DEPARTMENT OF INFORMATION TECHNOLOGY
GOVERNMENT COLLEGE OF ENGINEERING, AMRAVATI

B.TECH-SIXTH SEMESTER

LAB RECORD FOR

ITU 627

GEOSPATIAL TECHNOLOGY LAB

Submitted by

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GOVERNMENT COLLEGE OF ENGINEERING, AMRAVATI

(An Autonomous Institute of Govt. of Maharashtra)

DEPARTMENT OF INFORMATION TECHNOLOGY

CERTIFICATE

This is to certify that this lab record contains the bonafide lab work of **YUKTI KATURE** having ID **22107012** of semester VI of B.Tech in ***Information Technology*** during academic year 2023-24 for the

Course Title:-**Geo Spatial Technology Lab**

Course Code:-**ITU627**

Date:-

COURSE COORDINATOR

(**Prof. D. R. Uike**)

PRACTICAL 1

AIM : Understanding QGIS and other GIS mapping tools

THEORY:

GIS is an abbreviation. Sometimes it is used to mean **Geographic Information System** and sometimes it is used to mean **Geographic Information Science**. A more formal definition of a Geographical Information System is:

A powerful set of tools for collecting, storing, retrieving at will, transforming and displaying spatial data from the real world (Burrough, 1986)

The emphasis here is on pieces of software like QGIS. In practical terms, a Geographic Information System is a database to store data, a calculator which can manipulate and analyse data, a visualisation window to show results. GIS software like QGIS also has a Graphical User Interface (GUI) with menus and buttons which lets the user 'do stuff'.

A more formal definition of Geographical Information Science is given by Goodchild, (1992) who argues that Geographical Information Science involves research that investigates spatial data acquisition, spatial statistics, modelling and theories of spatial data, development of analytical tools and consideration of the management and ethics of working with spatial data.

As an introduction, the Wikipedia entry contains a lot of information. In the further reading section, there are references to crucial GIS textbooks for a more formal treatment of key GIS concepts.

1.4 Vector data

Vector data represents the features of the world as either 'points' 'lines' or 'areas' (also called polygons).

Each type of feature is displayed in the GIS as a distinct layer. A layer will only contain either points, or lines, or polygons. It is also good practice to have different layers for different types of line features. For example, it is good to have a layer for roads and another for rivers.

1.5 Raster data:

‘In its simplest form, a raster consists of a matrix of cells (or pixels) organised into rows and columns (or a grid) where each cell contains a value representing information, such as temperature.

1.6 Network data

A network dataset takes a line dataset and defines its topology explicitly. Defining topology means having data tables that explicitly lists which lines are connected and at which nodes.
In its simplest form, this means recording the connections between the ends of different lines.
Data in this form is often called a graph as the branch of mathematics that deals with networks is called graph theory.

1.7 Data formats

Data formats refer to how data stored in a GIS and on your computer.
QGIS can handle a vast number of different data formats.
In today’s exercises, we will start by using use a file format called “Shapefile” as it is a prevalent type of vector GIS data format. The Shapefile format was developed by ESRI who make the commercial GIS software ArcGIS (ArcGIS is also available on university machine).
The Shapefile format appears on your computer as several files which may seem a little confusing. Each file contains a different type of information that the GIS needs to represent the spatial data.
NB. If you ever want to share a shapefile with someone, you have to send the whole group of files.

File extension	What it's for
.shp	The description of the vector objects, and their geometry
.dbf	Attribute data – it looks like a spreadsheet when opened. Each point is a row and each attribute (e.g. for bus stops it might have an attribute number of busses per day)
.shx	An index file that allows the computer to search for features faster
.prj	Projection information (see further information below)

Figure 1.1: A shapefile is a group of files. It is a common file format

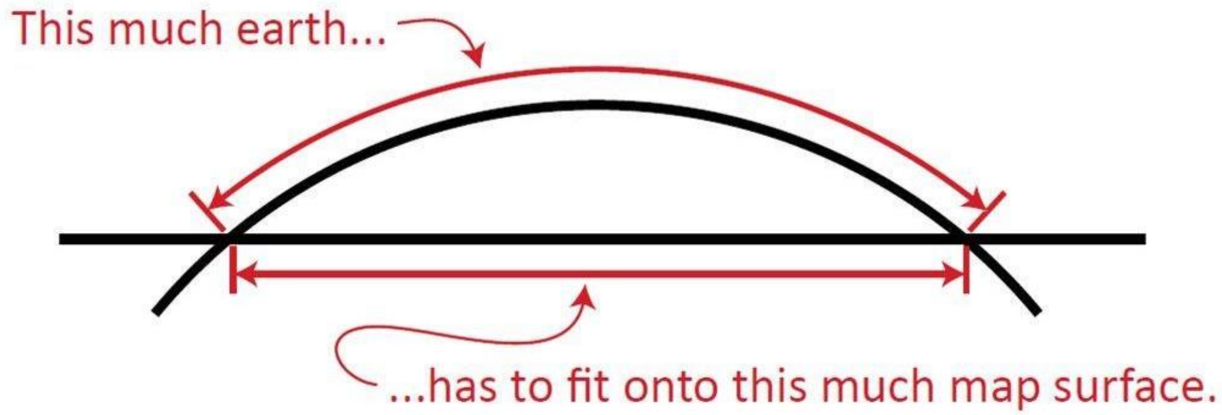
While shapefiles are still used, they have many limitations. Resulting in a campaign against shapefiles.

There are other types of GIS files, including GeoJSON and geo-package formats. Data is stored in GIS as database tables.

GIS data can be stored and shared in a very large number of ways.

1.8 Projections and coordinate systems

The world is not flat, but computer computer screens are. Coordinate systems, also known as coordinate reference systems (CRS), allow GIS to represent the curved surface of the Earth on a flat screen or page.



The projection is a mathematical formula explaining how places in the real world which are on a near spherical globe can be represented on a flat map. More information on projections and coordinate systems can be found in GIS test books.

Coordinate Reference Systems (CRS) refer to different ways of defining the X and Y coordinates used in different projections. Broadly they fall into two categories:

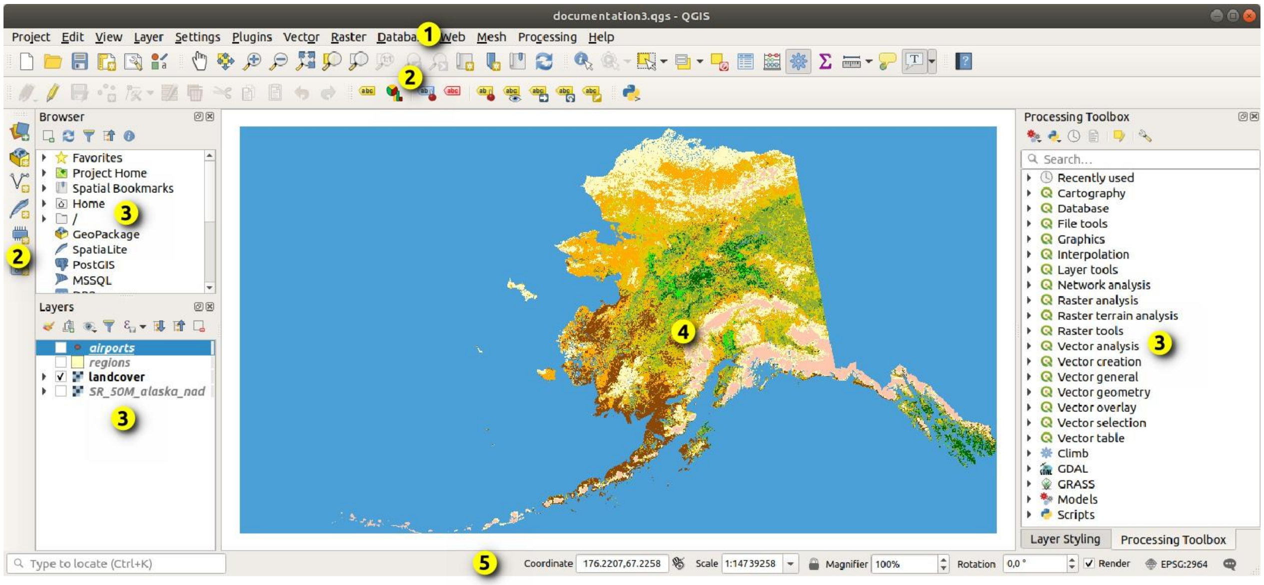
- Geographical Coordinate Systems: use latitude and longitude to represent any place on the Earth
- Projected Coordinate Systems: use distances from an origin point to represent a small part of the Earth, e.g. a country. The advantage of a projects CRS is that it is easier to calculate properties such as distance and area as coordinates are in metres.

You can find a catalogue of different CRSs

CRSs are often referred to by the EPSG number. The European Petroleum Survey Group publish a database of different coordinate systems. Two useful projections to commit to memory are:

- 4326 - the World Geodetic System 1984 which is a widely used geographical coordinate system, used in GPS datasets and the .geojson file format, for example.
- 27700 - the British National Grid

OUTPUT:



CONCLUSION:

Thus I have successful installed QGIS on the system and other GIS(SAGA GIS) mapping tools.

PRACTICAL 2

AIM : Working with QGIS.

THEORY:

MAP CANVAS: When you start QGIS, the large window, front-and-center is the map canvas. The map canvas displays all of your map features. Scrolling the wheel on your mouse up and down will zoom in and out. Holding the wheel on your mouse down will pan left, right, up, and down.

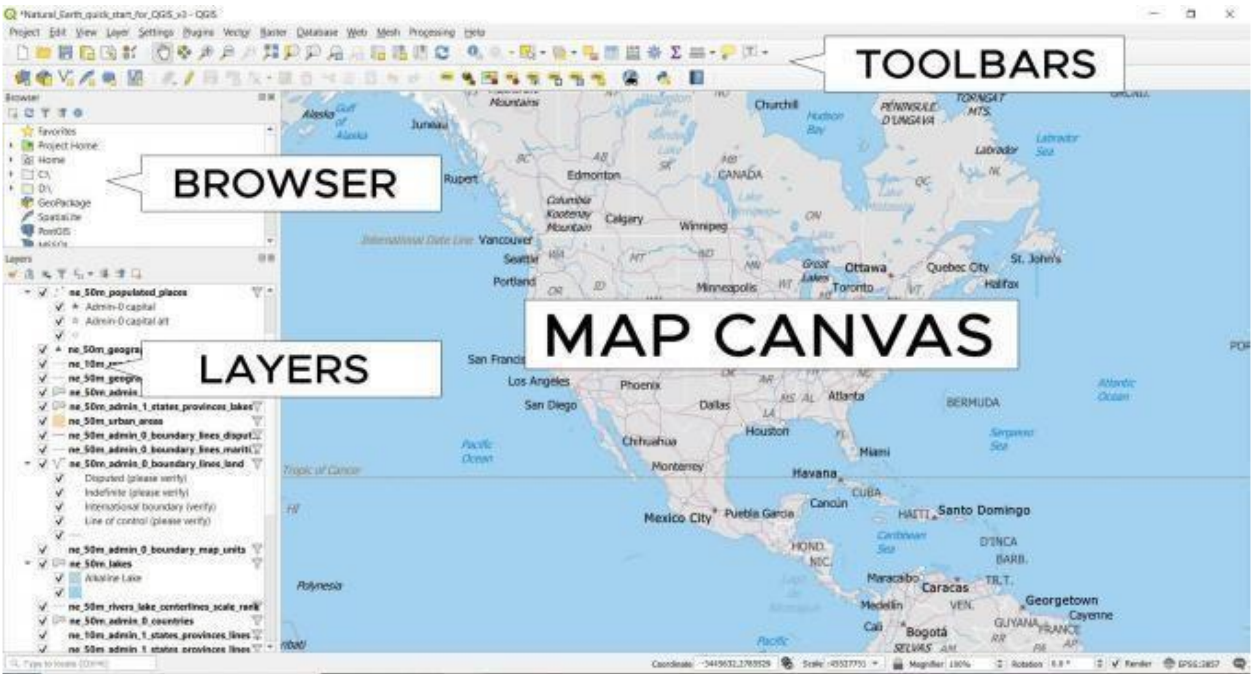
DATA BROWSER: The panel on the left is for browsing and managing your GIS data. It's like Windows Explorer for GIS data for adding layers in your map canvas. You can move and dock panels on either side. It's completely customizable and up to you where you want to dock it.

