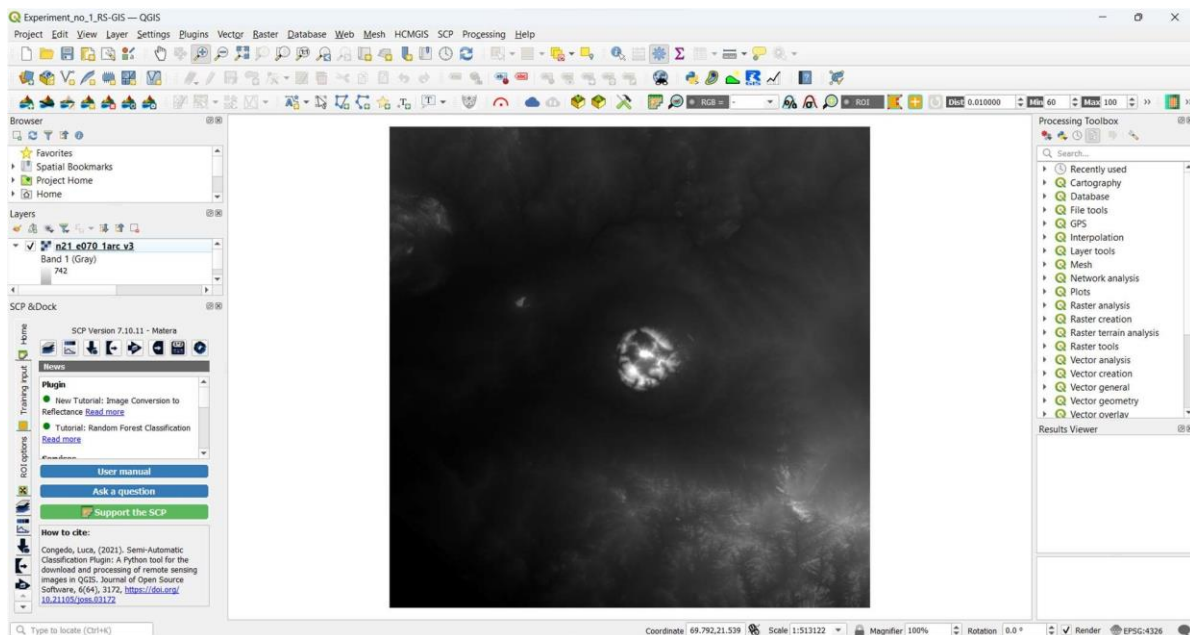
QGIS is widely used by a diverse range of users, including government agencies, non-profit organizations, and businesses. It is particularly useful for applications such as environmental management, urban planning, and natural resource management. The software has a large and active user community, which provides support and contributes to the development of the software through open-source contributions.

Procedure: Downloading and Installation of QGIS Software. Loading DEM data in QGIS and changing symbology.

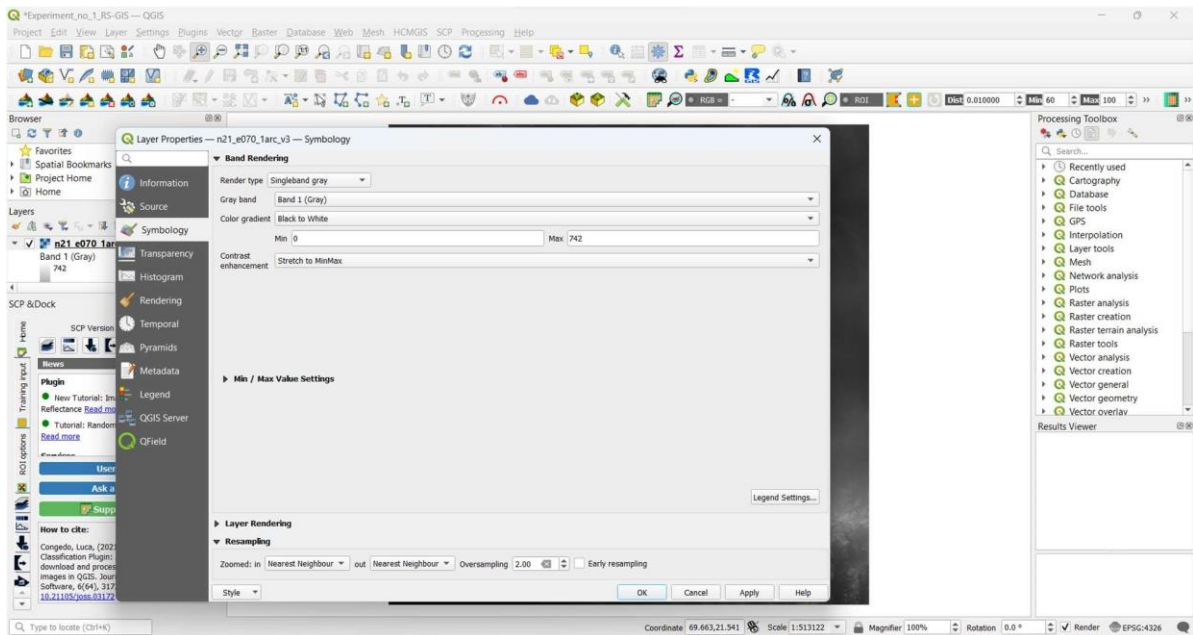
1) Download latest LTR (Long Term Release) version of the QGIS from <https://www.qgis.org/en/site/forusers/download.html#> and follow the instructions for the installation.



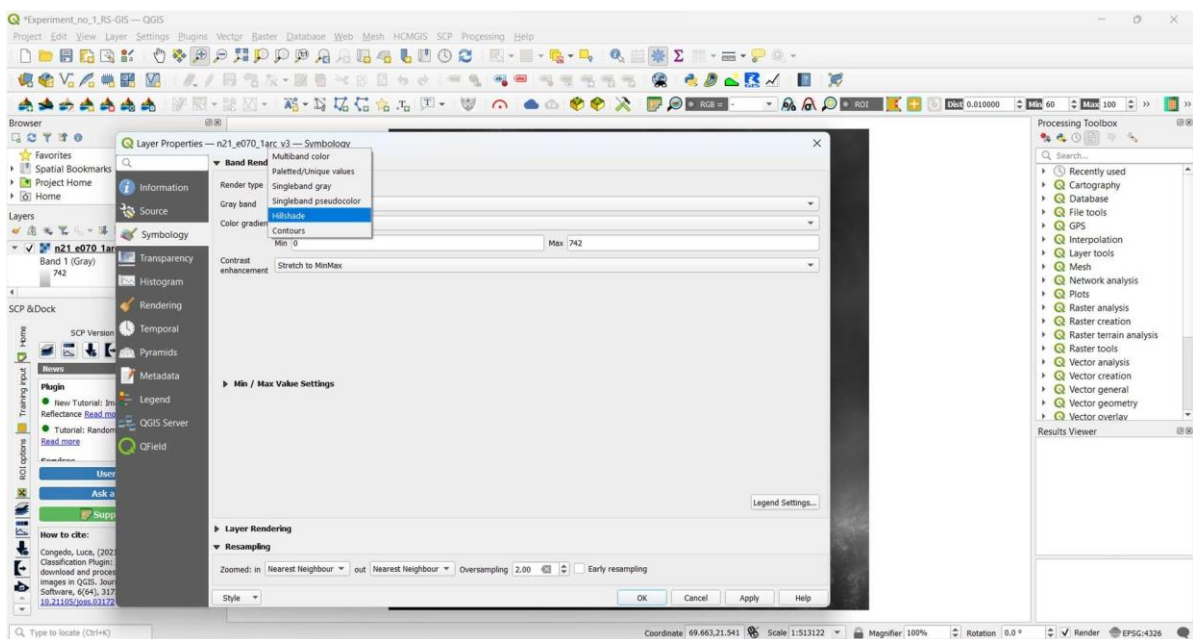
2) After installation open the software. To upload satellite data (DEM) simply drag-and-drop the .tif (TIFF) dataset from the file explorer to QGIS User Interface. The data will open in greyscale as shown below.

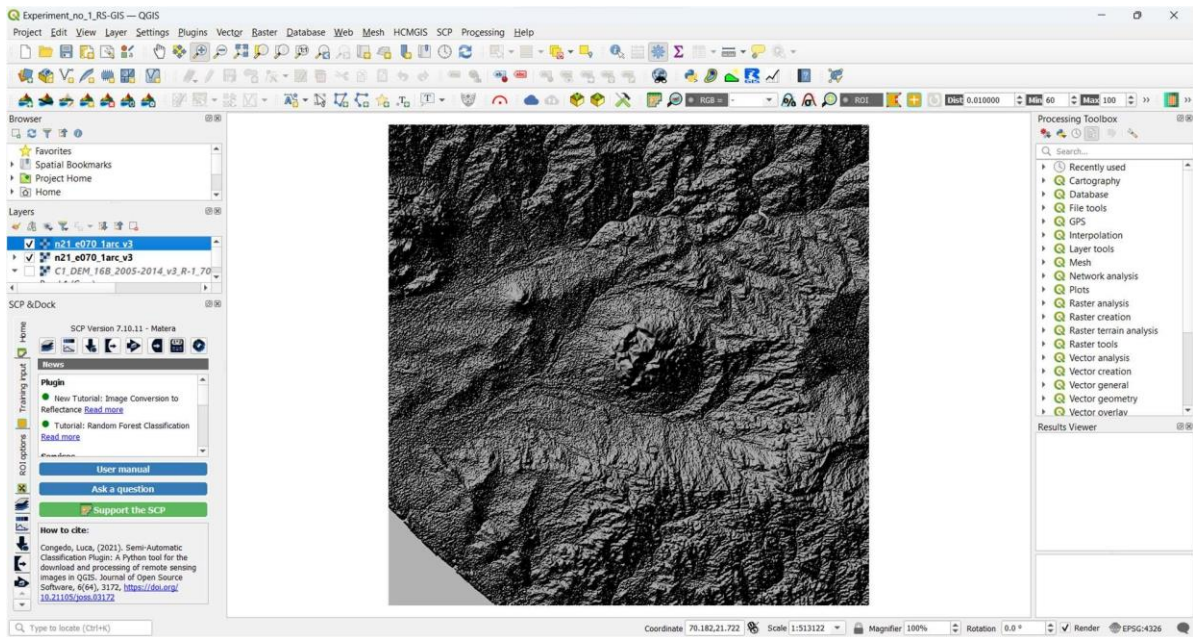


3) The visualization (rendering) of the uploaded .tif (TIFF) DEM dataset can be changed with following steps: In the layers tab on the left side click double click the desired layer. Following dialogue box will appear on the screen.

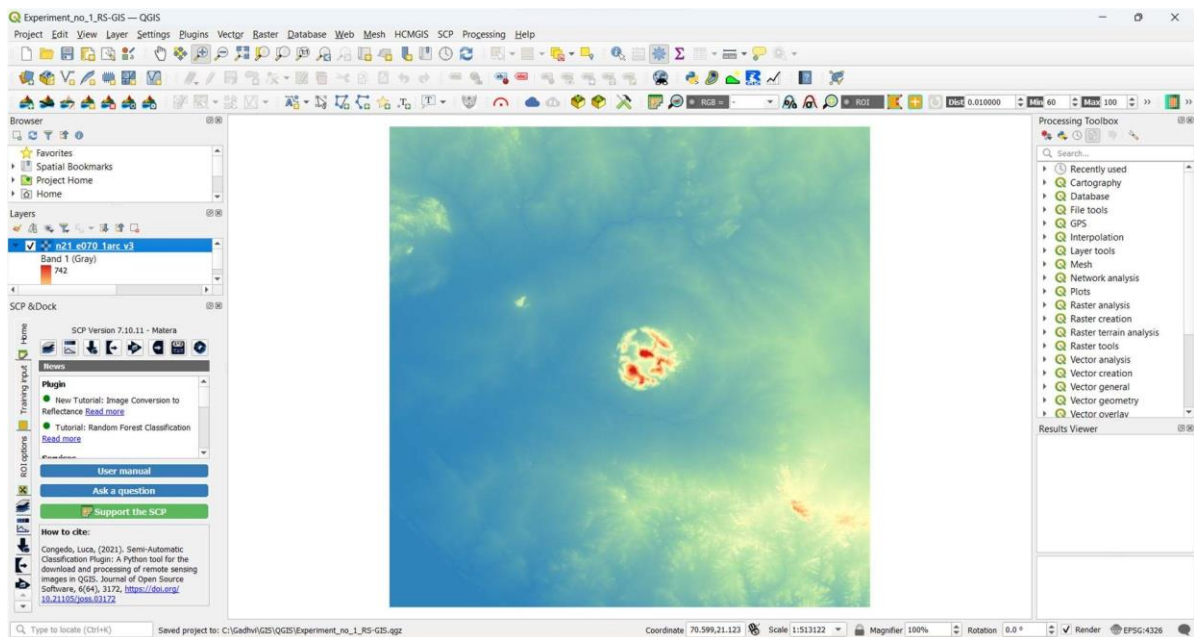


- 4) In above shown dialogue box click on the ‘Symbology’ tab and in the ‘Render type’ select ‘Hillshade’, the hillshade view of the dataset will be available on the screen as shown below.





- 5) The dataset can also be rendered in 'Singleband pseudocolor' by selecting desired color ramp and view will be as follows.



Quiz:

1. What is QGIS software and what are some of its key features for working with geospatial data?
2. How does the plugin architecture of QGIS allow users to extend the software's functionality?
3. What is the procedure for downloading and installing QGIS software and loading DEM data in QGIS?