TOOLBARS: Toolbars are specialized sets of tools located above the map canvas. You can undock and move them anywhere in QGIS 3. For example, these are the standard toolbars that are in a QGIS install:

- Attributes
- Data Source Manager
- Digitizing
- Help
- Labeling

- Map Navigation
- Plugins
- Project
- Vector
- Web

QGZ File: When you save your project, it will create a file with a QGZ extension. In QGIS 2, it was the QGS file. Now, it's the upgraded QGZ file. The advantage of this file type is that you can open it like a TXT file.



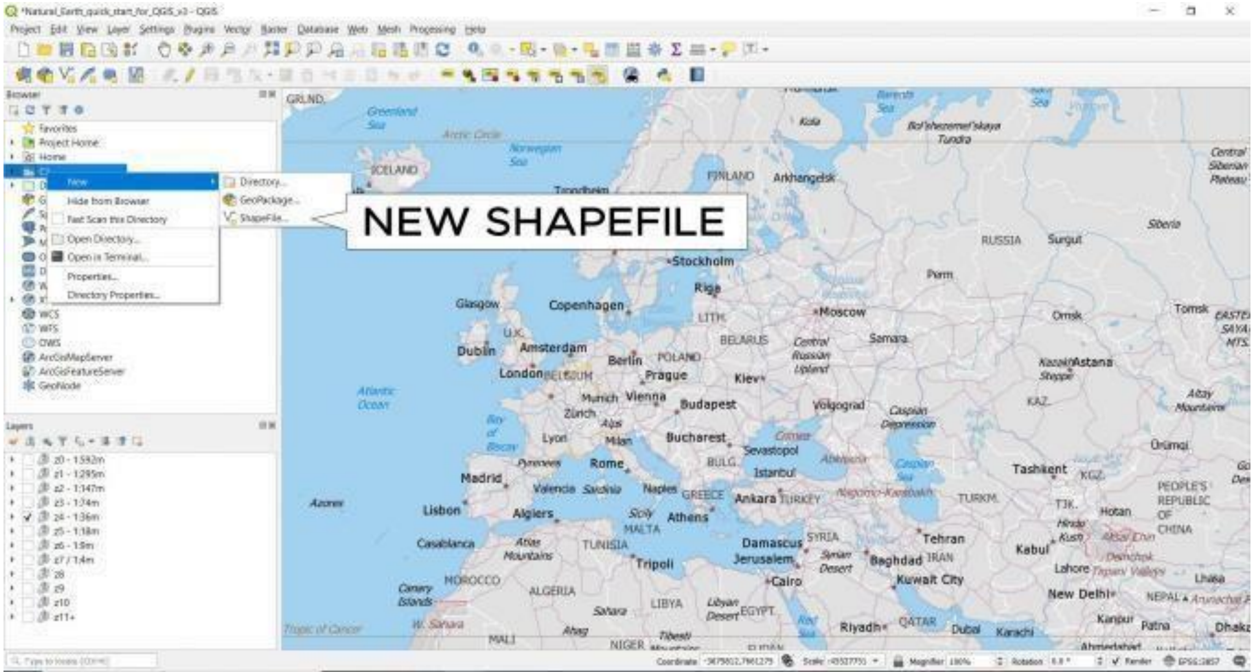
Creating data

If you want to create points, lines and polygons, then you can make a new shapefile to store these features:

- First, start by right-clicking the folder you want to create the shapefile in the Browser panel.
- Then, select New ‣ Shapefile.
- Next, choose the feature geometry as points, lines or polygons.
- Finally, select the encoding type and coordinate reference system.

When you click OK, it will prompt you to name the shapefile. Once you assign it a name, it automatically goes into your layer list.

Keep in mind there are other GIS formats for storing data. For example, you can use a Geopackage (GPKG), which is an SQLite database file.

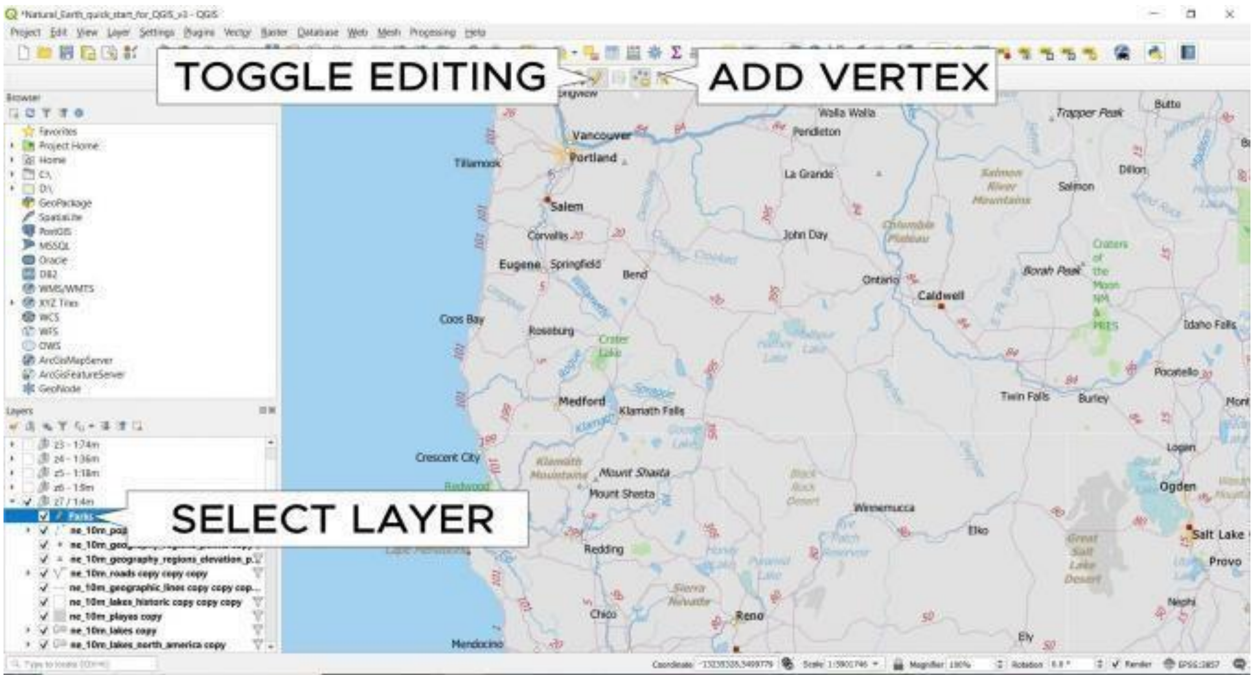


Editing data

If you want to edit a layer, first select, and highlight it in the layer panel. Next, click the Toggle Editing tool in the Editor toolbar. From here, it enables the editing tools.

Next, you can add vertices by using the “add point” or “vertex tool”. By clicking on the map canvas, this adds vertices to geometry.

If you want to finish geometry, you can simply right-click on the map canvas. From here, you can fill in the attributes. If you want to save your edits, click the “Save Layer” button.



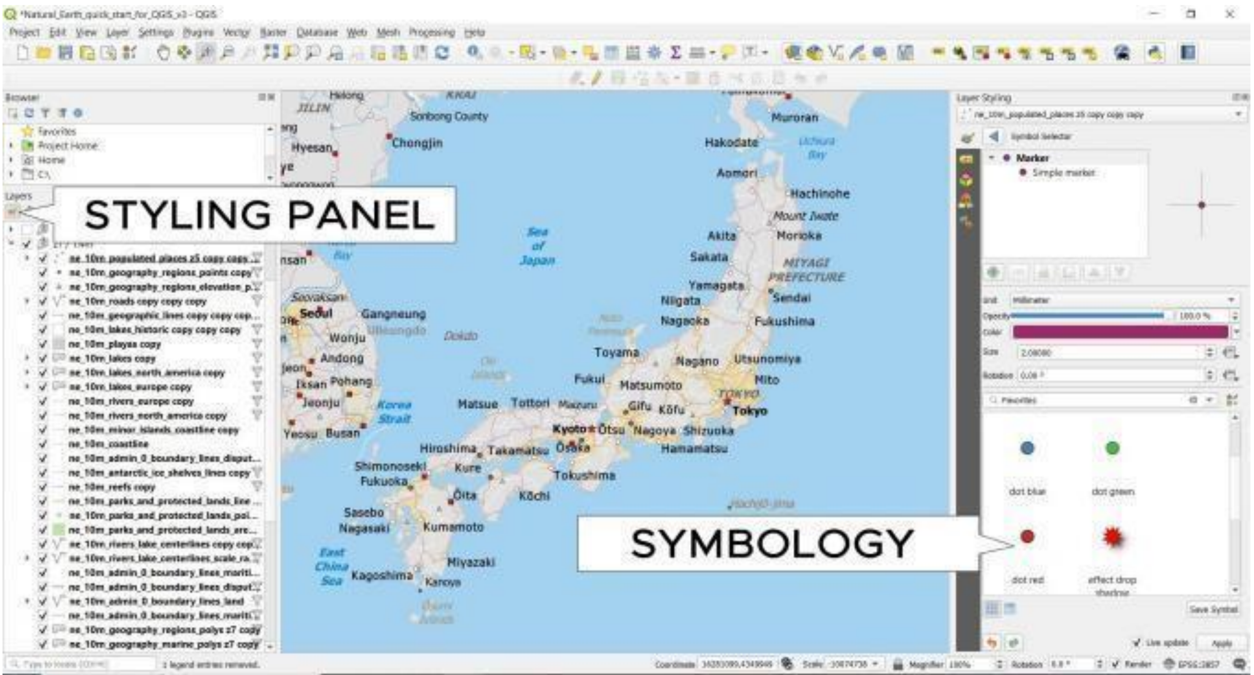
Adjusting symbology

If you want to adjust the symbology, QGIS has a shortcut to access the layer styling. By clicking the "layer styling" button, the symbology panel opens on the right-hand side.

In the layer styling panel, this is how you can change the symbology styles. You can also create points, lines, and polygon symbols by adding several together.

In the labels tab, you can decide which label styles to use. You get stylish labeling options in QGIS 3. For example, you can use halos, transparency, and drop-shadows.

You can also adjust the transparency of features on the map. Optionally, you can save it as a style file for later use.



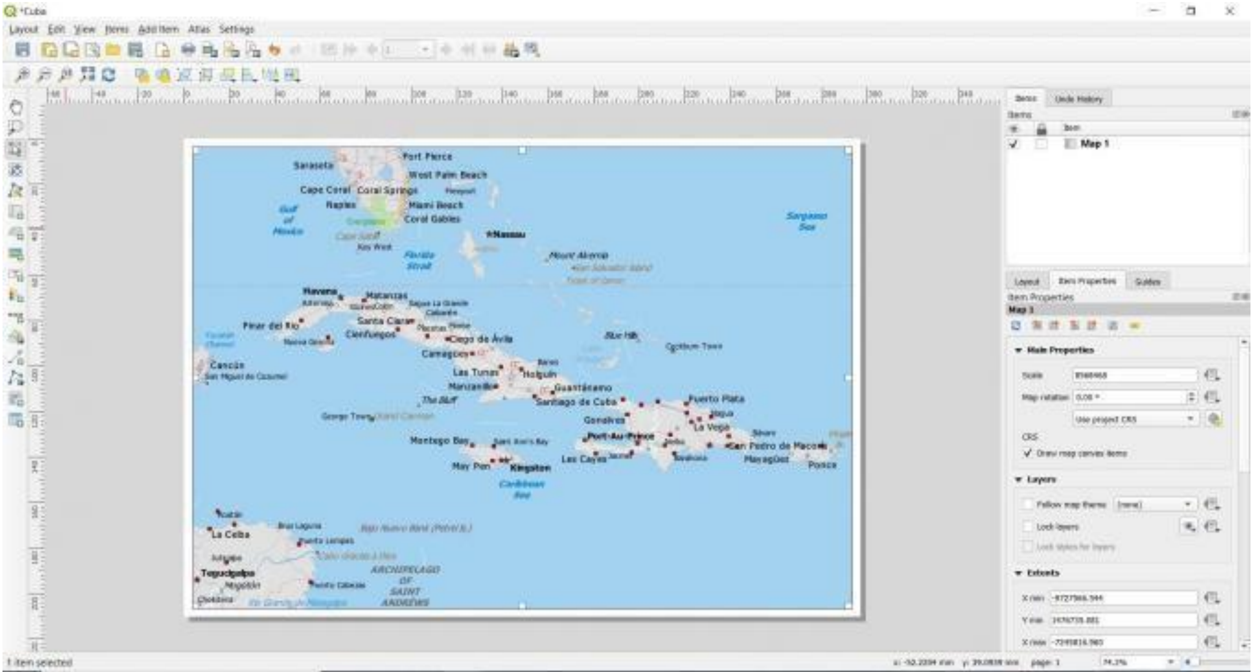
Using print layouts

Print layouts are almost like a secondary interface. It's how you make a professional quality map. It's also where you add common map elements like north arrows, scale bars and titles.

- First, click Project ‣ New Print Layout.
- Next, enter a name for your layout.
- Click Add Item ‣ Add Map
- Then, drag an area in your canvas.
- Use Edit ‣ Move Content to pan in the map window
- In the Item Properties tab, you can set the map scale, extent and even rotation of the map.
- By clicking Add Item ‣ Add Scalebar, it adds a scalebar.

There are options for adding labels, legends, and north arrows so you can test what everything does. This is also how you will create a 3D map, which is something completely new to QGIS 3.

Print layouts supersede its predecessor print composers from QGIS 2. Luckily, they have similar functionality and interface.

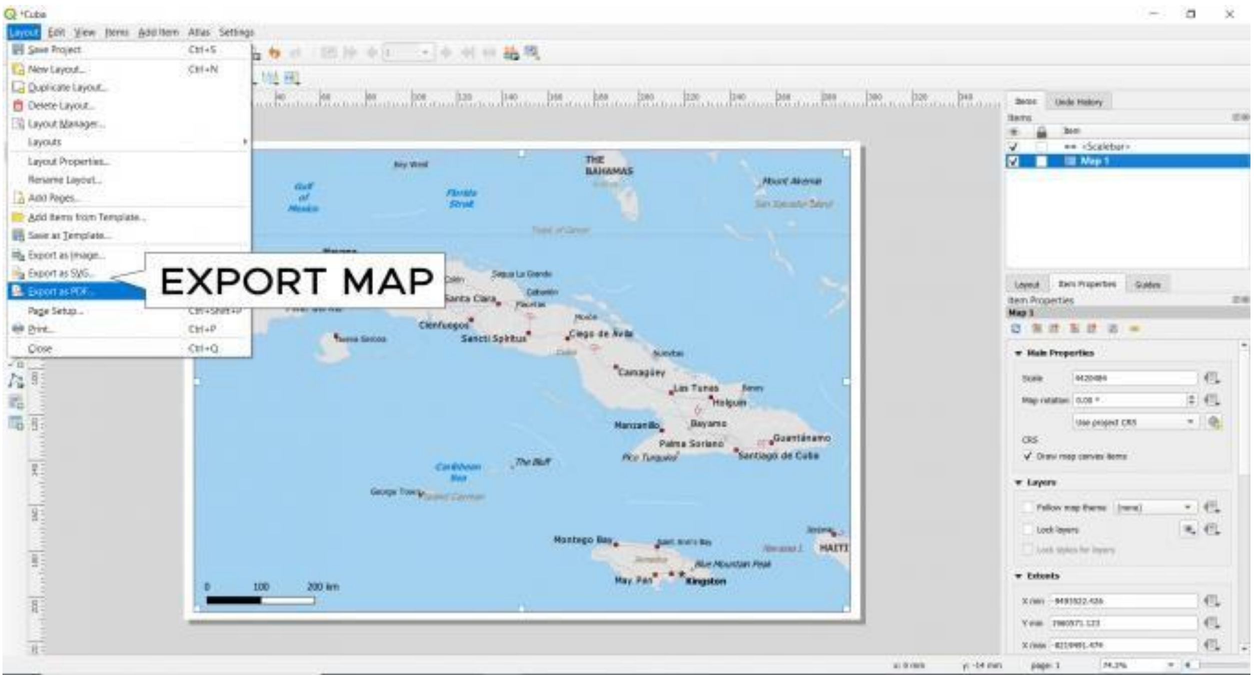


Exporting maps

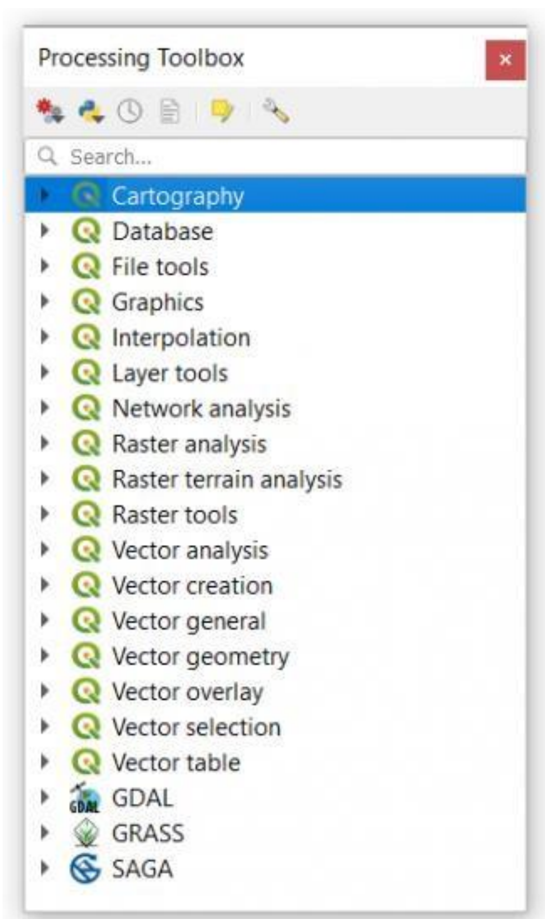
As explained above, print layouts are for exporting and printing professional-quality maps. It's in the composition panel that you set paper size, orientation, units, and background color. If you want to export a PDF map in QGIS, click

Layout ‣ Export as PDF.

If you export as SVG, this gives you the option to import the map in Adobe Illustrator. You can also export maps in a wide range of formats like JPG, PNG, and TIF.



Running geoprocessing tools



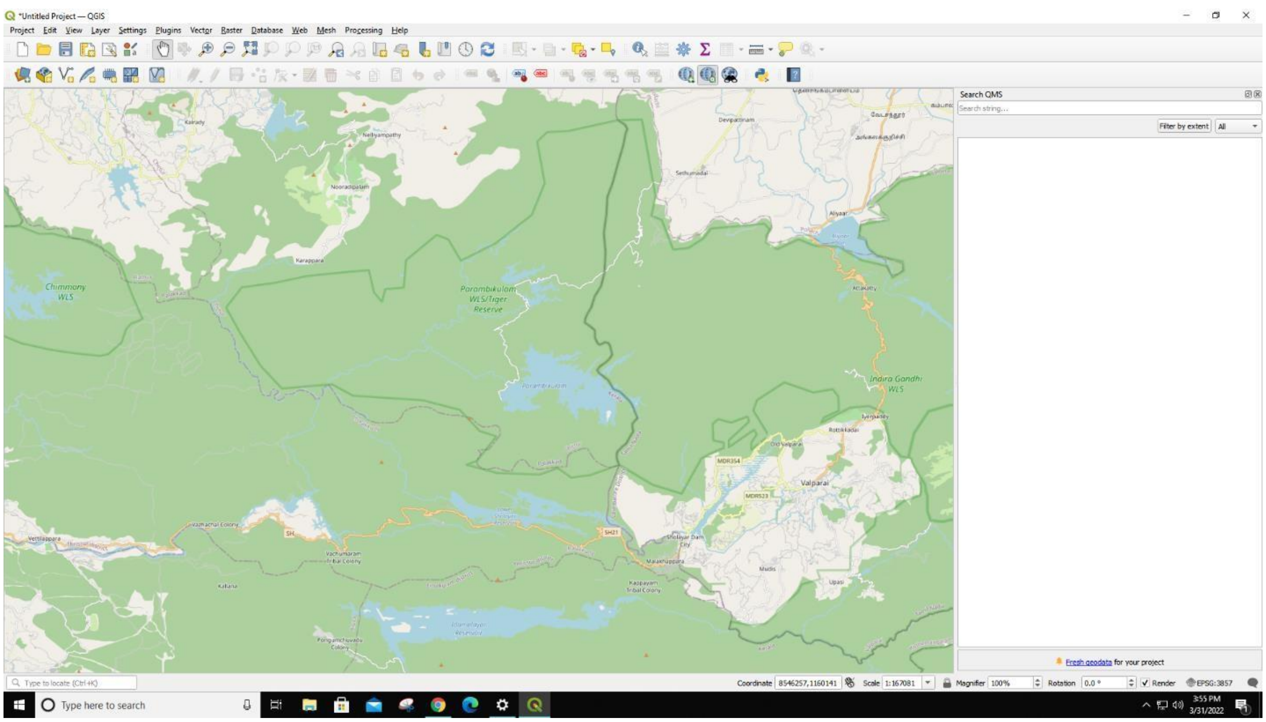
You can access the GIS processing tools by clicking:

Processing ‣ Toolbox.

If you want to find a specific tool, the easiest way is to search for it. The search bar at the top helps you to locate the tools you need from over 600 available tools.

- Cartography
- Database
- File tools
- Graphics
- Interpolation
- Layer tools
- Network analysis
- Raster
- Vector
- GDAL
- GRASS
- SAGA

OUTPUT- QGIS



CONCLUSION:

Thus I have Successfully Performed Data Balancing on the given Data Set.

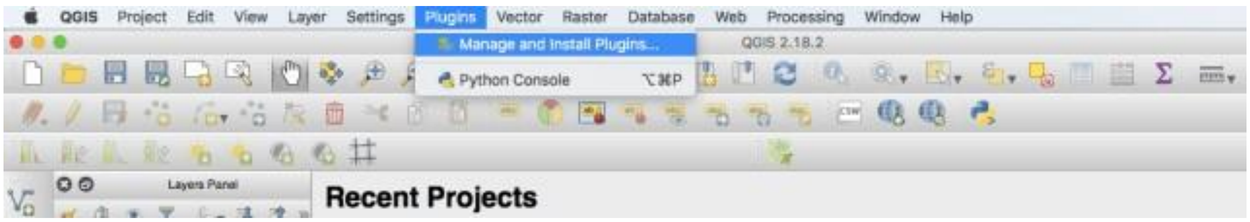
PRACTICAL 3

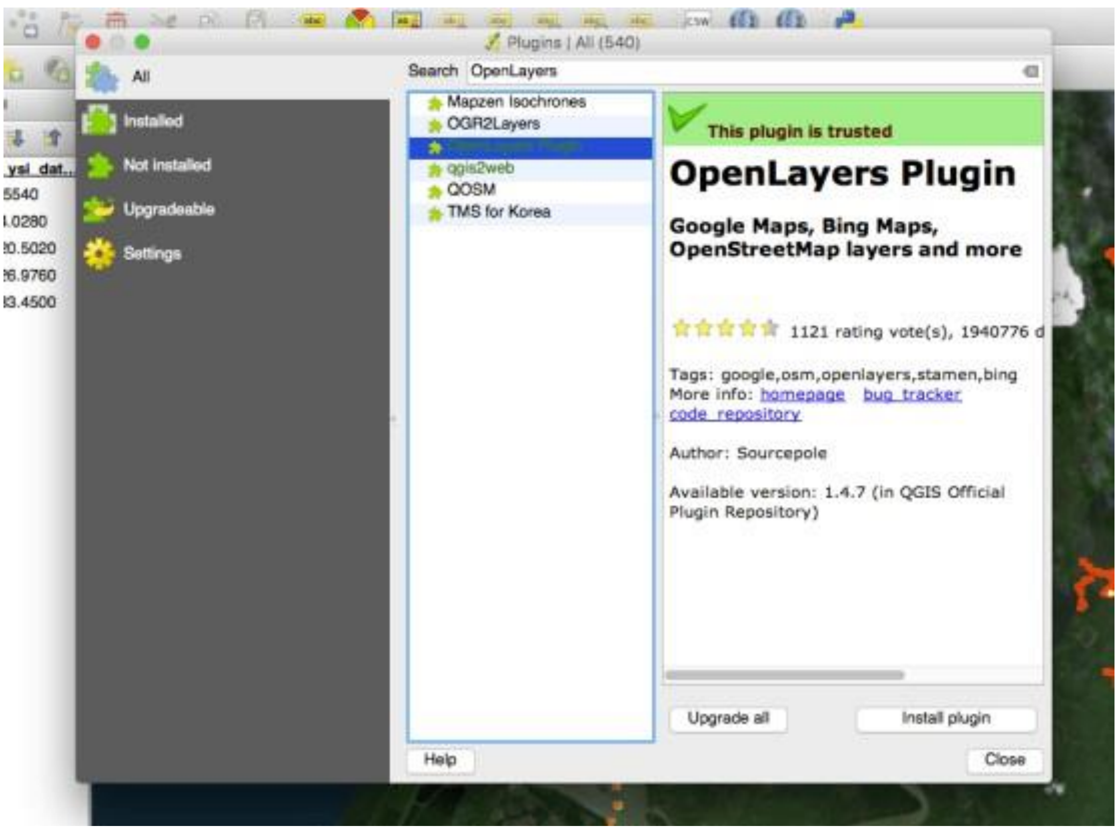
AIM: Creating digital Maps using geo spatial objects