Practical No: 3

Leveraging freely available remote sensing data sources using HCMGIS plugins in QGIS software and doing on-screen digitization

Date:

Competency and Practical Skills: Knowledge of GIS data Types; Raster data and Vector data. Knowledge of UTM Projection System and its Zones.

Relevant CO: CO1, CO2, CO3, CO4

Objectives:

- a) Introduction to and installation of HCMGIS Plugin of QGIS software.
- b) Learning to Load Google Satellite data as 'Basemaps'.
- c) Learning to create 'New Shapefile layer' or layers for different feature types such as point, polyline and polygon.
- d) Learning to digitize features visible on the screen (Google satellite data).

Equipment/Instruments: Computer with internet connection.

Theory:

HCMGIS Plugin:

The HCMGIS plugin is an open-source plugin for QGIS that provides users with access to a range of geospatial data and tools. It is designed to facilitate access to a variety of geospatial data. The HCMGIS plugin provides users with access to a range of data layers, including transportation networks, administrative boundaries, land use, hydrology, and topography. These layers can be used to create custom maps, perform spatial analysis, and visualize data.

In addition to data layers, the HCMGIS plugin provides users with access to a range of geospatial tools. These tools can be used to analyze and visualize spatial data, making it easier to understand complex geospatial relationships. Overall, the HCMGIS plugin is a valuable resource for users working with geospatial data and demonstrates the power of open-source software and collaboration in the field of geospatial analysis.

Raster Data Layer:

In GIS, raster data is a type of geospatial data that represents the Earth's surface as a grid of cells or pixels. Each cell in a raster dataset contains a value that represents some attribute or characteristic of the Earth's surface, such as elevation, temperature, or land use.

Raster data is typically used to represent continuous data, such as elevation or temperature, because it can be easily divided into smaller cells to represent changes in the attribute being measured. For

example, a raster dataset representing elevation might have cells with values ranging from sea level to the top of a mountain, with each cell representing a small area of the Earth's surface. Raster datasets are commonly used in GIS applications because they are easy to create, store, and analyze. They can be easily manipulated using a variety of mathematical and statistical techniques, and they can be displayed in a range of different formats to help users visualize and understand the data.

One of the key advantages of raster data is that it can be easily combined with other geospatial data layers to create complex maps and visualizations. For example, a raster dataset representing land use could be combined with a vector dataset representing roads to create a map that shows how land use patterns are influenced by transportation networks.

Overall, raster data is an important component of GIS and plays a key role in understanding the Earth's surface and its many complex characteristics.

Vector data:

In GIS, vector data is a type of geospatial data that represents the Earth's surface as discrete points, lines, and polygons. Each of these features is defined by a set of coordinates that correspond to their geographic location on the Earth's surface, as well as additional attributes that describe their characteristics.

Vector data is used to represent discrete or discontinuous data, such as the location of roads, buildings, and water bodies. Each feature is represented as a separate entity in the dataset, with its own set of attributes and characteristics.

Vector datasets are commonly used in GIS applications because they can represent complex geographic features in a clear and concise way. For example, a vector dataset representing the location of roads could be used to create a detailed map that shows the exact location of each road segment, as well as its width, surface type, and other relevant information.

One of the key advantages of vector data is that it can be easily edited and manipulated. Features can be added, deleted, or modified using a variety of tools and techniques, making it easy to update and maintain the dataset over time.

Vector data can also be easily combined with other geospatial data layers to create complex maps and visualizations. For example, a vector dataset representing the location of buildings could be combined with a raster dataset representing elevation to create a map that shows the relationship between building density and topography.

Overall, vector data is an important component of GIS and plays a key role in representing complex geospatial features in a clear and concise way.

Visual Image Interpretation:

Visual image interpretation is a key component of remote sensing, which is the science of collecting and analyzing information about the Earth's surface using aerial or satellite-based sensors. Visual

image interpretation involves analyzing remote sensing images to extract information about the Earth's surface features. There are several elements that are important to consider when interpreting remote sensing images.

1. **Tone:** Tone refers to the brightness or darkness of an object in an image. Different objects will have different tones, depending on their reflectance properties. Interpreters must be able to distinguish between different tones and understand their meaning.
2. **Texture:** Texture refers to the surface characteristics of an object in an image. Interpreters must be able to distinguish between smooth and rough textures, as well as identify patterns and other characteristics that can help identify objects.
3. **Size:** Size is an important element to consider when interpreting remote sensing images. Objects of different sizes will have different features and characteristics that can help identify them.
4. **Shape:** Shape is another important element to consider when interpreting remote sensing images. Objects of different shapes will have different features and characteristics that can help identify them.
5. **Shadow:** Shadows can provide important information about the height and shape of objects in an image. Interpreters must be able to distinguish between different types of shadows and understand their meaning.
6. **Context:** Context is critical when interpreting remote sensing images. Interpreters must consider the surrounding area and understand how it relates to the object being analyzed.

Overall, visual image interpretation is an important skill for remote sensing analysts and requires a deep understanding of the elements described above, as well as other technical and contextual factors.

Feature types in GIS:

In GIS, feature types are used to represent geographic objects on the Earth's surface. The three most common feature types are point, polyline, and polygon.

1. **Point:** A point feature represents a single location on the Earth's surface. Points are typically used to represent features such as landmarks, wells, and sampling locations. Point features are represented by a single coordinate pair, which corresponds to the location of the feature on the Earth's surface.
2. **Polyline (or 'LineString' in QGIS):** A polyline feature represents a series of connected line segments on the Earth's surface. Polyline features are typically used to represent features such as roads, rivers, and hiking trails. Polyline features are represented by a series of coordinate pairs, which define the location of each vertex in the line segment.

3. Polygon: A polygon feature represents a closed area on the Earth's surface. Polygons are typically used to represent features such as land use areas, parks, and lakes. Polygon features are represented by a series of coordinate pairs that define the location of each vertex in the polygon.

Each feature type has its own unique characteristics and uses in GIS. Points are useful for representing discrete locations on the Earth's surface, while polylines are useful for representing linear features such as roads and rivers. Polygons are useful for representing closed areas such as land use areas and lakes.

Overall, understanding the different types of features in GIS is important for effectively representing geographic objects and analyzing spatial data.

UTM Projection System:

The Universal Transverse Mercator (UTM) projection system is a widely used map projection system that divides the Earth's surface into 60 zones, each spanning 6 degrees of longitude. UTM is a conformal projection, meaning that it preserves angles and shapes, but not areas.

The UTM projection system uses a transverse Mercator projection to transform the Earth's three-dimensional surface onto a two-dimensional map. In this projection, the Earth's surface is divided into a series of narrow, vertical strips that are projected onto a flat plane. Each strip is based on a central meridian within the UTM zone, which is used to ensure minimal distortion within the zone.

UTM projections are commonly used for mapping and navigation purposes, particularly in applications where a high level of accuracy is required over a relatively small area. They are widely used by government agencies, military organizations, and commercial mapping companies.

One of the key advantages of the UTM projection system is that it provides a consistent and uniform method for representing the Earth's surface across multiple zones. This makes it easier to compare and analyze spatial data across different regions and countries.

Overall, the UTM projection system is a useful tool for accurately representing and navigating the Earth's surface, particularly in applications where a high level of accuracy and consistency is required.

WGS84 reference system:

WGS84 (World Geodetic System 1984) is a global geodetic reference system used to represent the Earth's surface in three-dimensional space. It is based on a coordinate system that uses latitude, longitude, and height to describe the location of points on the Earth's surface.

The WGS84 reference system is used by a wide range of applications and organizations, including the military, government agencies, and commercial mapping companies. It provides a common reference framework for spatial data, allowing different datasets to be combined and compared with a high degree of accuracy.

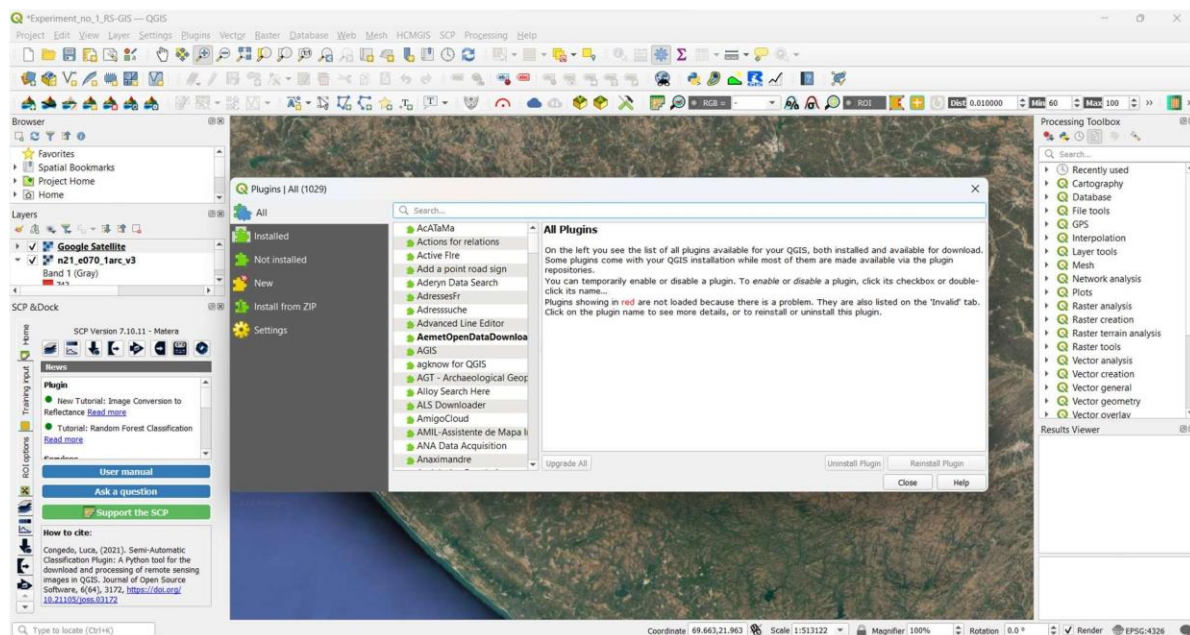
WGS84 is based on an ellipsoidal model of the Earth's surface, which approximates the shape of the Earth as an oblate spheroid. This ellipsoid has a semi-major axis of 6,378,137 meters and a semi-minor axis of 6,356,752.3 meters. The WGS84 coordinate system uses a standard set of parameters to define the ellipsoid and the Earth's orientation in space.

The WGS84 system includes a number of different coordinate systems and datums, each with its own unique set of parameters and characteristics. These include geographic coordinate systems (GCS) and projected coordinate systems (PCS), which are used to represent the Earth's surface in different ways depending on the needs of the application.

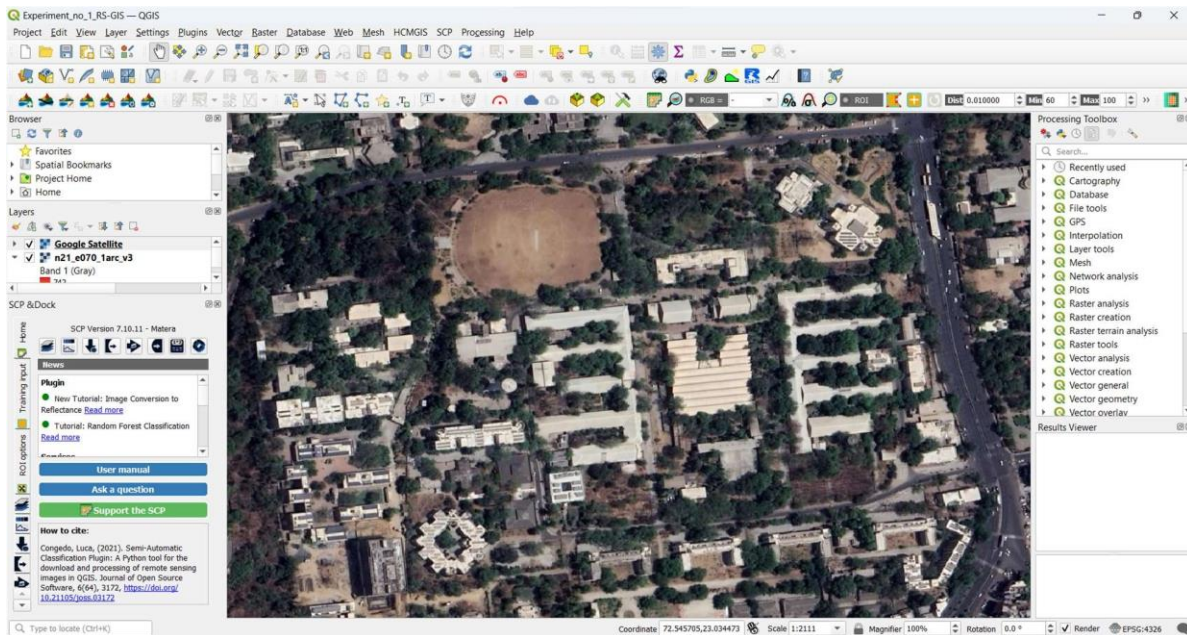
Overall, WGS84 is an important reference system for geospatial data, providing a consistent and accurate way to represent the Earth's surface in three-dimensional space. It is widely used in a variety of applications, from navigation and surveying to mapping and remote sensing.

Procedure-1: Installation of HCMGIS Plugin in QGIS and loading Google satellite data as base map.