THEORY:

1. Install QGIS Plug-in

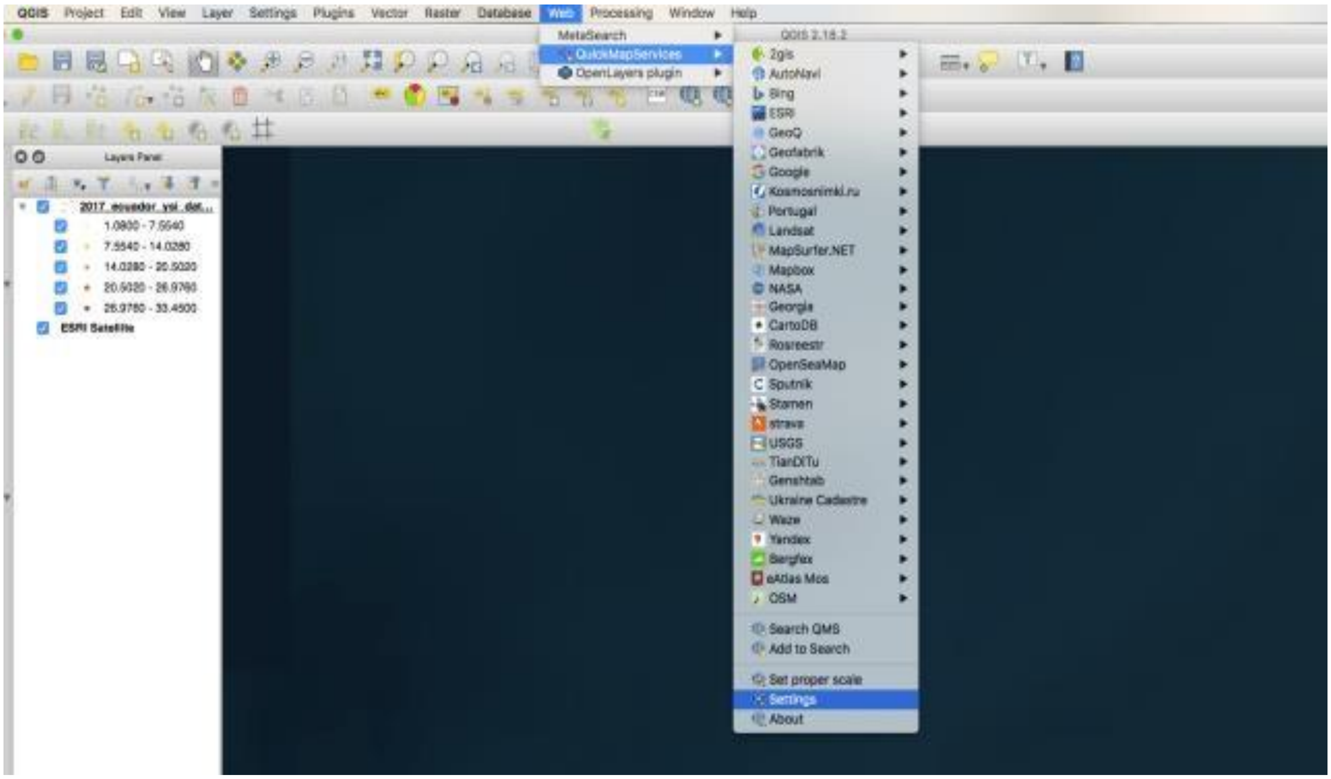
   Go to Plugins and select Manage and Install plugins. This will open the plugins dialogue box and type OpenLayers Plugin and click on Install plugin.

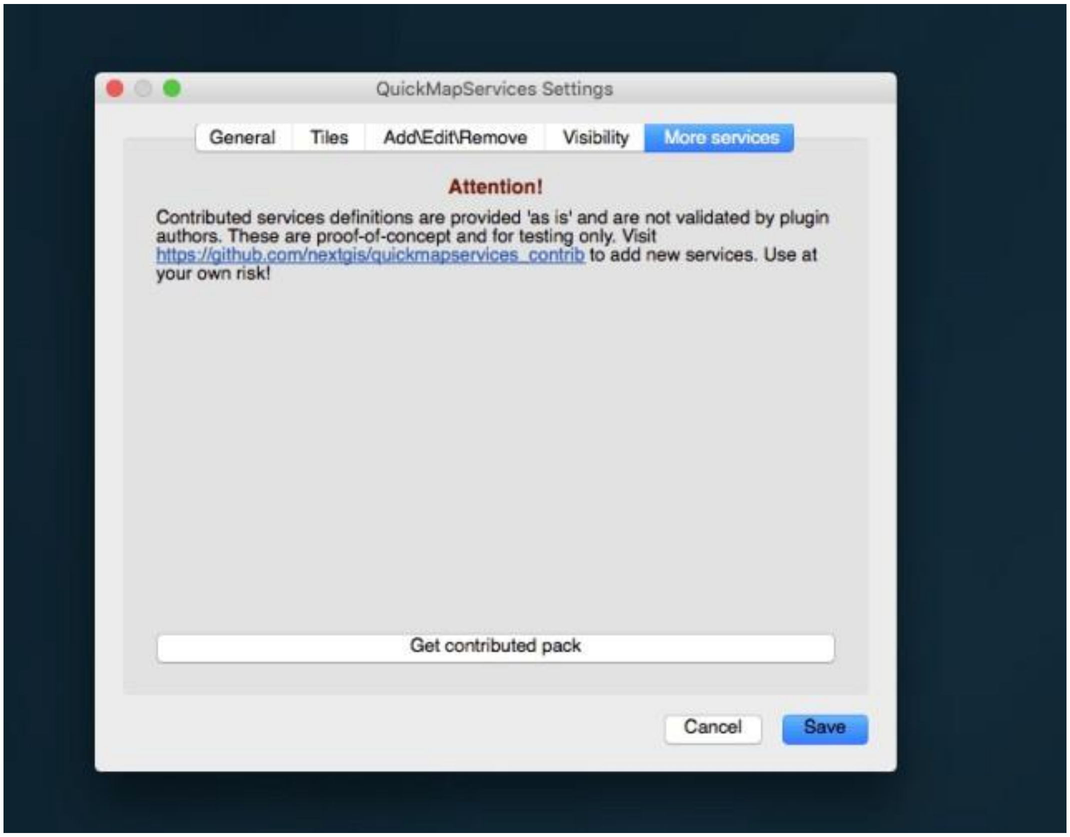




This plugin will give you access to Google Maps, openStreet map layers and others, and it is very useful to make quick maps from Google satellite, physical, and street layers. However, the OpenLayers plugin could generate zoom errors in your maps. There is another plug in: **Quick Map Service** which uses tile servers and not the direct api for getting Google layers and others. This is a very useful plugin which offers more options for base maps and less zoom errors. To install it you should follow the same steps as you did for the OpenLayers plugin except this time you'll type **QuickMap Service** and install the plugin.

Also, If you want to experiment with QuickMap services you can expand the plugin: Go to Web->Quick Map Services->Settings->More services and click on get contributed pack. This will generate more options for mapping.