- 1) Open QGIS software and click 'Plugins' tab> Click 'Manage and install plugins'.

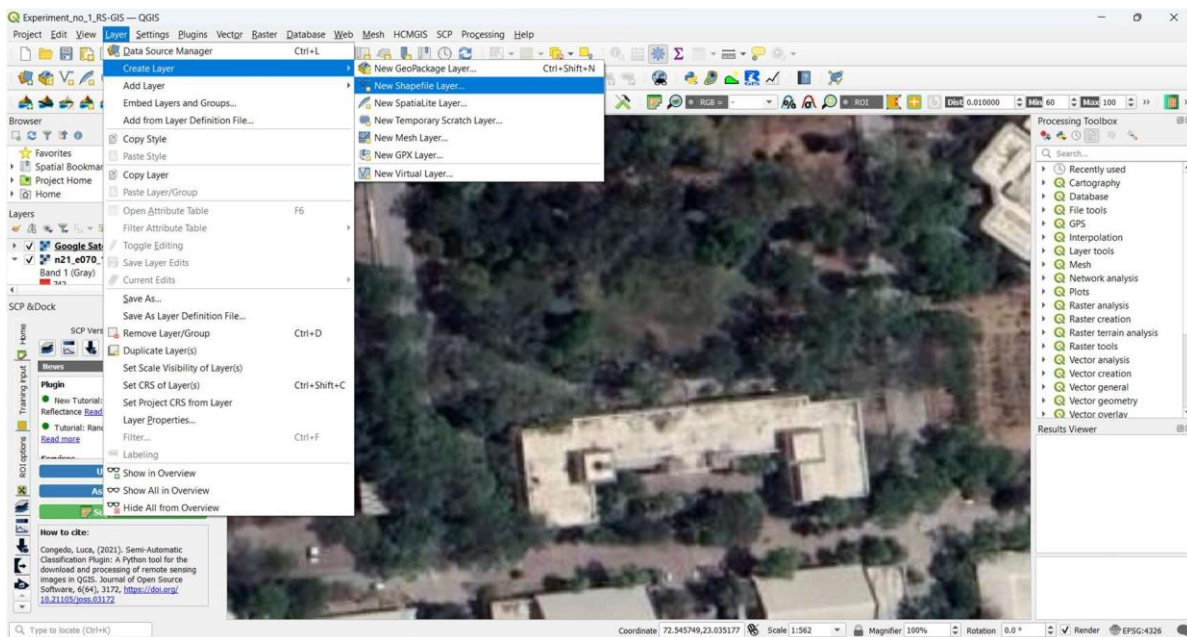


- 2) In the dialogue box that appears on the screen search for HCMGIS. Select the plugin HCMGIS and install it, so a tab of HCMGIS will be added in the main menu of the software.
- 3) Click on the 'HCMGIS' tab > 'Basemaps' > 'Google Satellite'. The Google satellite data will be loaded on the user interface of the QGIS. Zoom in to your area of interest.

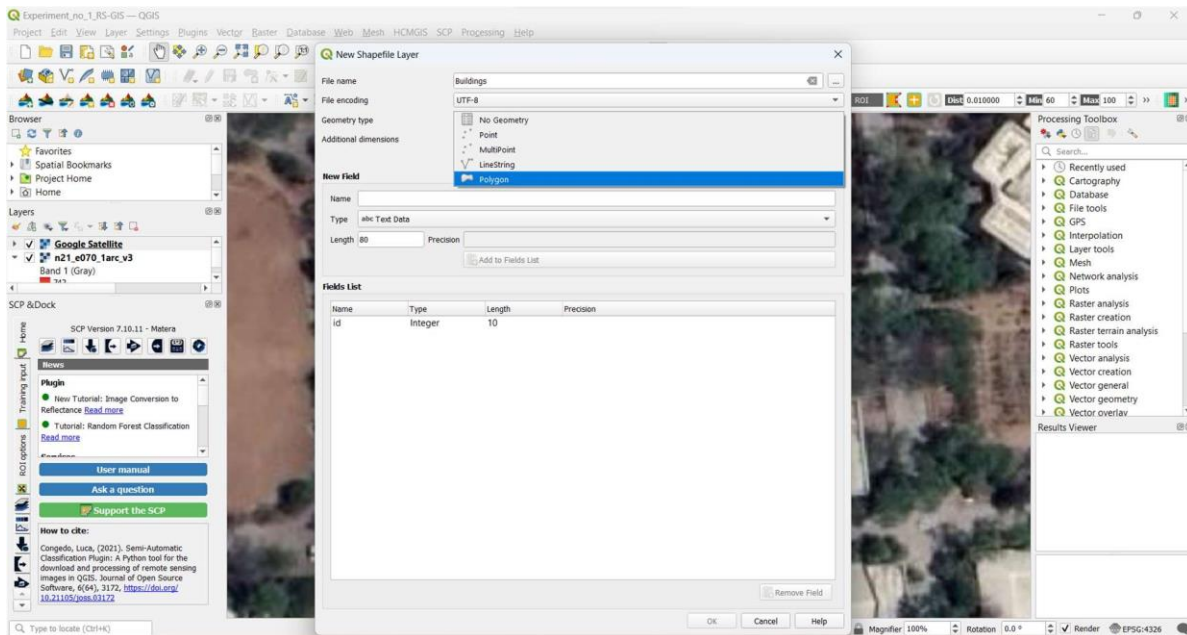


Procedure-2: Creating 'New Shapefile layers' for feature types tree (point), road ('LineString') and building (polygon). On screen digitization of features.

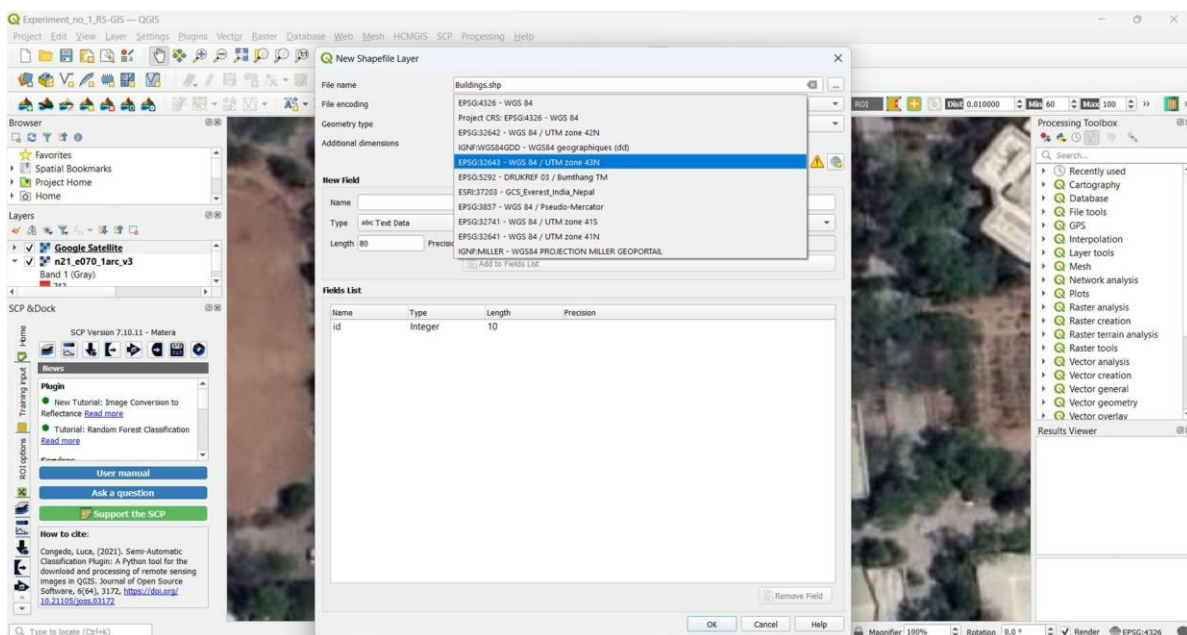
1) Click 'Layer' > 'Create layer' > 'New Shapefile Layer'.



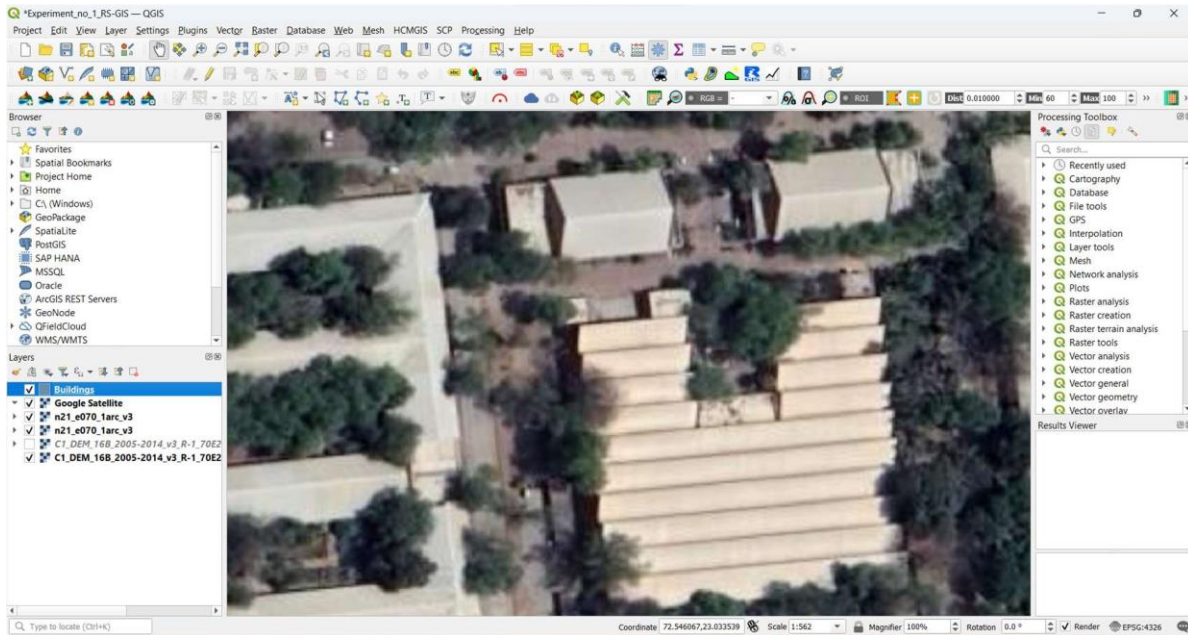
2) In the dialogue box that appears at this stage give a suitable name to the feature to be digitized and select appropriate 'Geometry type'. For buildings it will be 'polygon'.



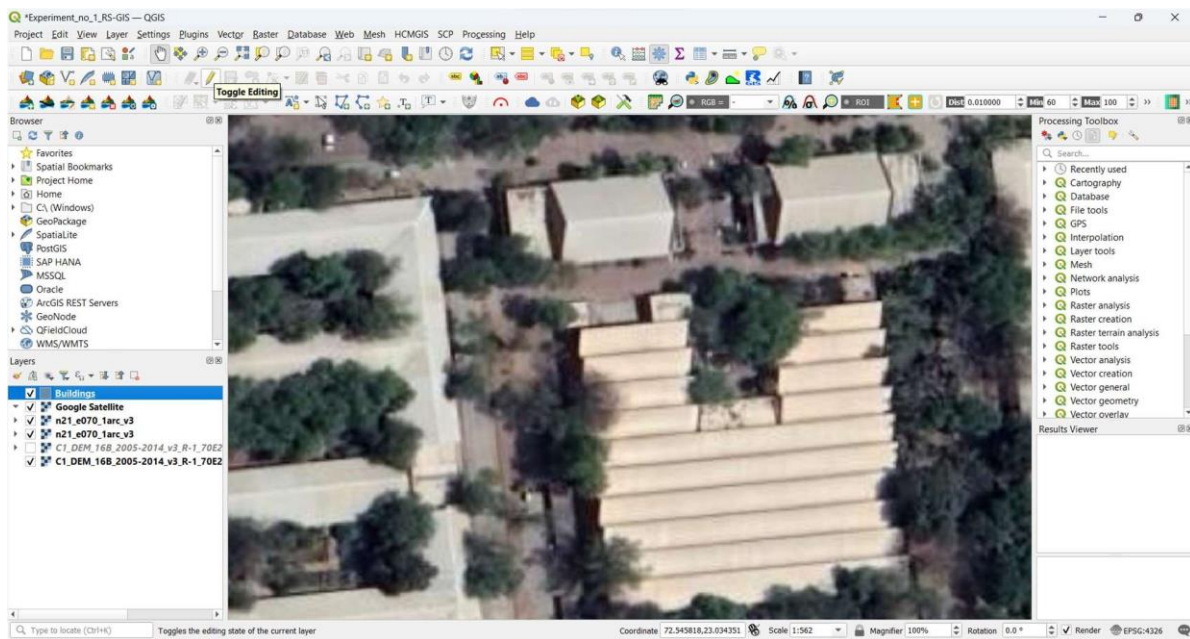
3) In the next field select appropriate reference coordinate system and projection (e.g., WGS 84 / UTM Zone 43 N for Ahmedabad).



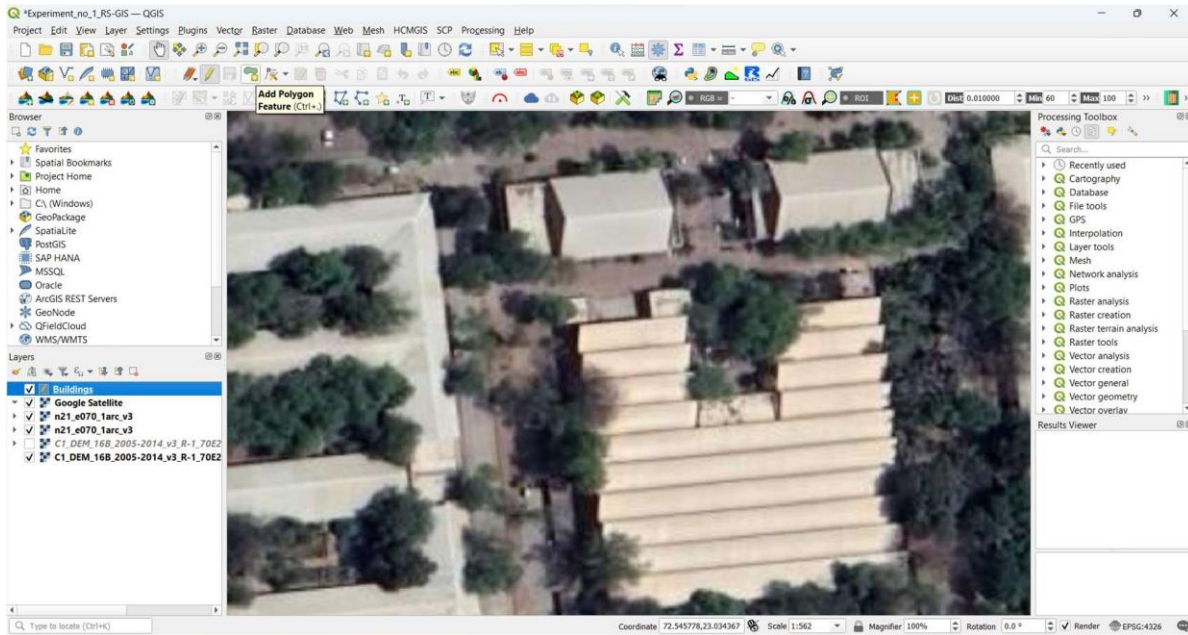
4) Now click 'OK', so a new vector layer ('Buildings' shapefile layer) will be added in the layers panel on the left side. At this stage there will be no feature in this particular layer.



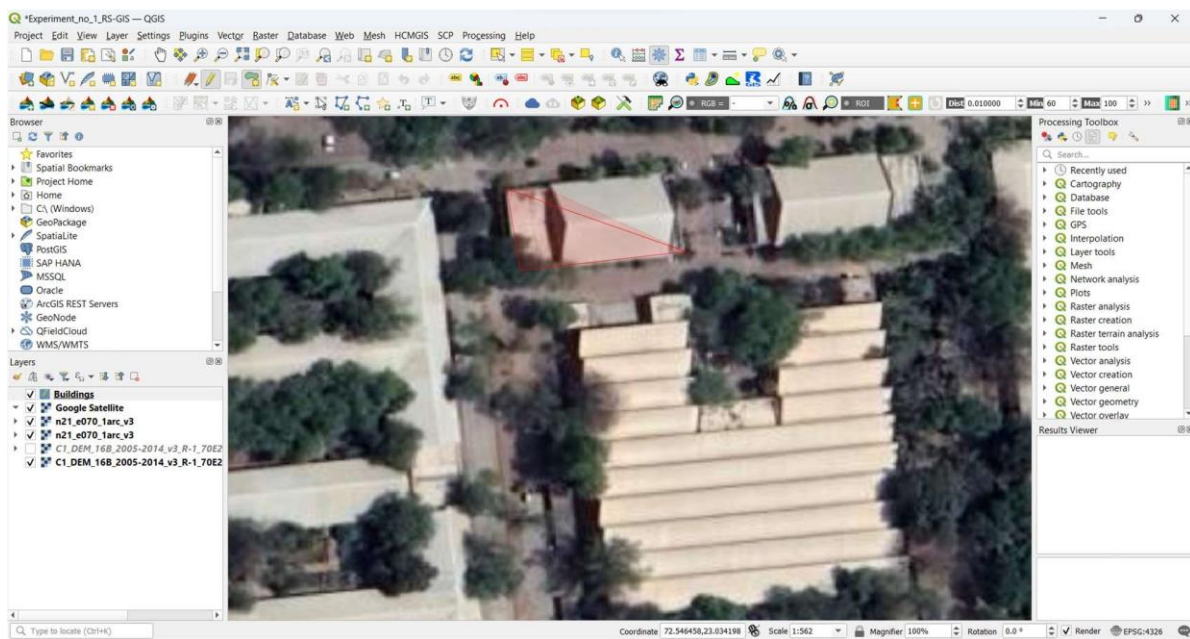
5) To digitize (or create) a 'polygon feature, first of all 'Toggle Editing' from the tool bar as shown below.



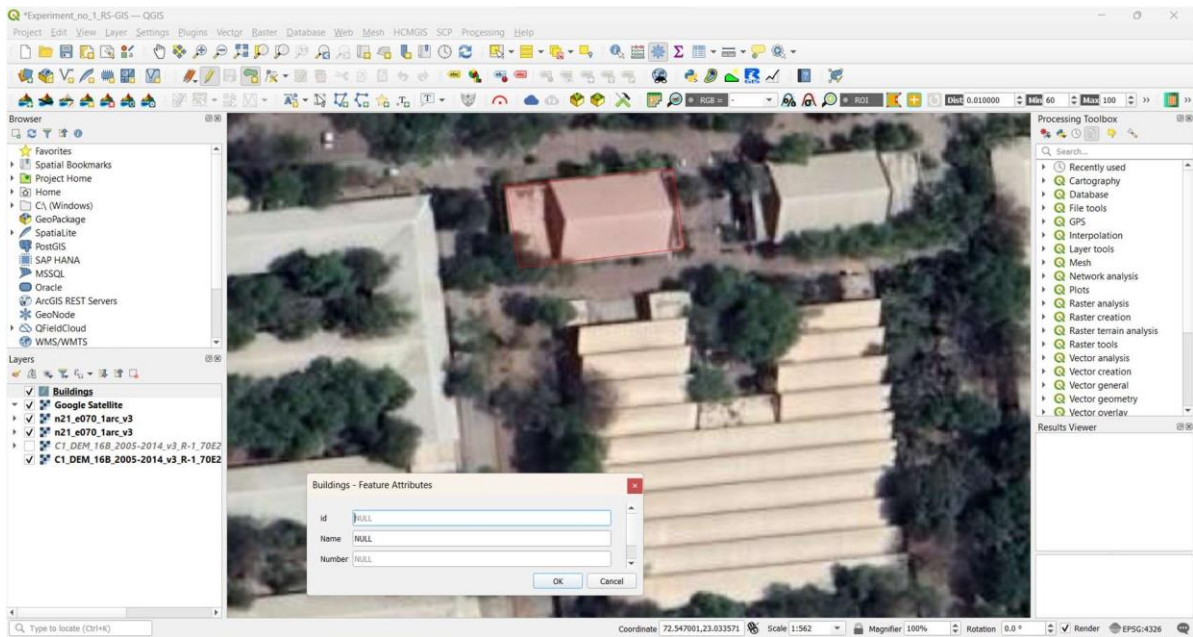
6) Once we click on 'Toggle Editing' a few disabled tools (such as 'Add Polygon Feature' tool) get enabled as shown below.



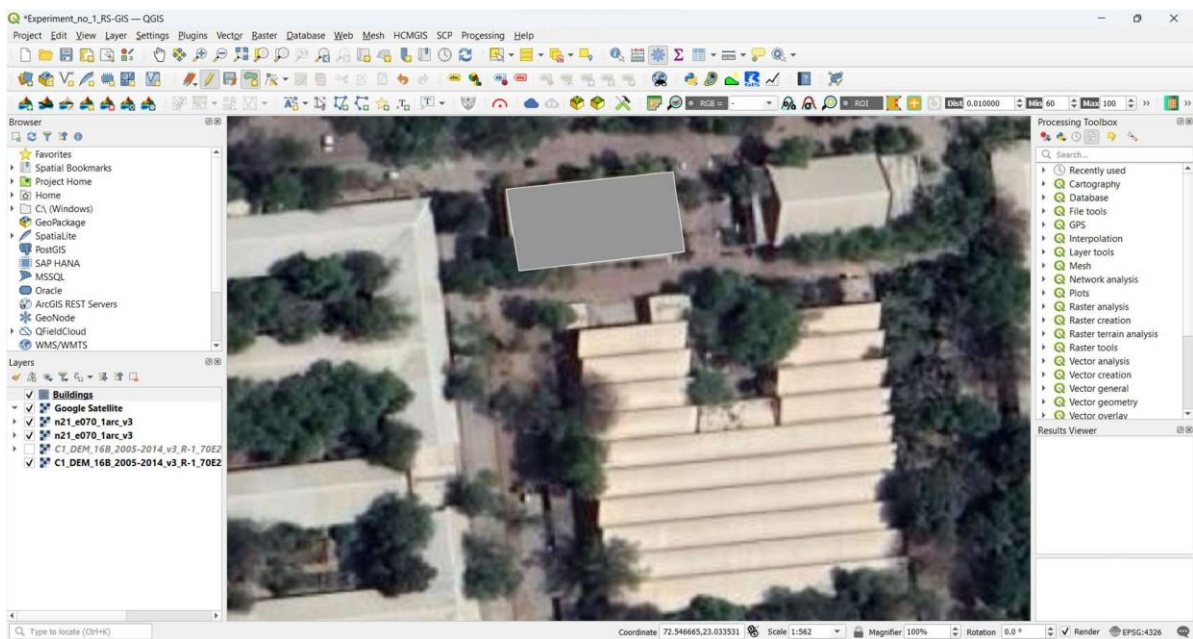
- 7) Now click 'Add Polygon Feature (or Ctrl+.) tool. Notice the cursor will change to round with a cross symbol. Now you are ready to digitize a polygon feature on the screen. Left click on corners of a building you wish to digitize as shown below.



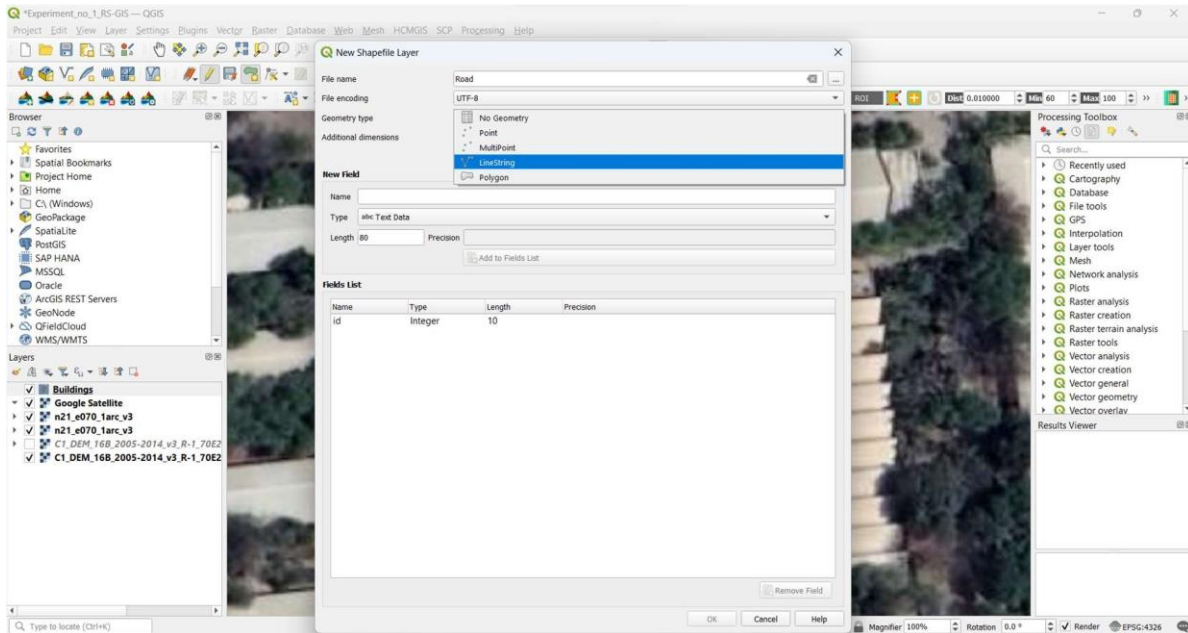
- 8) Left click on all the corners of the building you want to digitize and to finish the digitization right click. At this stage, software will open a dialogue box for feature attribute, wherein only one attribute 'id' will be shown, you may give suitable 'id' number to the feature just digitized. We shall learn more about feature attributes in next Practical.