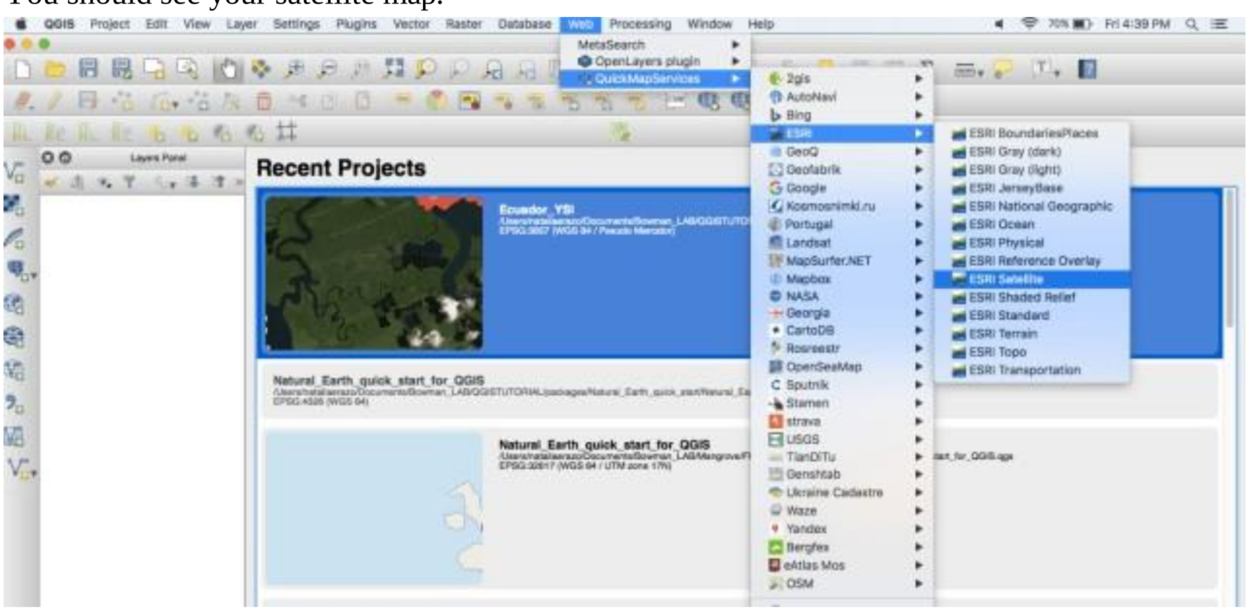


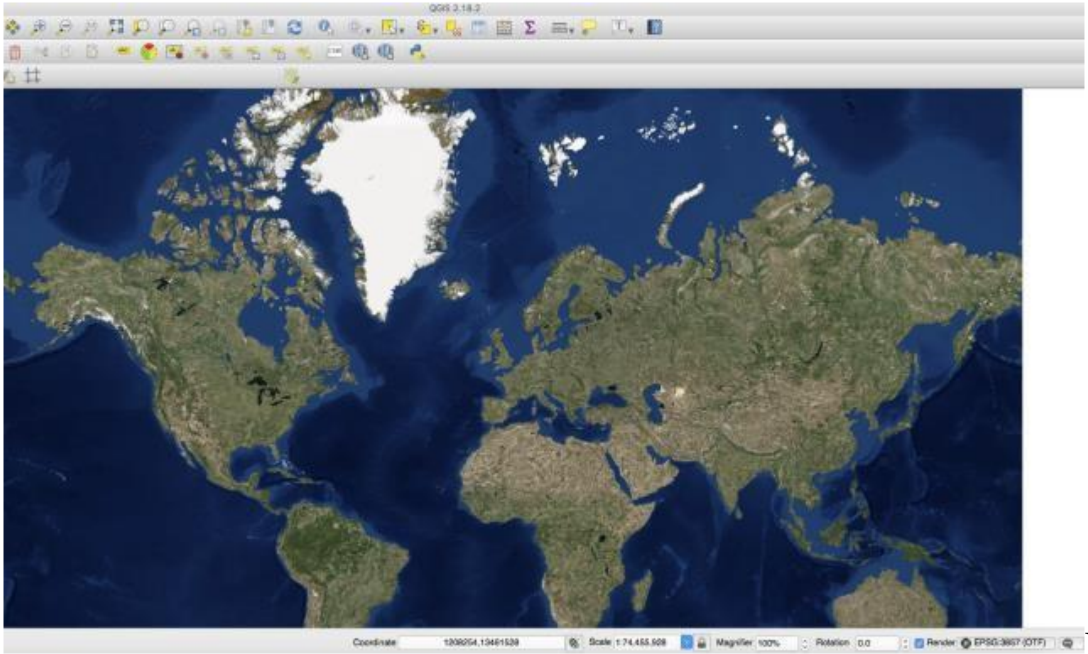


2. Add the base layer Map:

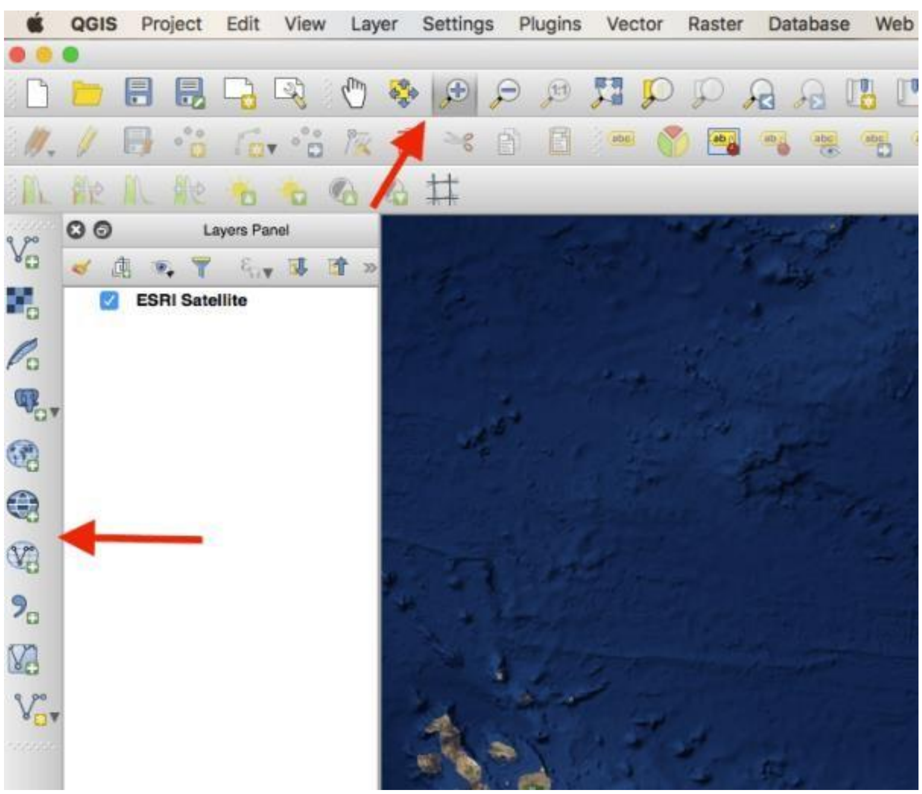
I recommend playing with the various options in either OpenLayers like the Google satellite, physical, and other maps layers, or QuickMap Service.For this map, we will use ESRI library from QuickMap services. Go to–> Web- ->QuickMapServices–> Esri–> ESRI Satellite

You should see your satellite map.





You can click on the zoom in icon to adjust the zoom, as shown in the map below where I zoom in the Galapagos Islands. You’ll also notice that on the left side you have a **Layers panel** box, this box shows all the layers you add to your map. Layers can be raster data or vector data, in this case we see the layer: ESRI Satellite. At the far left you’ll see a list of **icons** that are used to import your layers. It is important to know what kind of data you are importing to QGIS to use the correct function.



III. Adding our vector data.

We will now add our data file which contains latitude and longitude of all the sites we collected samples, in addition to values for salinity, temperature, and turbidity. You can do this with your own data by creating a file in excel and have a column with longitude and latitude values and columns with other variables and save it as a csv file. To input data you'll go to the icons on the far left and click on "Add Delimited Text Layer". Or you can click on Layer-> Add Layer-> Add Delimited Text Layer.

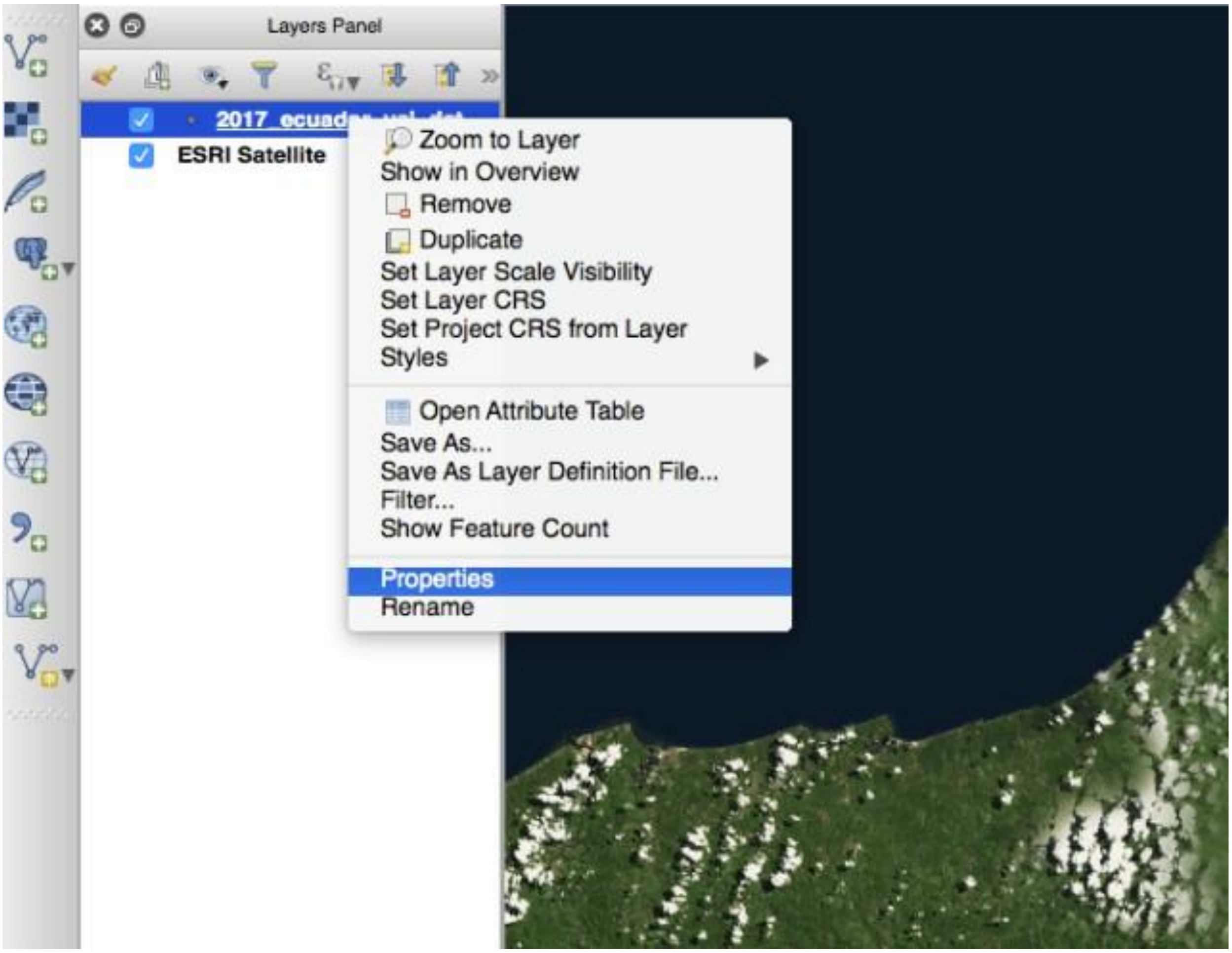
You'll browse to the file with your data. Make sure that csv is selected for File format. Additionally, make sure that **X field** represents the column for your longitude points and **Y field** for latitude. QGIS is smart enough to recognize longitude and latitude columns but double check! You can also see an overview of the data with columns for latitude, longitude, Barometer mmHg, conductivity, Salinity psu and other variables. You can leave everything else as default and click ok.

You'll be prompt to select the coordinate reference system selector, and this is very important because if you do not select the right one you'll get your points in the wrong location. For GPS coordinates, as the data we are using here, you need to select WGS 84 ESPG 43126.

Now we can see all the points where we collected data!

As we saw earlier, the data contains environmental measurements such as: salinity, turbidity, temperature and others. We can style the layer with our sampling points based on the variables of our data. In this example we will create a layer representing salinity values.

You'll right click on the layer with our data in the Layer Panel, in this case our layer: 2017_ecuador_ysi_dat.. and select properties.

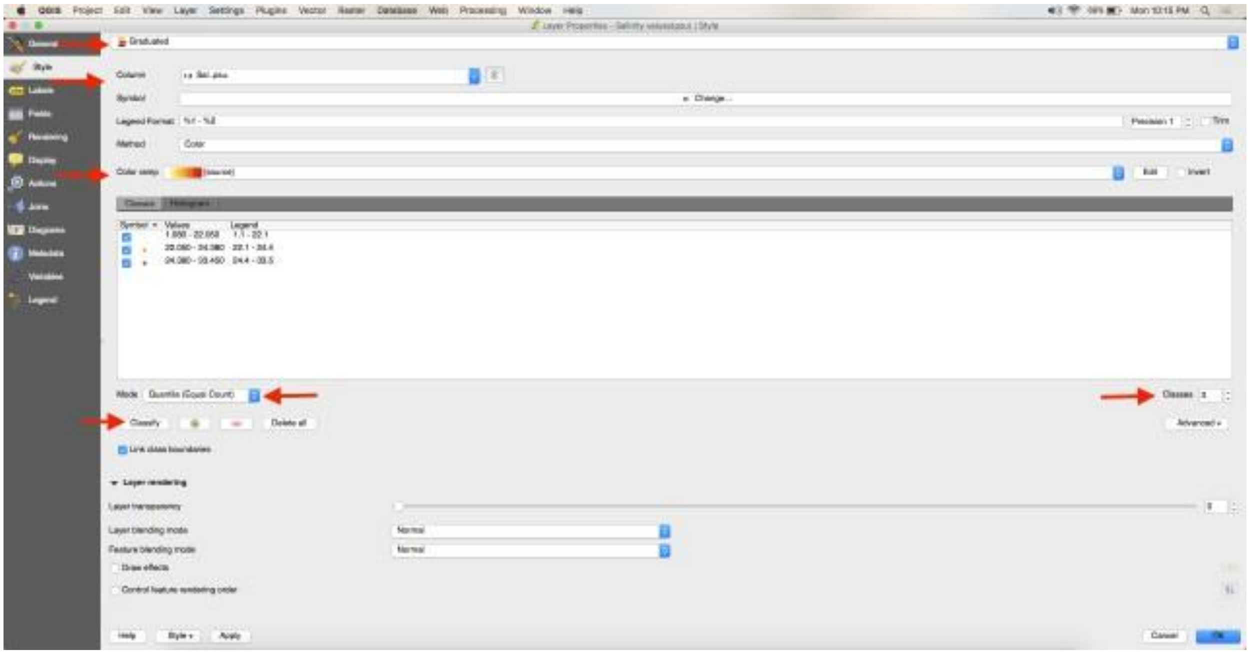


The are many styles you can choose for the layer and the styling options are located in the **Style tab** of the Properties dialogue. Clicking on the drop-down bottom in the Style dialogue, you'll see there are five options available: Single Symbol, Categorized, Graduated, Rule Based and Point displacement. We'll use **Graduated** which allows you to break down the data in unique classes. Here we will use the salinity values and will classify them into 3 classes: low, medium, and high salinity. There are 5 modes available in the Graduated style to do this: Equal interval, Quantile, Natural breaks, Standard deviation and Pretty breaks. You can read more about these options in qgis documentation.