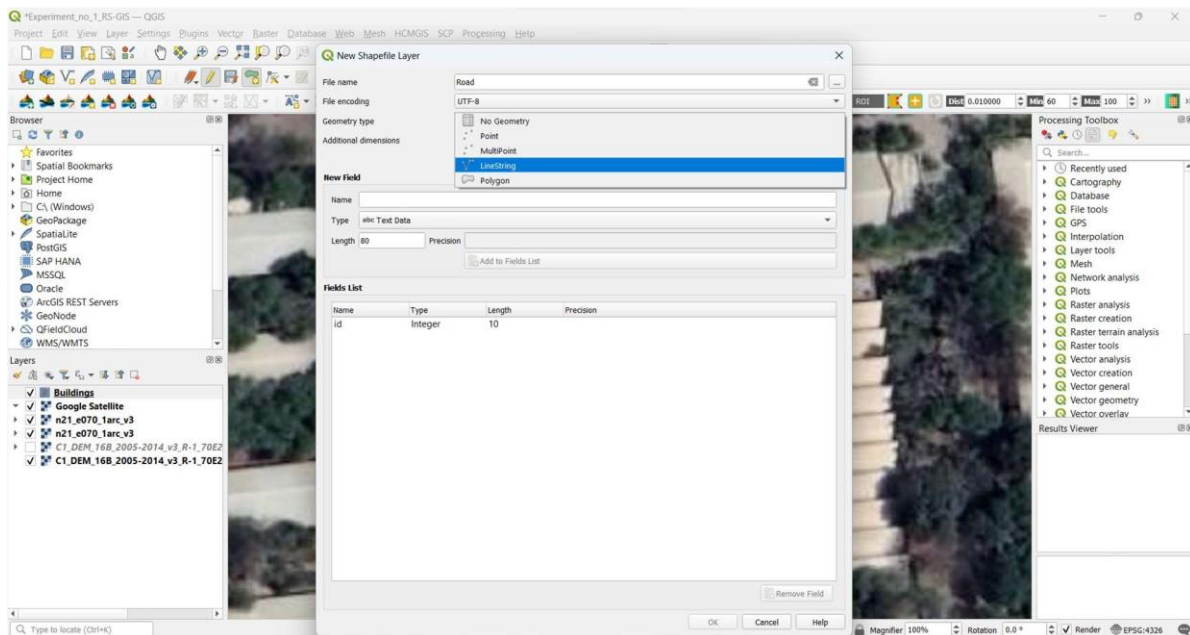
9) Click 'OK' on the 'Buildings-Feature Attributes' dialogue box and a polygon for the feature (building) just digitized will appear on the screen.



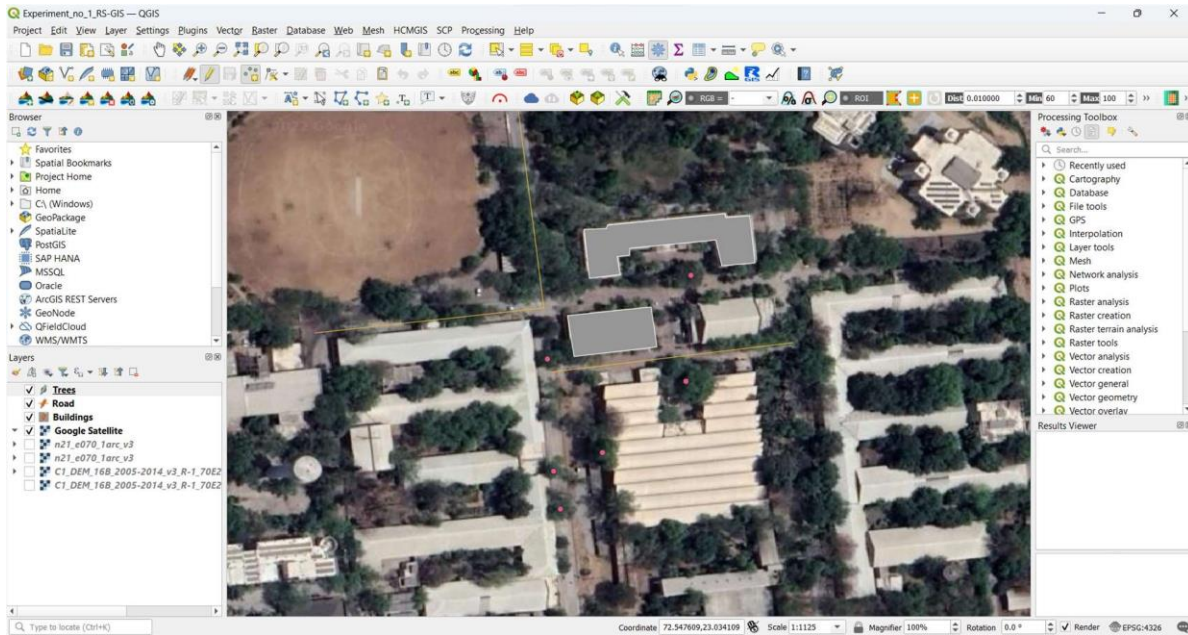
10) In similar manner 'New Shapefile layers' for feature types tree ('Point') and road ('LineString') can be created in the QGIS software.



11) While creating these types of features remember to select appropriate 'Geometry type' in the dialogue box as shown below.



12) Digitize a few features on the screen by following the procedure explained above. Also note that new features 'trees' and 'road' will be visible on the left side panel.



Observations:

1. Vector features 'Trees', 'Road' and 'Buildings' will appear on 'Layers' panel on the left side of the screen.
2. The features trees, roads and buildings digitized on the satellite data will appear on the screen.

Quiz:

1. What is the HCMGIS plugin and what are its features in QGIS software?
2. What is raster and vector data and how is it used in GIS applications?
3. How is raster data different from vector data in GIS applications?
4. How can users load Google Satellite data as Basemaps in QGIS software?
5. What are the key elements to consider when interpreting remote sensing images?
6. What are the important elements to consider when interpreting remote sensing images in visual image interpretation?

Practical No: 4

Adding new attribute field and calculating geometry (area/length) of features digitized on screen. Changing symbology and attribute-based labelling of features.

Date:

Competency and Practical Skills: Knowledge of GIS data Types; Raster data and Vector data. Knowledge of attribute data type in GIS.

Relevant CO: CO1, CO2, CO3, CO4, CO5

Objectives:

- a) Introduction to attribute data type.
- b) Learning to open attribute data and add attribute field for a different feature types.
- c) Learning to calculate geometry such as area or length of features digitized on screen. d)

Learning to change symbology and attribute-based feature labelling.

Equipment/Instruments: Computer with internet connection.

Theory:

Attribute data:

In GIS, attribute data types refer to the different types of data that can be associated with geographic features in a vector dataset. Attribute data types can include text, numbers, dates, and Boolean values, among others.

Text data types are used to store alphanumeric characters, such as names, addresses, and descriptions. Numeric data types can be used to store values such as elevation, area, and population. Date data types can be used to store time-stamped information such as when a feature was created or last updated.

Boolean data types are used to store binary values such as true/false or yes/no. Other data types that can be associated with GIS features include images, multimedia, and hyperlinks.

Attribute data types are an important component of GIS, as they allow spatial data to be linked to non-spatial data. This makes it possible to perform complex analyses and visualizations that take into account both spatial and non-spatial attributes of features. For example, attribute data can be used to calculate statistics, perform spatial queries, and generate thematic maps.

Overall, attribute data types play a crucial role in GIS, allowing users to associate a wide range of information with spatial features and perform complex analyses and visualizations based on that information.

Field calculator in QGIS:

The field calculator is a powerful tool in QGIS that allows users to perform calculations on attribute data associated with vector layers. It can be accessed through the attribute table of a layer, or by right-clicking on a layer in the Layers panel and selecting "Open Attribute Table" and then "Field Calculator".

The field calculator supports a wide range of mathematical, logical, and string functions that can be used to perform complex calculations on attribute data. Some of the common functions include:

- Mathematical functions: These functions allow users to perform arithmetic operations on numeric fields, such as addition, subtraction, multiplication, and division.
- Logical functions: These functions allow users to evaluate conditions and return a true or false value, such as "if", "else", and "and/or".
- String functions: These functions allow users to manipulate and format text strings, such as "concatenate", "replace", and "substring".

Users can also create new fields and populate them with calculated values using the field calculator. This can be useful for generating new data based on existing attribute data, such as calculating the area or length of features.

The field calculator in QGIS is a powerful tool that can save users a lot of time and effort by automating complex calculations on attribute data. With a wide range of functions and the ability to create new fields, it provides a flexible and customizable way to work with attribute data in GIS.

Symbology and Labelling in GIS:

Symbology and labeling are two important components of cartographic representation in GIS.

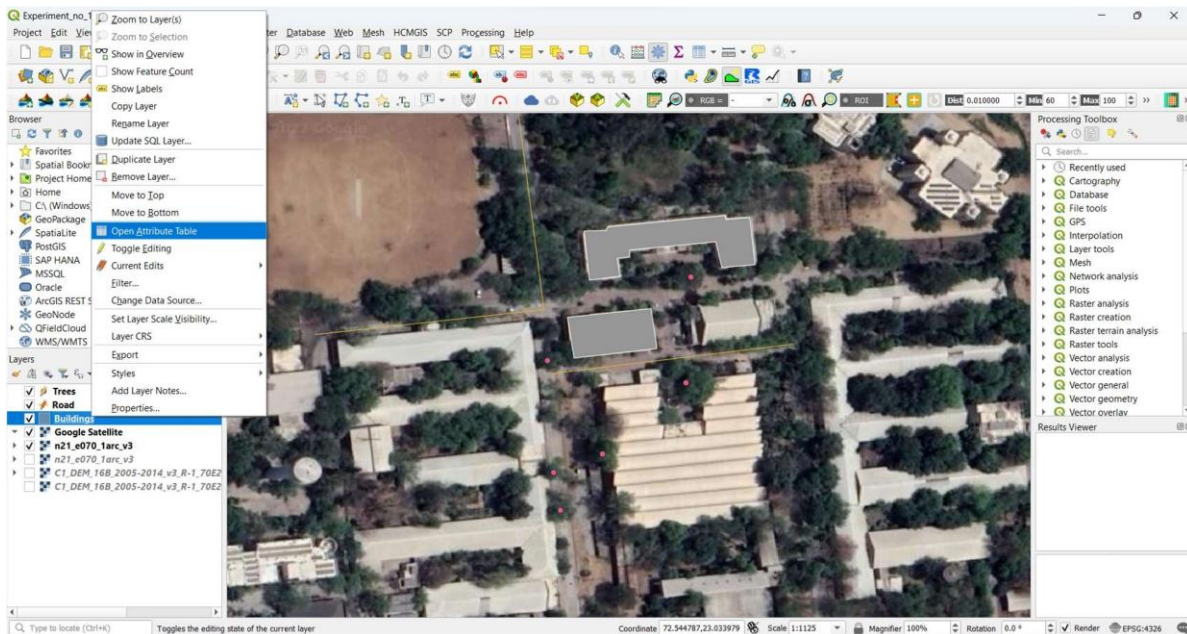
Symbology refers to the graphical representation of spatial features on a map or in a data visualization. It involves the use of symbols, colors, and patterns to represent different types of features and their attributes. For example, point symbols may be used to represent cities or other point features, while line symbols may be used to represent roads or rivers. Polygon symbols may be used to represent land use or administrative boundaries. Symbology can be used to differentiate between different types of features, highlight areas of interest, or provide additional information about the features being displayed.

Labeling, on the other hand, involves the placement of text on a map or in a data visualization to provide additional information about features. Labels can be used to display the names of places, roads, or other geographic features. They can be customized to display different font sizes, styles, and colors, depending on the needs of the user. Labeling is an important aspect of cartographic representation because it provides context and additional information about features that may not be immediately apparent from the symbology alone.

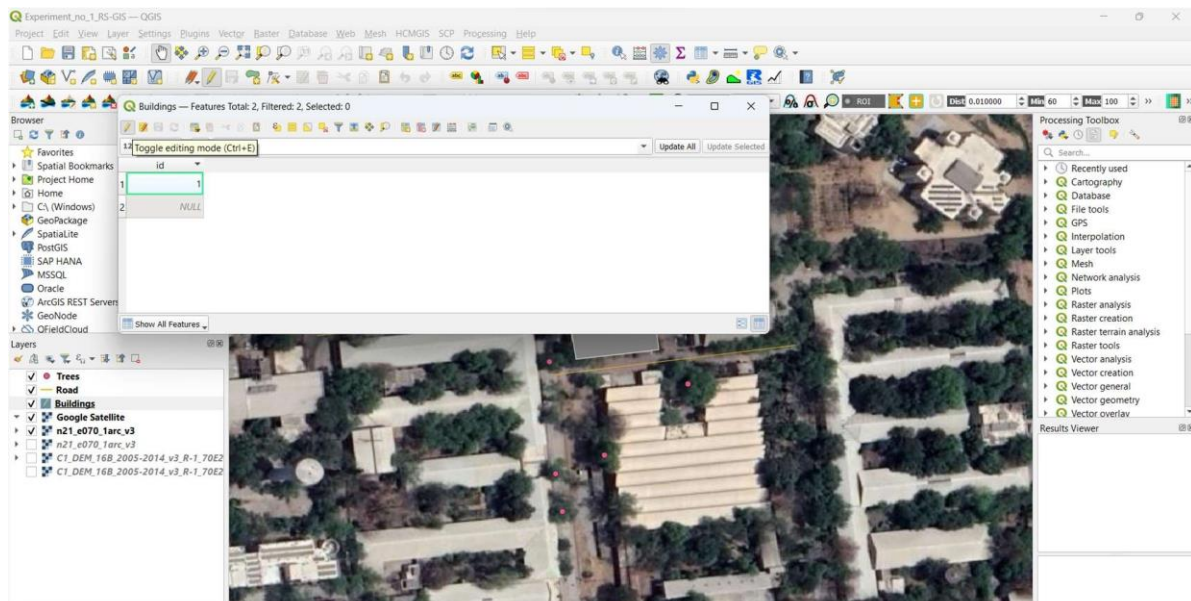
In summary, symbology and labeling are both important components of cartographic representation in GIS. Symbology is used to represent different types of features and their attributes, while labeling is used to provide additional information about features in a graphical format. By using both symbology and labeling effectively, GIS analysts and cartographers can create clear, informative, and visually appealing maps and data visualizations.

Procedure-1: Adding new attribute field and calculating geometry (area/length) of features digitized on screen.

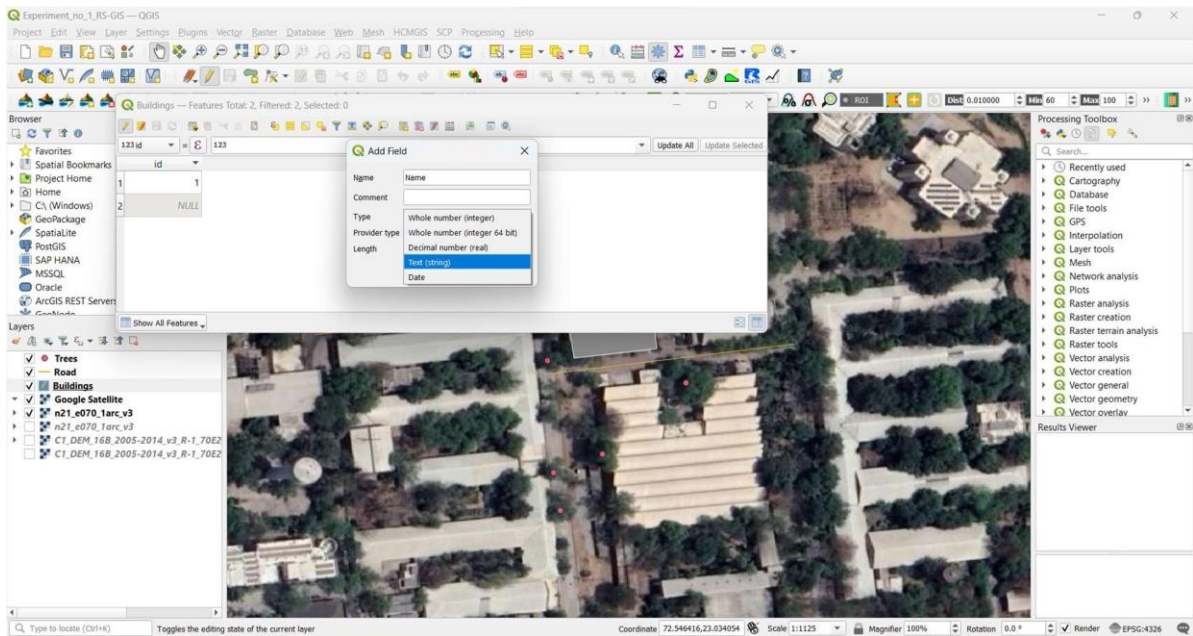
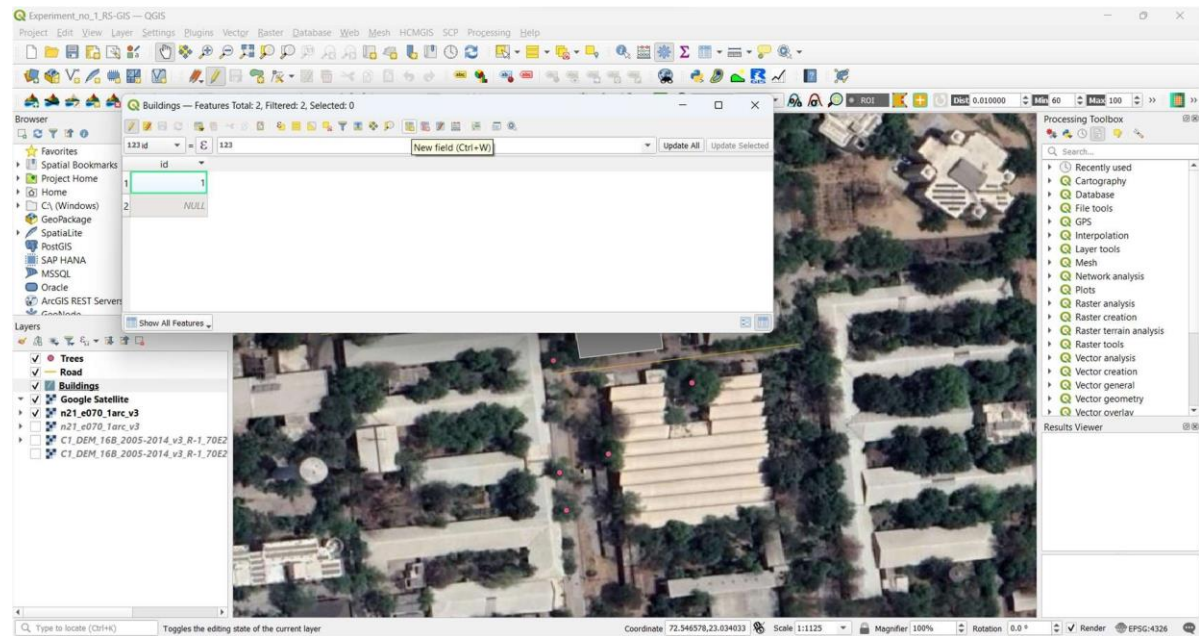
- 1) To open attribute table right click particular feature layer in the 'Layers' panel. Now click on 'open attribute table', a dialogue box exhibiting attribute table of that particular feature (Buildings in this case) will open.



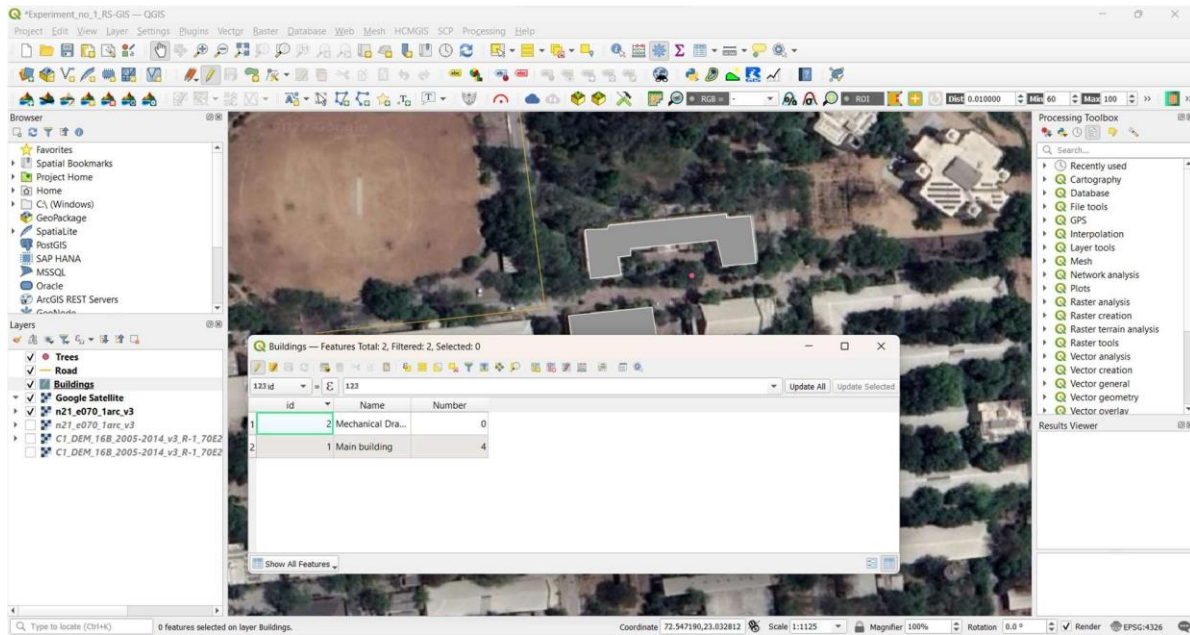
- 2) In the attribute table click 'toggle editing mode' so some of the disabled tool icons will be enabled.



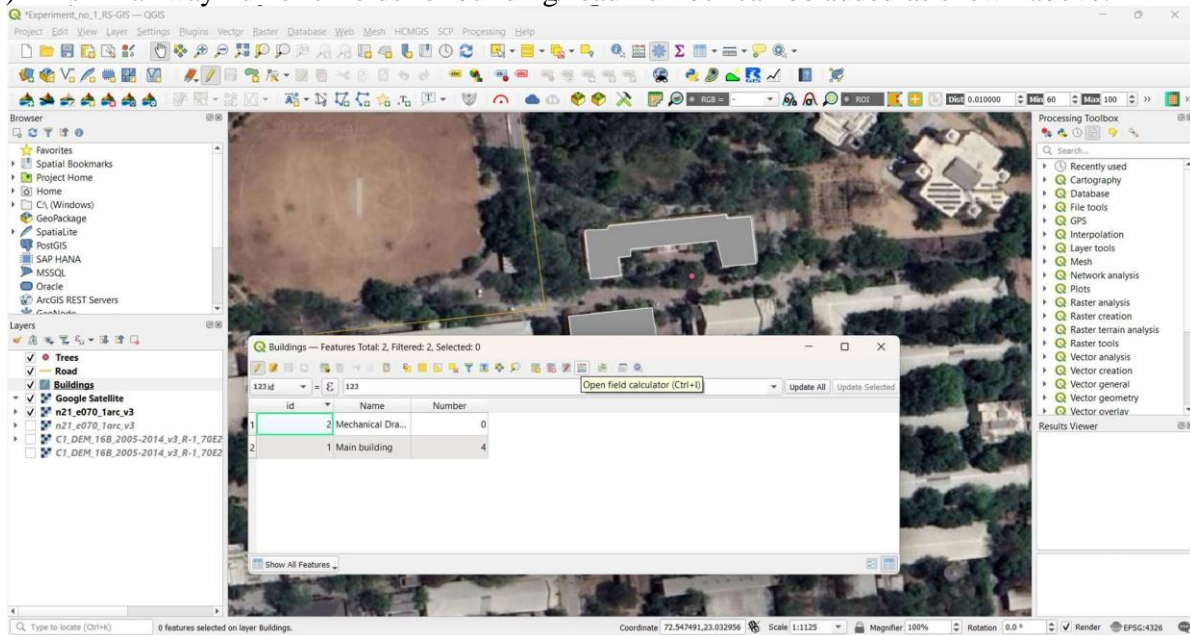
- 3) Click icon for “New field” (Ctrl+W) and a new dialogue box for details of new field will open as shown below.



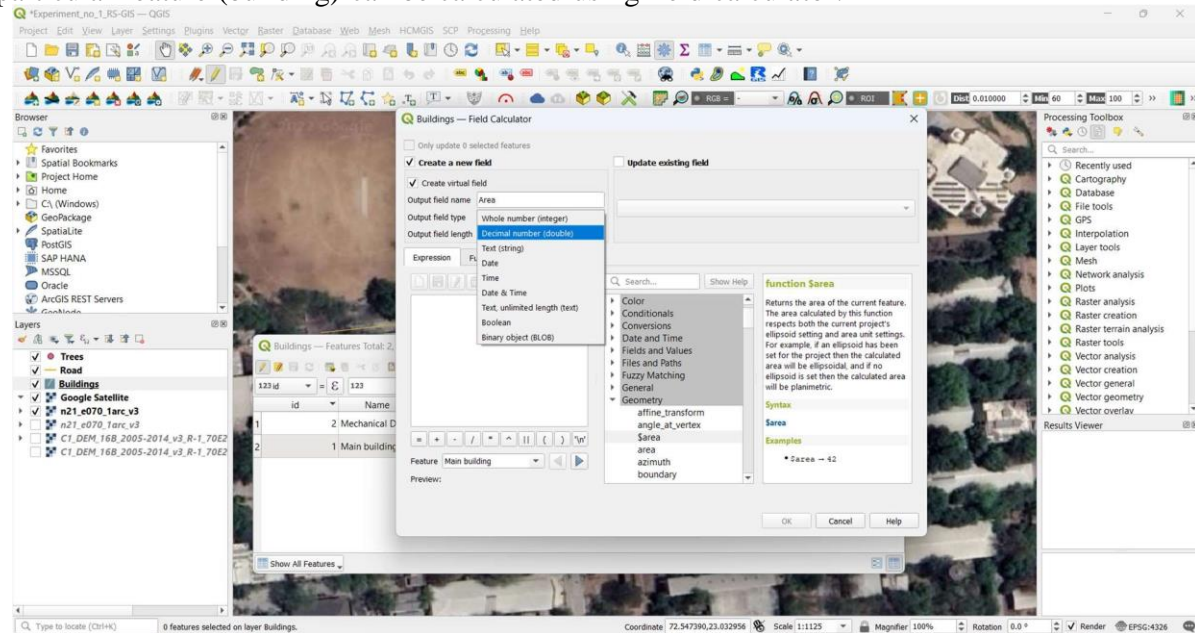
- 4) Give a suitable name to the field. Also, select an appropriate 'type' of the field. For naming feature field name could be 'Name' and field type should be 'Text (String)', as shown above. The length of the field could be change as per the requirement of letters in the field.