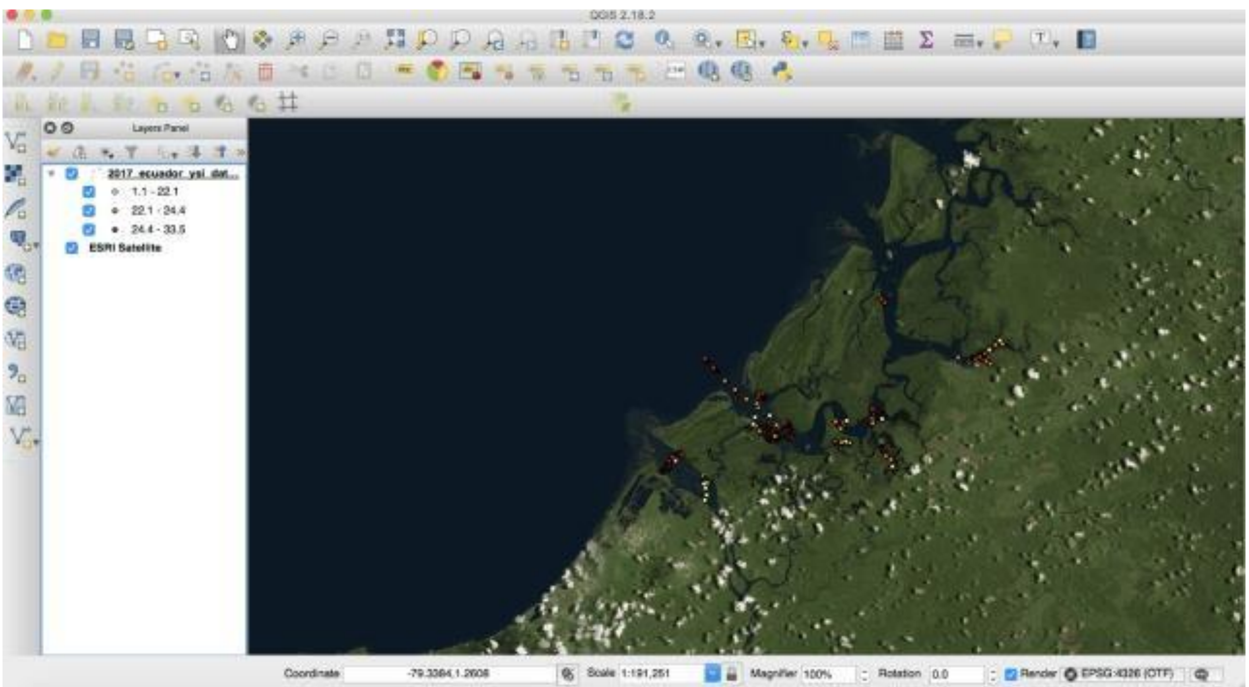
In this tutorial, for simplicity we'll use the **Quantile** option. This method will decide the classes such that number of values in each class are the same; for example, if there are 100 values and we want 4 classes, the quantile method decide the classes such that each class will have 25 values.

In the **Style section**: Select->**Graduated**, in **Column**->salinity psu, and in color ramp we'll do colors ranging from yellow to red.

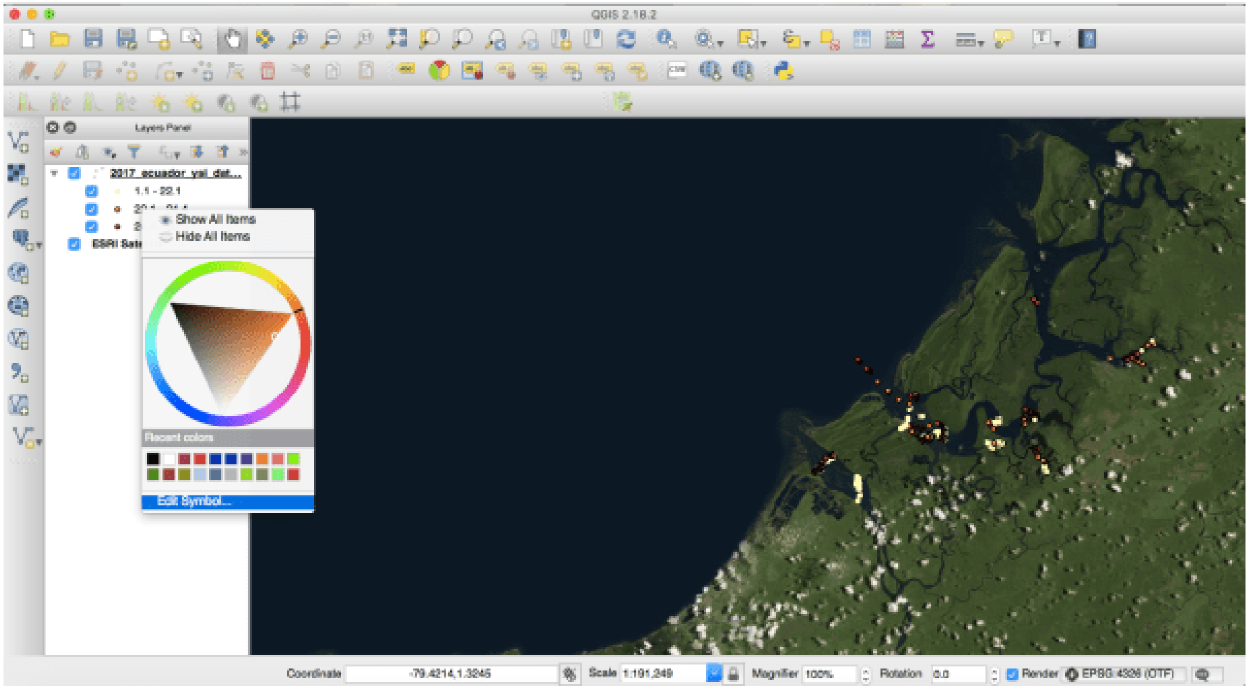
In the classes box write down **3** and select mode–>**Quantile**. Click on **classify**, and QGIS will classify your values in different ranges.



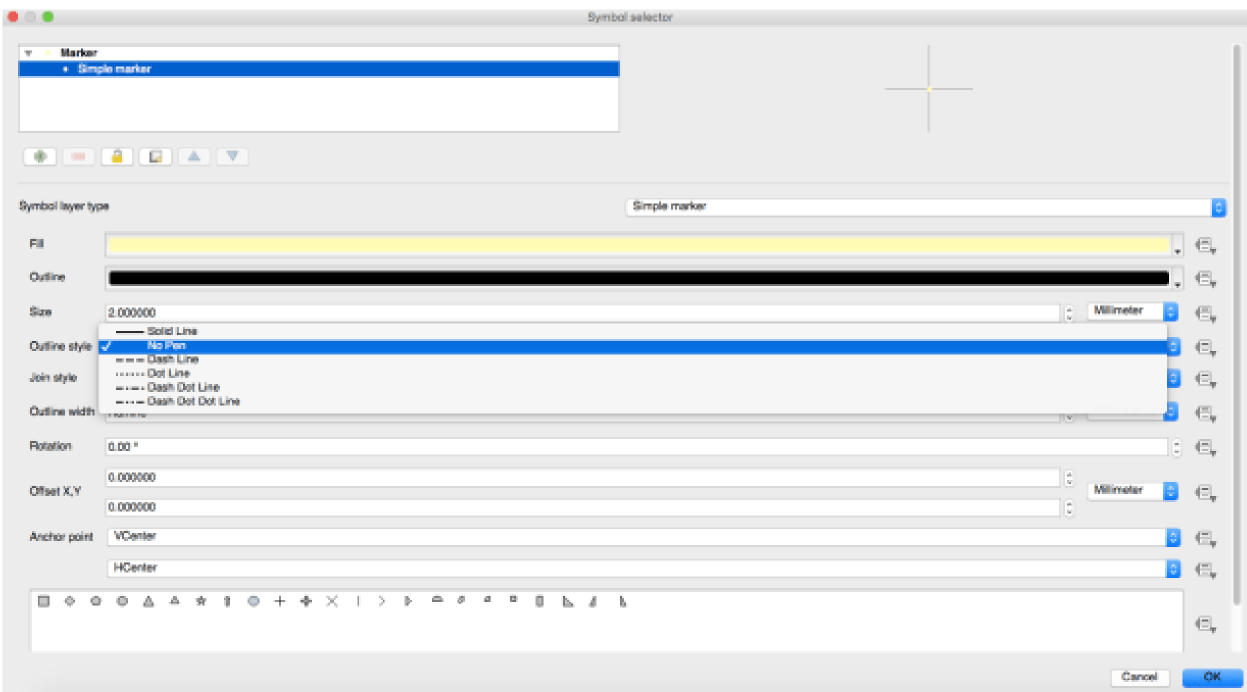
Now we have all the data points color in the 3 different ranges: low, medium, and high salinity.



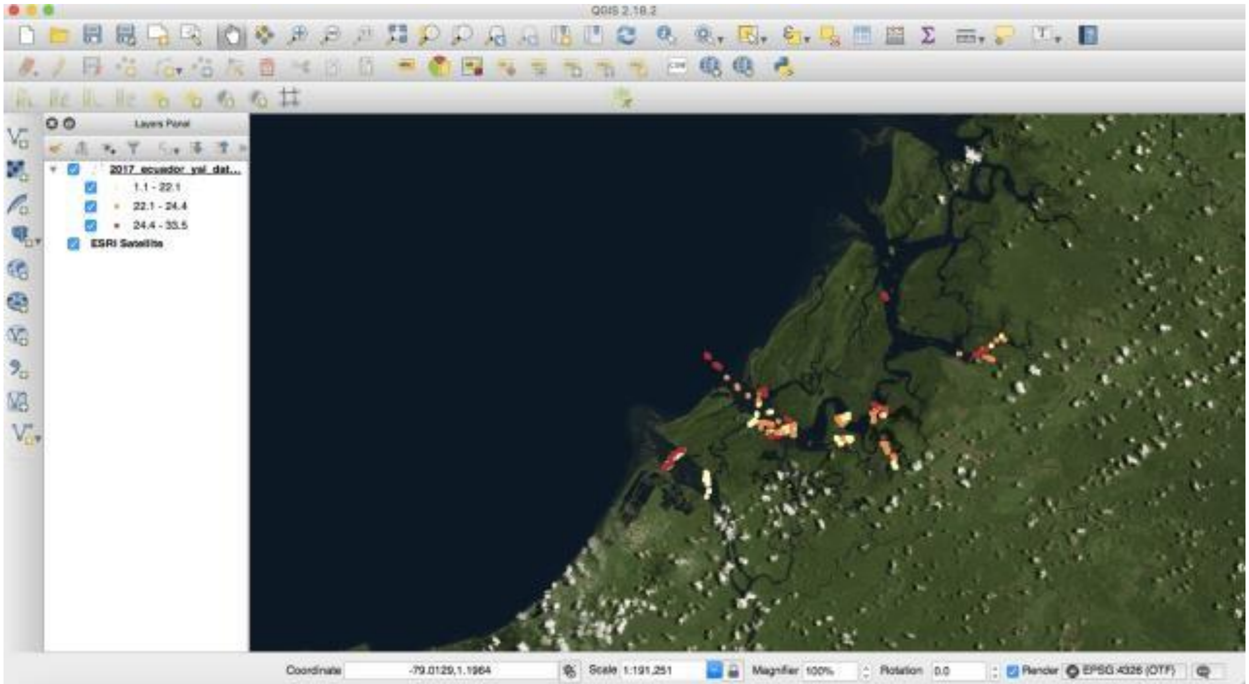
However, we have a lot of points and it is hard to visualize the data points. We can edit the points by right clicking on the marker points and select edit symbol.