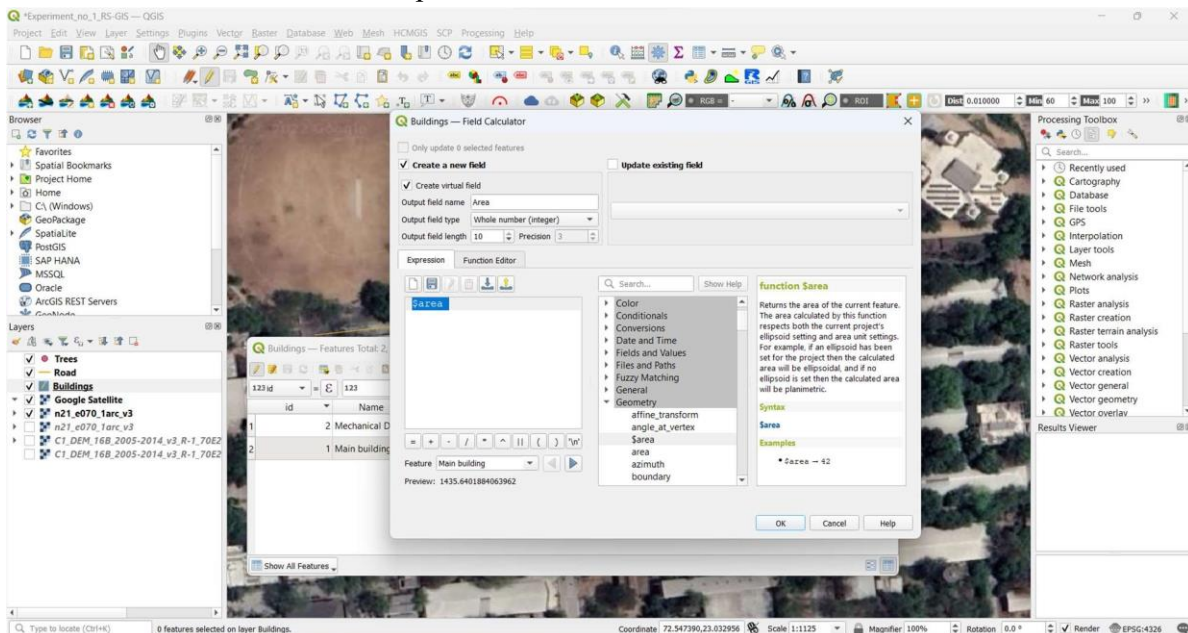
- 5) In similar way numeric fields for building/road number can be added as shown above.



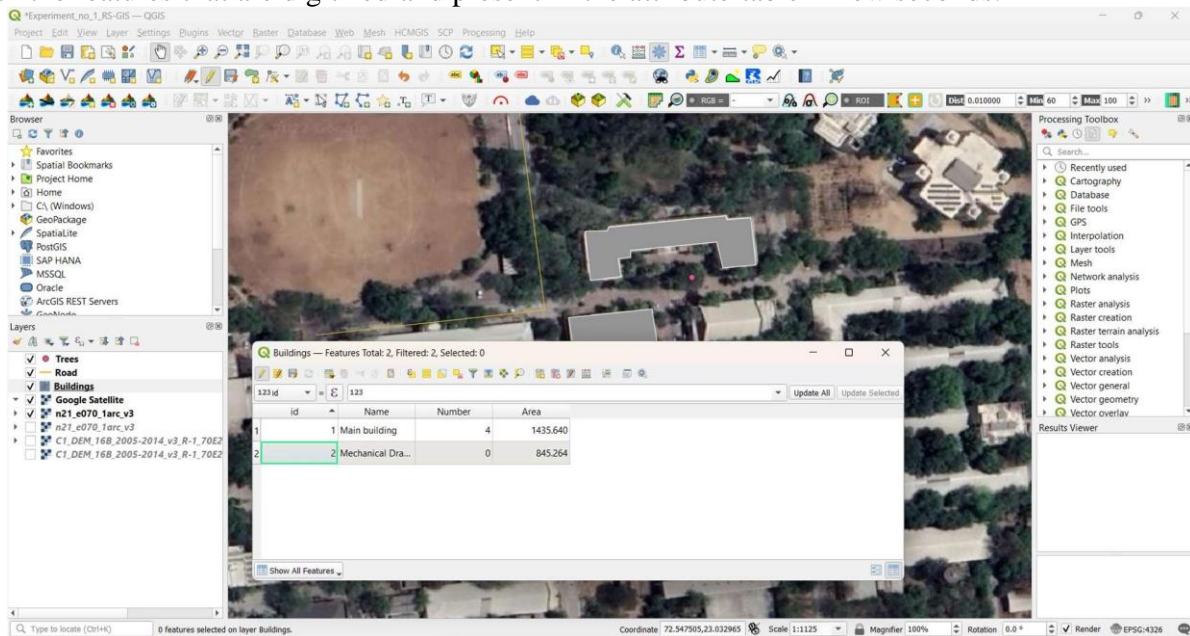
- 6) Geometric fields, depending upon feature type, can also be added in the attribute table or it can be generated using field calculator (as shown above). For example, in the attribute table of polygon feature (in this case 'Buildings') a field for 'Area' can be added and the area of footprint of a particular feature (building) can be calculated using field calculator.



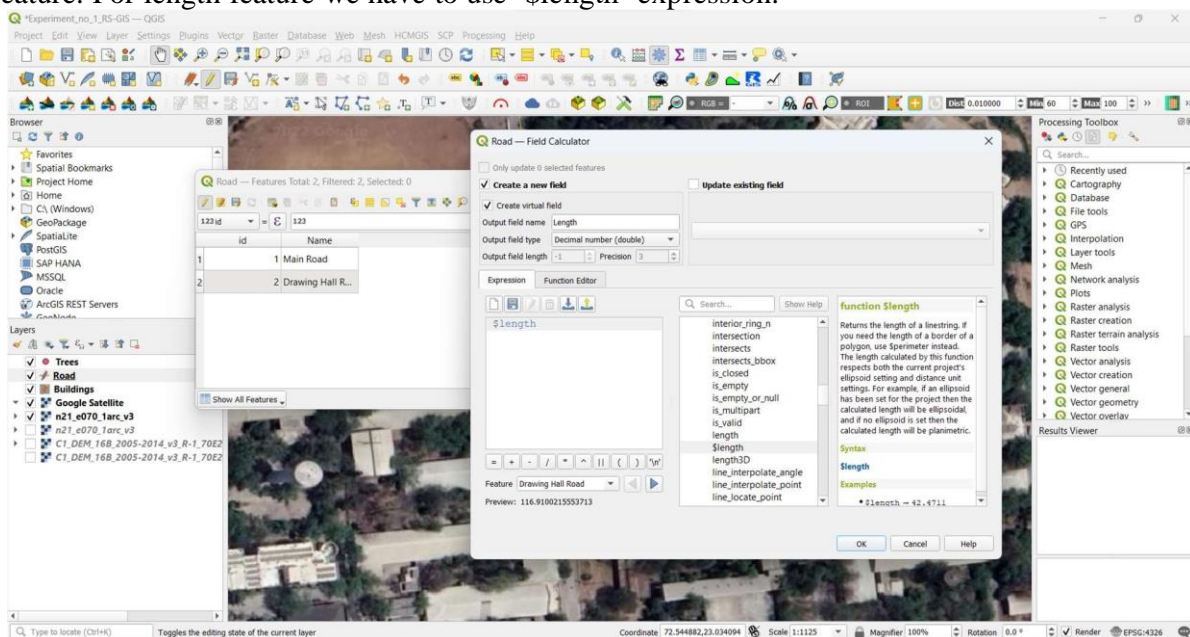
- 7) As we click on 'Field calculator' tab in the attribute table pan, a dialogue box as shown above will open, wherein, tic 'Create virtual field' > give 'Output field name' (in this case 'area') > select 'Output field type', 'Decimal number (integer)'. Now in function list (middle column of the dialogue box click 'Geometry' > double click '\$area' function so the '\$area' function will be added in the 'Expression' box on the left side, as shown below.



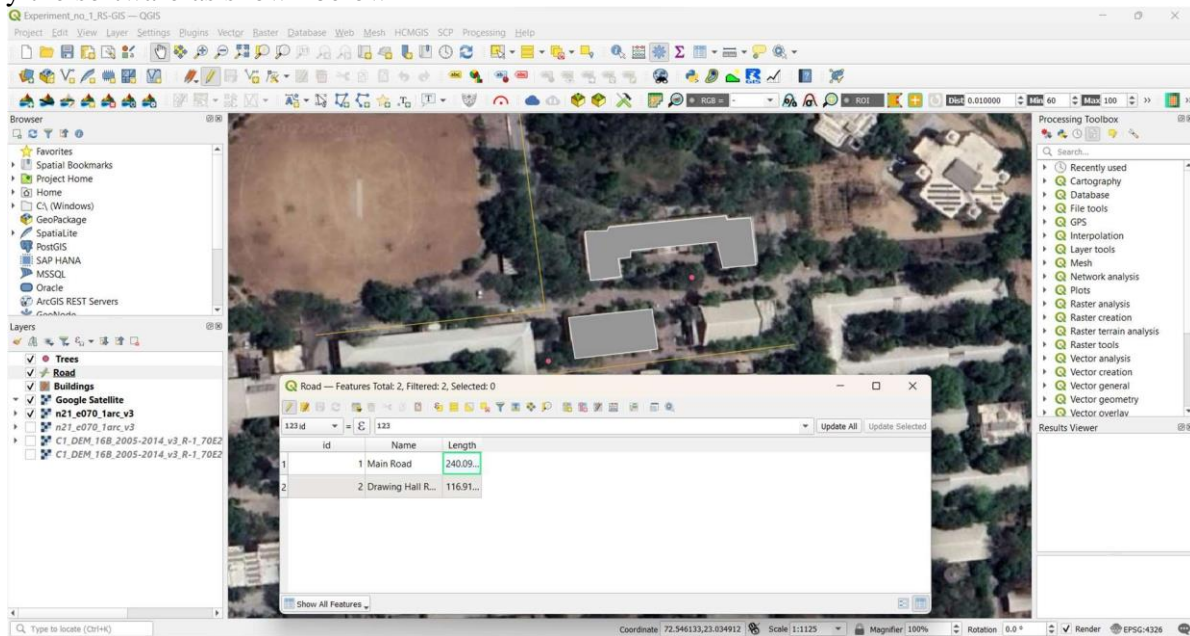
- 8) Close the dialogue box by clicking ‘OK’ and a new field ‘Area’ along with calculations will be added into the attribute table as shown below. This way software will be able to calculate area of all the features that are digitized and present in the attribute table in few seconds.



- 9) The other attribute features such as ‘perimeter’ for polygon features and length of polyline/road (lineString) feature can also be calculated using ‘field calculator’ in attribute table of concerned feature. For length feature we have to use ‘\$length’ expression.

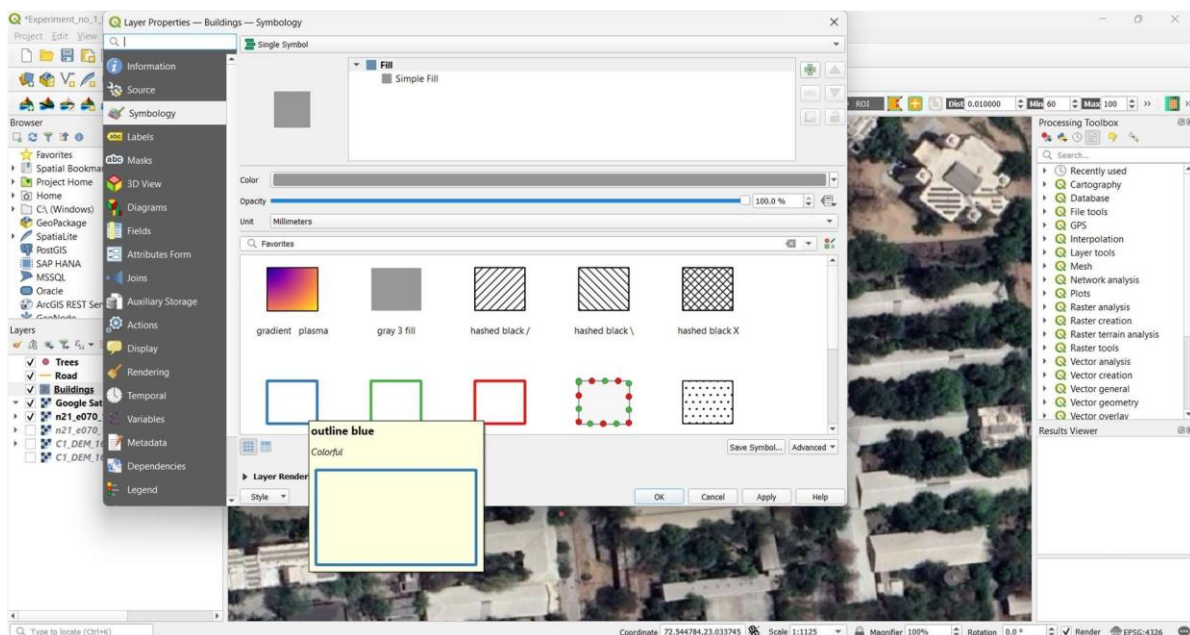


- 10) After performing ‘\$length’ expression a new field ‘Length’ will be added to the attribute table of concerned feature (in this case ‘Road’). And the length of the feature/road will be calculated by the software as shown below

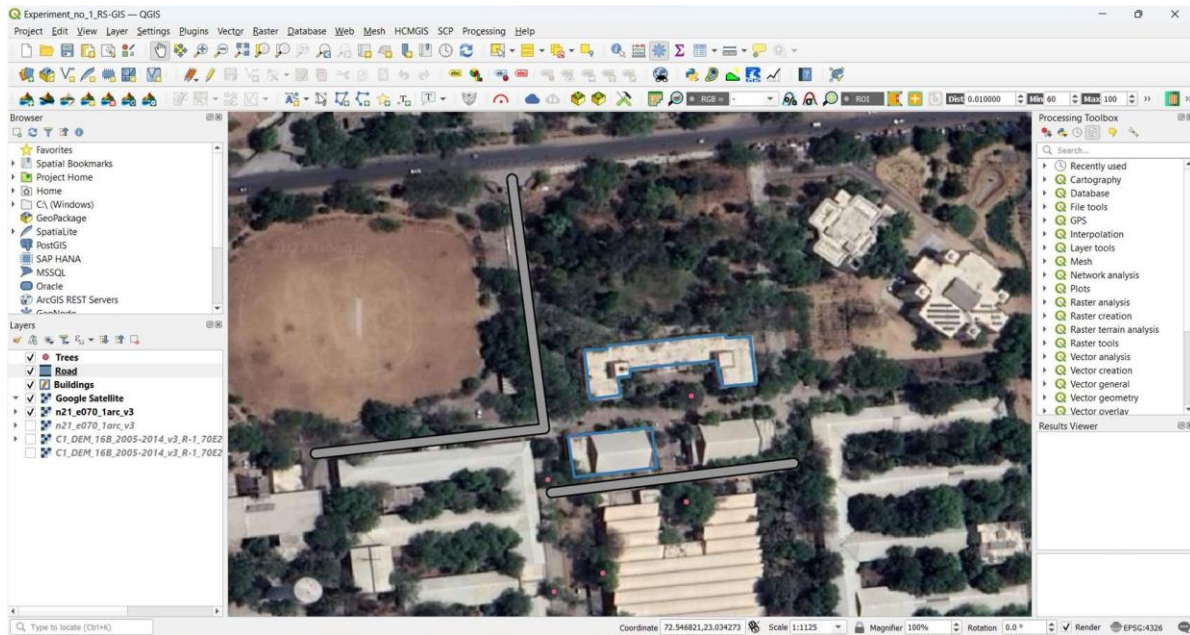


Procedure-2: Changing symbology and attribute-based labelling of features.

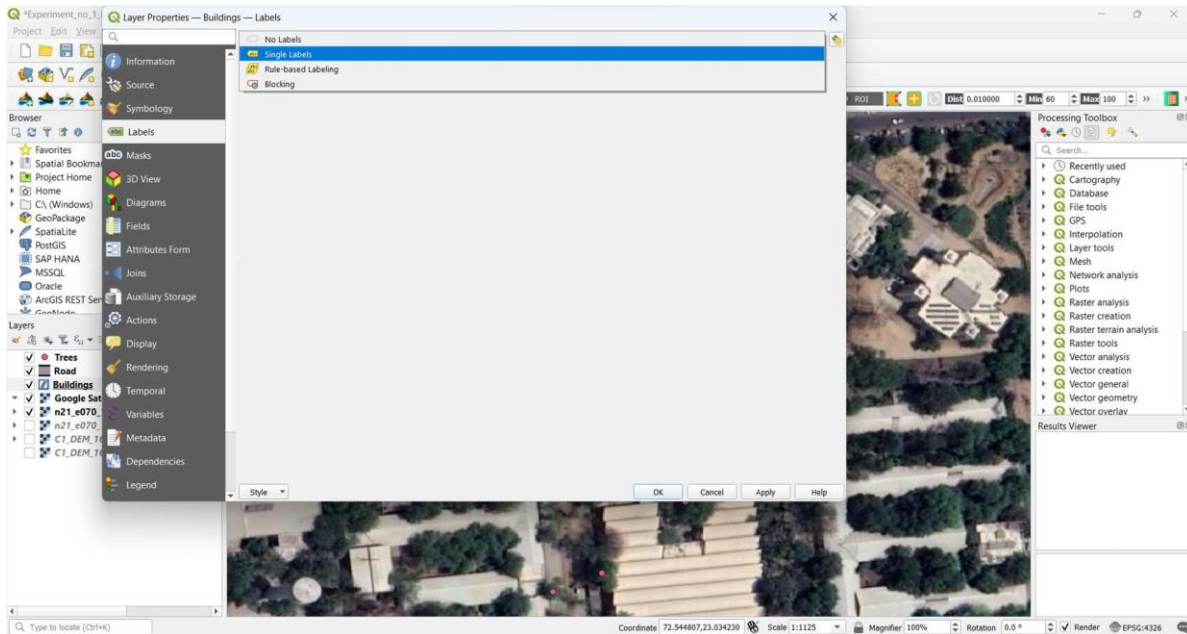
- 1) Symbol of any feature layer can be changed from > Layer Properties > Symbology dialogue box. To open layer properties double click a particular layer in the ‘Layers’ panel or right click a particular layer and click properties.



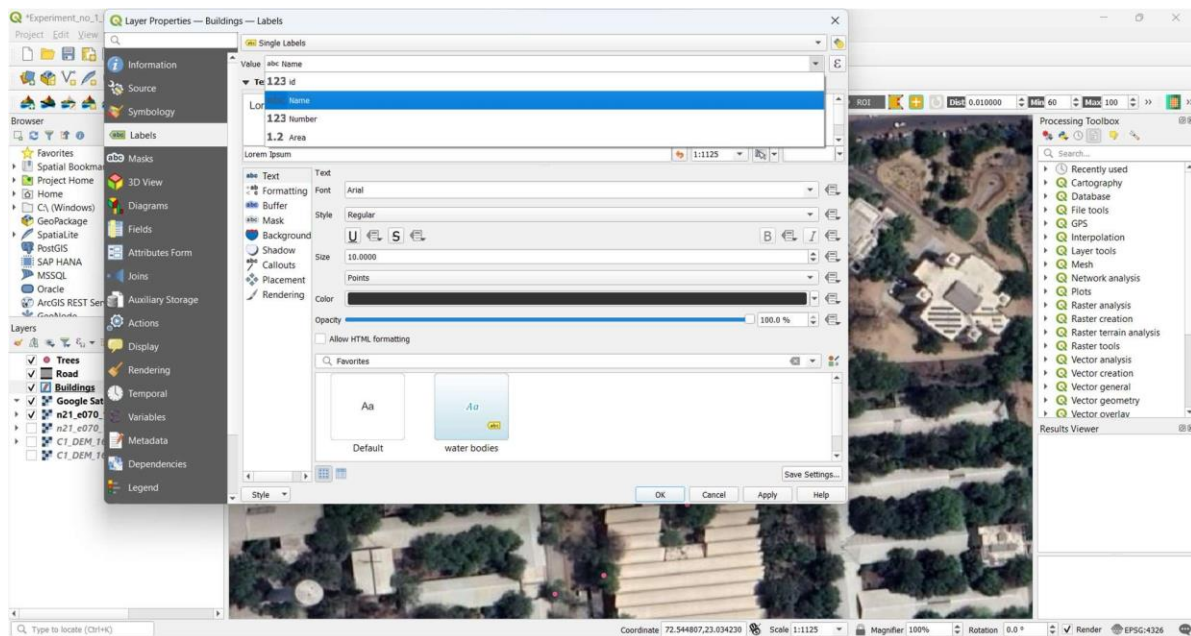
- 2) Depending upon feature type there will be host of symbols. For a polygon feature as we can see in above pic different types of symbols. Similarly for polyline (LineString) feature we can change the symbol and our map representation will be as shown below.



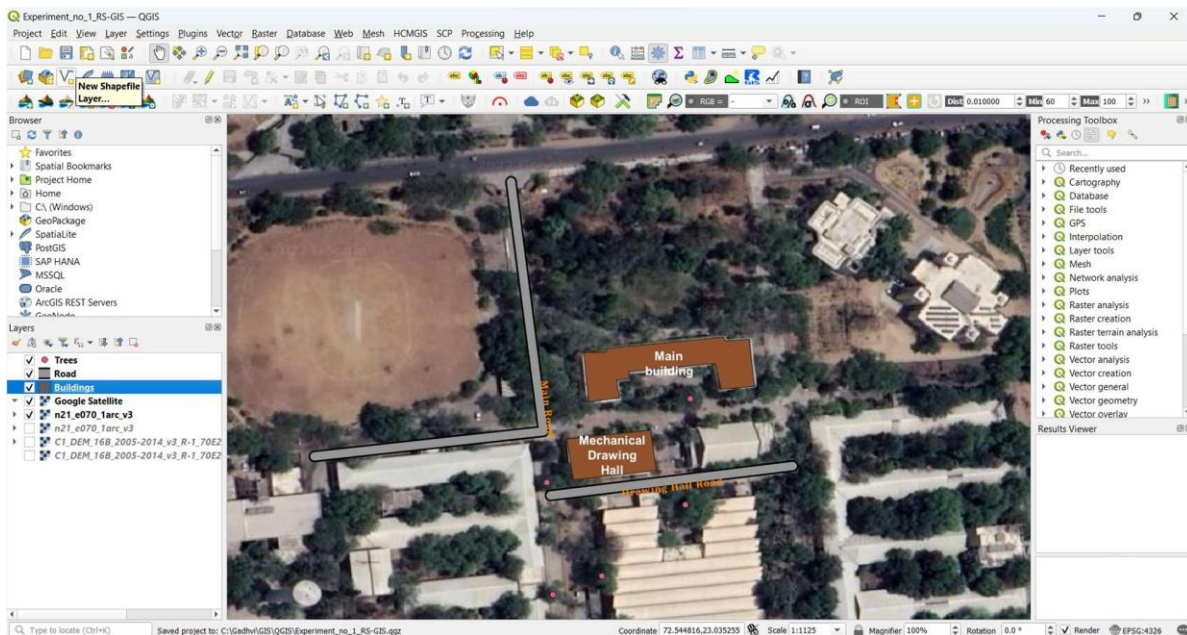
- 3) To label the feature open the layer properties > click on labels tab > select 'Single Labels' instead of 'No Labels'.



- 4) As we select option for 'Single Labels' the layer property dialogue box will display other options select 'Name' in the field of 'Value'.



- 5) We can also change other parameters such as font size, font color and style etc. And click 'OK' to see the feature names displayed on the map interface in the QGIS Software.

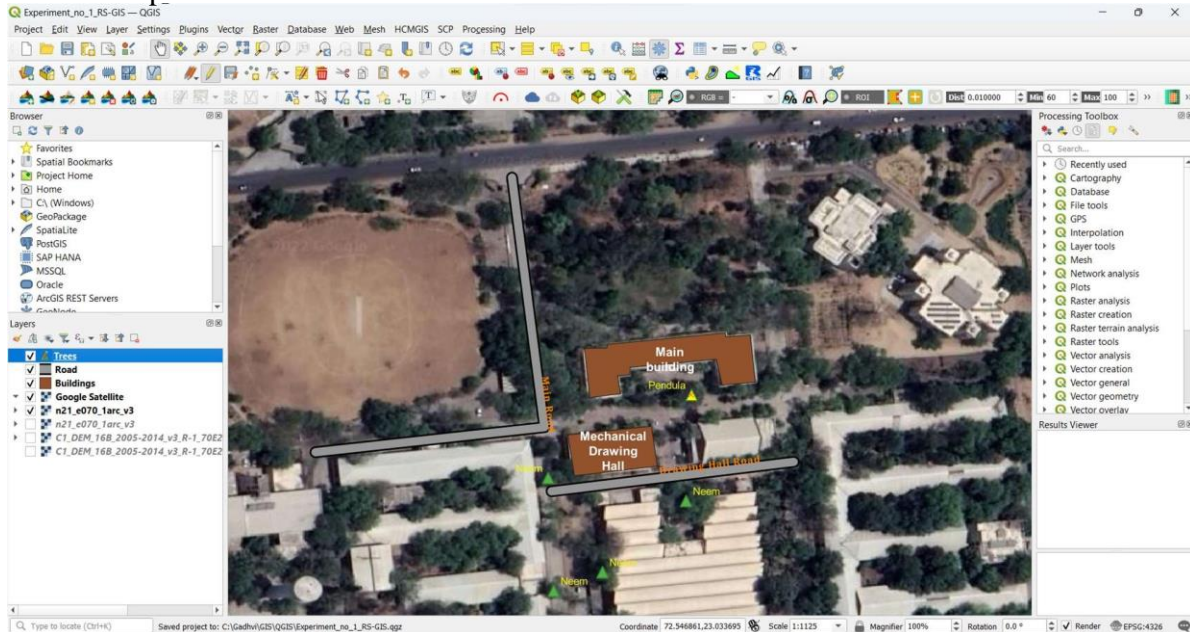


Observations:

1. Geometric fields 'Area' along with calculated values appears in the attribute table of the 'Buildings' feature.
2. Geometric field 'Length' along with calculated values appears in the attribute table of the 'Road' feature.
3. The symbol of vector layers 'Building', 'Road' and 'Trees' change.
4. The features on these vector layers are labelled.

Result:

The final map on the screen should be visible as shown below



Conclusion:

Quiz:

1. What are attribute data types in GIS, and why are they important?
2. How can users use the field calculator in QGIS to perform calculations on attribute data?
3. What is the difference between symbology and labeling in GIS, and how are they both important for cartographic representation?
4. Can attribute data types be associated with non-spatial data in GIS? If so, what are some examples?

Suggested Reference:

1. <https://bhuvan.nrsc.gov.in/home/index.php>
2. <https://earthexplorer.usgs.gov/>
3. <https://www.qgis.org/en/site/forusers/download.html#>

References used by the students: (Sufficient space to be provided)

Rubric wise marks obtained:

Rubrics	1	2	3	4	5	Total
Marks						