Now, I am going to get rid of the black outline to make the points easy to visualize. Select the point by clicking on **Simple Marker** and in **Outline style** select the **No Pen**. Do the same for the remaining two points.

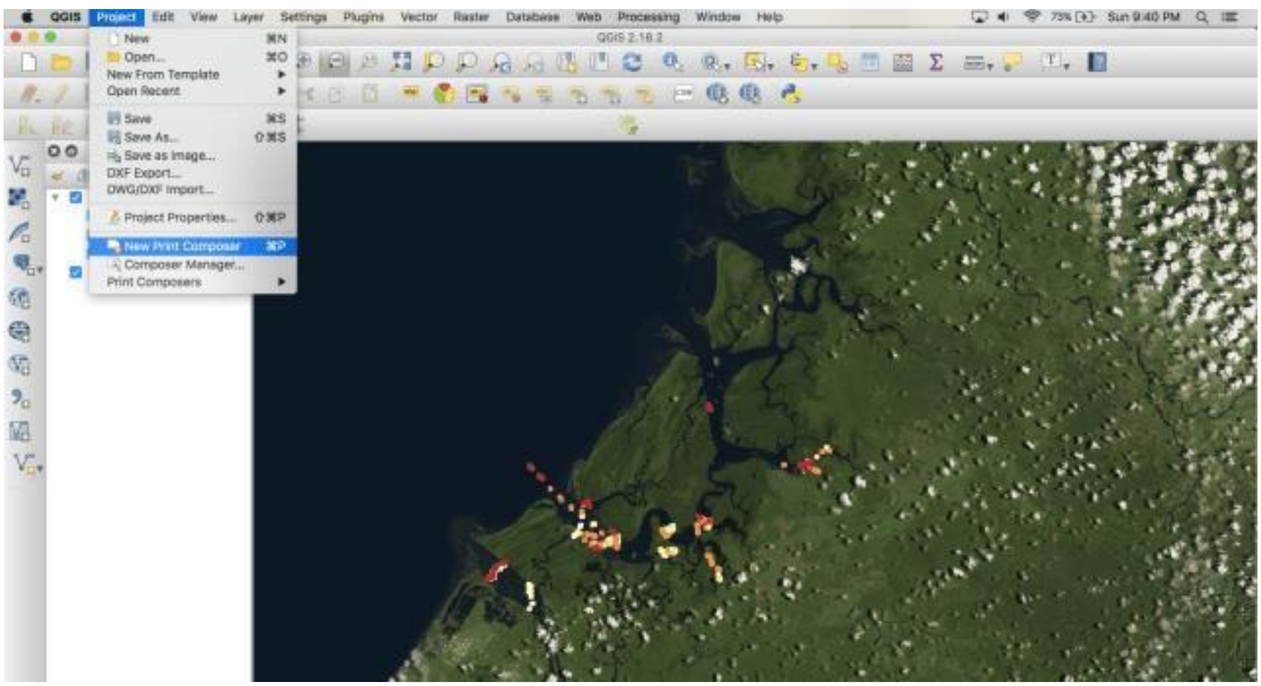


Nice, now we can better see variations in our points based on salinity!



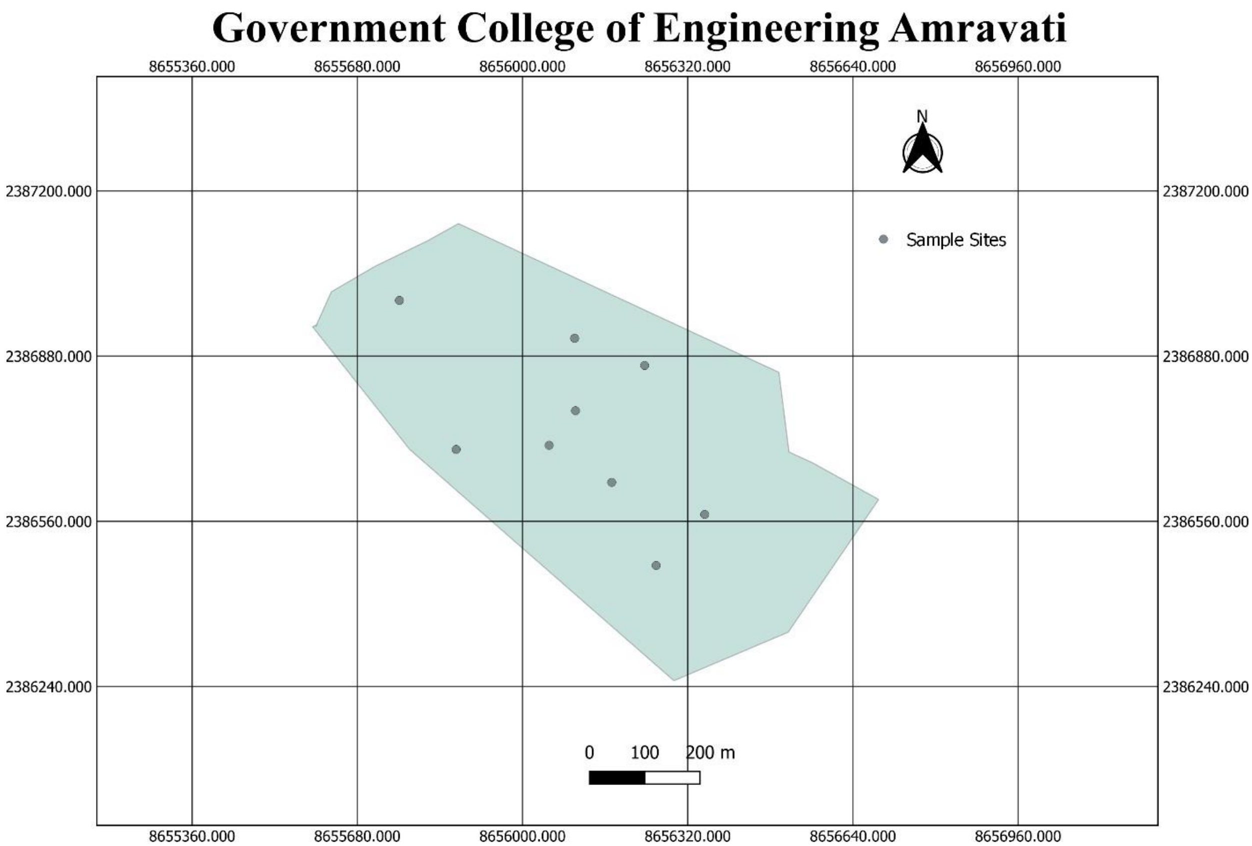
IV. Print Composer: making a final map

We can start to assemble the final version of our map. QGIS has the option to create a Print composer where you can edit your map. Go to Project -> New Print composer



You will be prompted to enter a title for the composer, enter the title name and hit ok. You will be taken to the Composer window.

OUTPUT:



CONCLUSION: Thus I have successfully created digital maps using geospatial objects.

PRACTICAL 4

AIM: Understanding digital data, data collection techniques and various data formats.

THEORY:

Data collection is split into data capture (direct data input) and data transfer (input of data from other systems).

Two main types of data capture are

- Primary data sources are those collected in digital format specifically for use in a GIS project.
- Secondary sources are digital and analog datasets that were originally captured for another purpose and need to be converted into a suitable digital format for use in a GIS project.

• The processes of data collection are also variously referred to as data capture, data automation, data conversion, data transfer, data translation, and digitizing.

• Data collection is a time consuming, tedious, and expensive process.

• Typically it accounts for 15–50% of the total cost of a GIS project

• If staff costs are excluded from a GIS budget, then in cash expenditure terms data collection can be as much as 60–85% of costs.

<u>Primary geographic data capture: They are of two types : raster and vector</u>

Raster data capture

• Remote sensing is a technique used to derive information about the physical, chemical, and biological properties of objects without direct physical contact

• Information is derived from measurements of the amount of electromagnetic radiation reflected, emitted, or scattered from objects.

• Figure 9.2 shows the spatial and temporal characteristics of commonly used remote sensing systems and their sensors

• Resolution is a key physical characteristic of remote sensing systems.

• Spatial resolution refers to the size of object that can be resolved and the most usual measure is the pixel size.

• Spectral resolution refers to the parts of the electromagnetic spectrum that are measured.

• Temporal resolution, or repeat cycle, describes the frequency with which images are collected for the same area.

• A paragraph describes SPOT imagery

• Aerial photography is equally important in medium- to large-scale projects

• Photographs are normally collected by analog optical cameras and later scanned

• Aerial Photographs are usually collected on an ad hoc basis

• Can provide stereo imagery for the extraction of digital elevation models

• **Advantages are**

o Consistency of the data

o Availability of systematic global coverage

o Regular repeat cycles

• **Disadvantages are**

o Resolution is often too coarse

o Many sensors are restricted by cloud cover.

Vector data capture

• Two main branches are ground surveying and GPS

o Distinction is increasing blurred

9.2.2.1 Surveying

• Ground surveying is based on the principle that the 3-D location of any point can be determined by measuring angles and distances from other known points.

• Traditional equipment like transits and theodolites have been replaced by total stations that can measure both angles and distances to an accuracy of 1 mm

• Ground survey is a very time-consuming and expensive activity, but it is still the best way to obtain highly accurate point locations.

• Typically used for capturing buildings, land and property boundaries, manholes, and other objects that need to be located accurately.

- Also employed to obtain reference marks for use in other data capture projects

Secondary data captures include data from various third party organizations it includes buying their data and building on it.

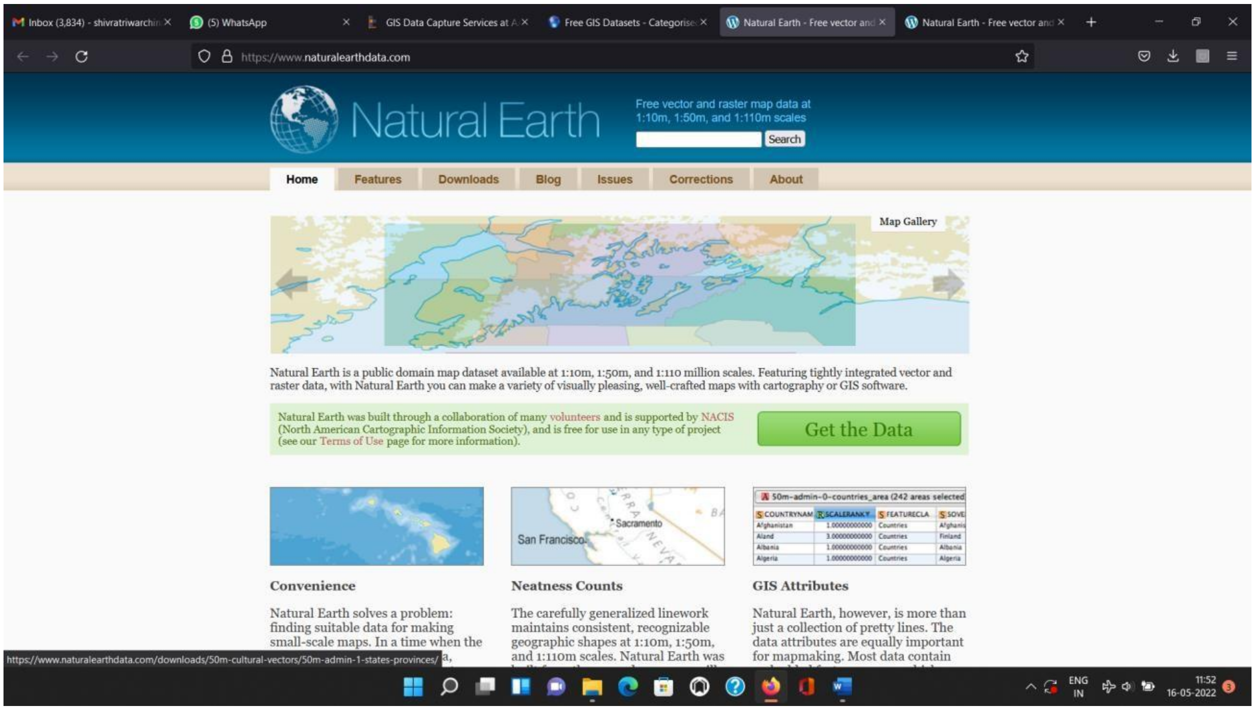
VARIOUS DATA FORMATS:

QGIS uses the OGR library to read and write vector data formats, including ESRI shapefiles, MapInfo and MicroStation file formats, AutoCAD DXF, PostGIS, SpatiaLite, Oracle Spatial and MSSQL Spatial databases, and many more. GRASS vector and PostgreSQL support is supplied by native QGIS data provider plugins

OUTPUT:

GIS Data Capture Service by Third Party Organizations classifies as primary data

Secondary Data available at naturalearthdata.com, both raster and vector data is available for free



CONCLUSION: Thus I have understood the process of data collection and various data formats in GIS using QGIS.

Practical No:5

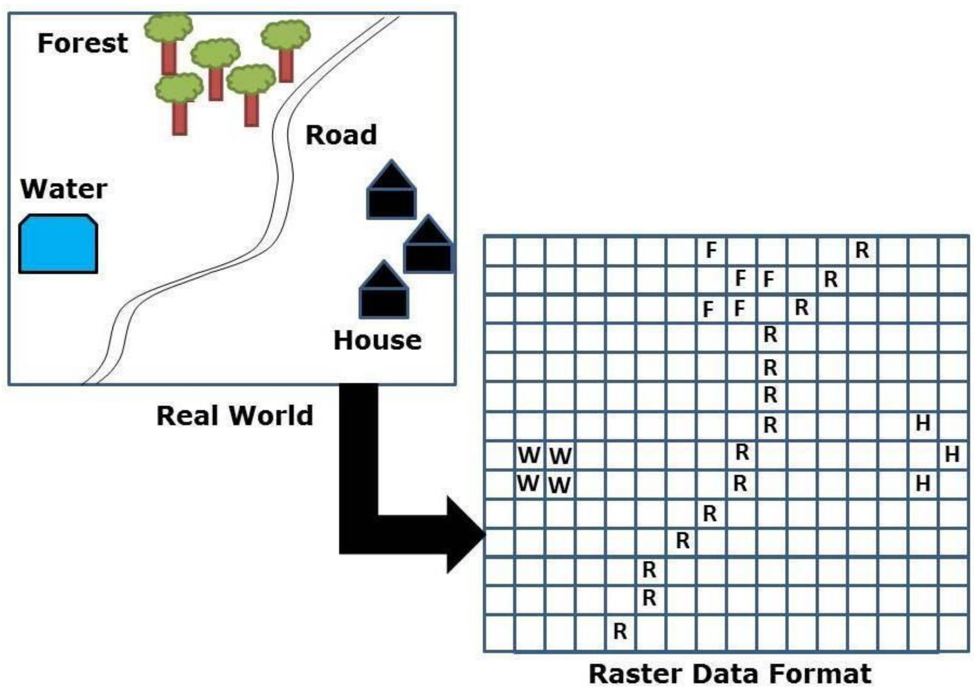
Aim: Importing various data formats to QGIS to build map and features

Theory:

What is QGIS?

Geographic information systems (GIS) are used in a wide range of academic and applied fields. Simply put, GIS allows you to combine tabular data (e.g. spreadsheet sheet) with geographic boundaries (e.g. maps). QGIS (or Quantum GIS) is an open source geographic information system, meaning that it can be downloaded and installed on your desktop free of charge. It runs on Windows, Mac OS X, and Linux. If you have used ArcGIS before, QGIS is very similar, except it has less functionality but is free.
QGIS uses the OGR library to read and write vector data formats, including ESRI shapefiles, MapInfo and MicroStation file formats, AutoCAD DXF, PostGIS, SpatiaLite, Oracle Spatial and MSSQL Spatial databases, and many more. GRASS vector and PostgreSQL support is supplied by native QGIS data provider plugins. Vector data can also be loaded in read mode from zip and gzip archives into QGIS.

Raster data

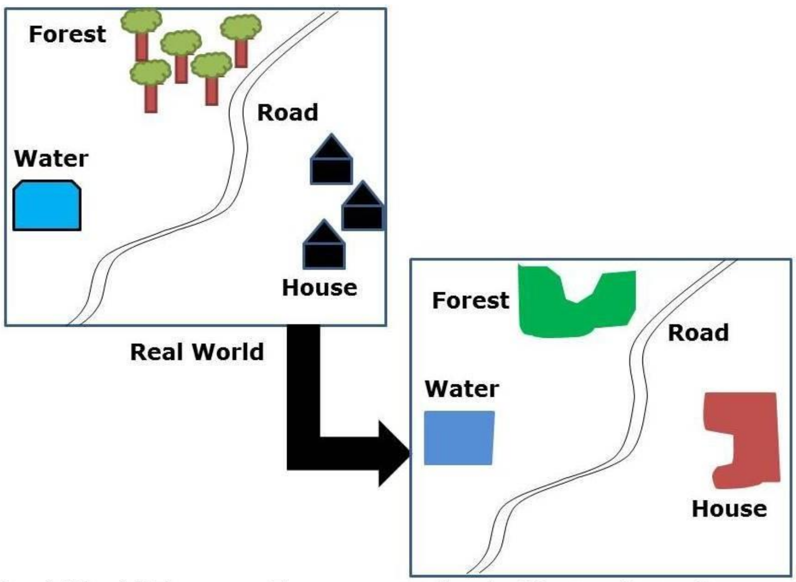


Real World Feature Representation in Raster Data Format

Raster data in GIS are matrices of discrete cells that represent features on, above or below the earth's surface. Each cell in the raster grid has the same size, and cells are usually rectangular (in QGIS they will always be rectangular). Typical raster datasets include remote sensing data, such as aerial photography, or satellite imagery and modelled data, such as an elevation matrix.

Unlike vector data, raster data typically do not have an associated database record for each cell. They are geocoded by pixel resolution and the X/Y coordinate of a corner pixel of the raster layer. This allows QGIS to position the data correctly in the map canvas.
The GeoPackage format is convenient for storing raster data when working with QGIS. The popular and powerful GeoTiff format is a good alternative.
QGIS makes use of georeference information inside the raster layer (e.g., GeoTiff) or an associated *world file* to properly display the data.

Vector Data



Real World Feature Representation in Vector Data Format

Many of the features available in QGIS work the same, regardless the vector data source. However, because of the differences in formats specifications (ESRI Shapefile, MapInfo and MicroStation file formats, AutoCAD DXF, PostGIS, SpatiaLite, DB2, Oracle Spatial and MSSQL Spatial databases, and many more), QGIS may handle differently some of their properties. This section describes how to work with these specificities.

Vector representation of data

In the vector based model (figure 4), geospatial data is represented in the form of co-ordinates. In vector data, the basic units of spatial information are points, lines (arcs) and polygons. Each of these units is composed simply as a series of one or more co-ordinate points, for example, a line is a collection of related points, and a polygon is a collection of related lines.

co-ordinate

Pairs of numbers expressing horizontal distances along orthogonal axes, or triplets of numbers measuring horizontal and vertical distances, or n-numbers along n-axes expressing a precise location in n-dimensional space. Co-ordinates generally represent locations on the earth's surface relative to other locations.

point
A zero-dimensional abstraction of an object represented by a single X,Y co-ordinate. A point normally represents a geographic feature too small to be displayed as a line or area; for example, the location of a building location on a small-scale map, or the location of a service cover on a medium scale map.

line
A set of ordered co-ordinates that represent the shape of geographic features too narrow to be displayed as an area at the given scale (contours, street centrelines, or streams), or linear features with no area (county boundary lines). A lines is synonymous with an arc.

arc
An ARC/INFO term that is used synonymously with line.

polygon
A feature used to represent areas. A polygon is defined by the lines that make up its boundary and a point inside its boundary for identification. Polygons have attributes that describe the geographic feature they represent.

GeoPackage

The GeoPackage (GPKG) format is platform-independent, and is implemented as a SQLite database container, and can be used to store both vector and raster data. The format was defined by the Open Geospatial Consortium (OGC), and was published in 2014.
GeoPackage can be used to store the following in a SQLite database:

- **vector** features
- **tile matrix sets of imagery** and **raster** maps
- attributes (non-spatial data)
- extensions

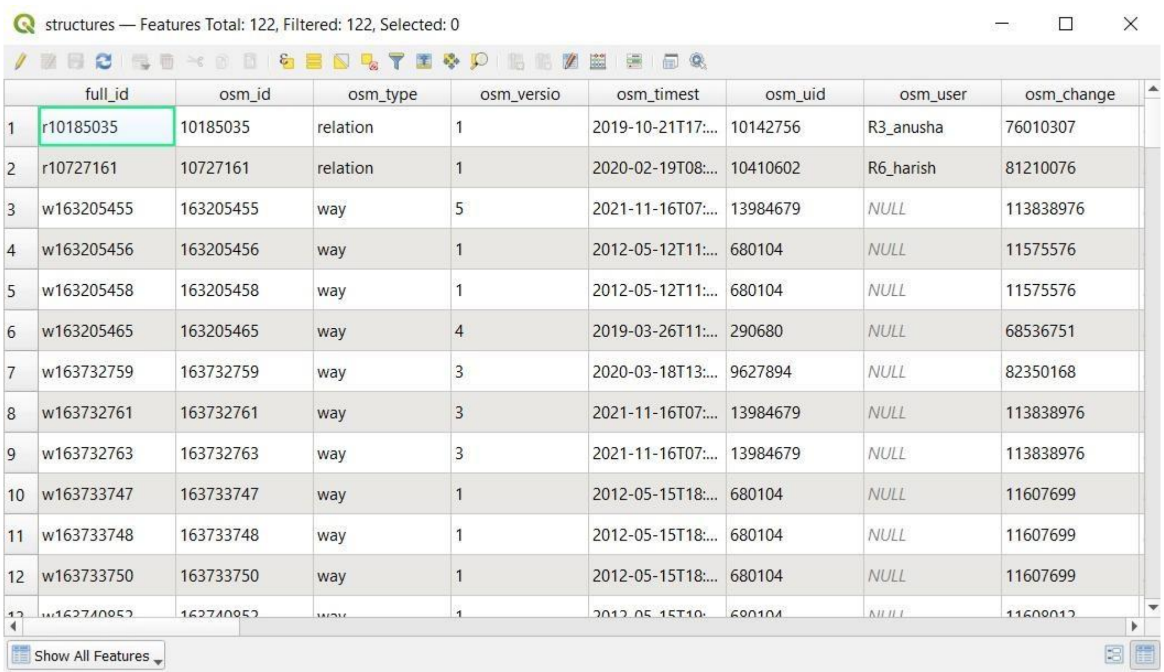
Features

QGIS offers many common GIS functionalities provided by core features and plugins. A short summary of six general categories of features and plugins is presented below, followed by first insights into the integrated Python console.

View data

You can view and overlay vector and raster data in different formats and projections without conversion to an internal or common format. Supported formats include:

- Spatially-enabled tables and views using PostGIS, SpatiaLite and MS SQL Spatial, Oracle Spatial, vector formats supported by the installed OGR library, including ESRI shapefiles, MapInfo, SDTS, GML and many more. See section *Working with Vector Data*.
- Raster and imagery formats supported by the installed GDAL (Geospatial Data Abstraction Library) library, such as GeoTIFF, ERDAS IMG, ArcInfo ASCII GRID, JPEG, PNG and many more. See section *Working with Raster Data*.
- GRASS raster and vector data from GRASS databases (location/mapset). See section *GRASS GIS Integration*.
- Online spatial data served as OGC Web Services, including WMS, WMTS, WCS, WFS, and WFS-T. See section *Working with OGC Data*.


structures — Features Total: 122, Filtered: 122, Selected: 0

	full_id	osm_id	osm_type	osm_versio	osm_timest	osm_uid	osm_user	osm_change
1	r10185035	10185035	relation	1	2019-10-21T17:...	10142756	R3_anusha	76010307
2	r10727161	10727161	relation	1	2020-02-19T08:...	10410602	R6_harish	81210076
3	w163205455	163205455	way	5	2021-11-16T07:...	13984679	NULL	113838976
4	w163205456	163205456	way	1	2012-05-12T11:...	680104	NULL	11575576
5	w163205458	163205458	way	1	2012-05-12T11:...	680104	NULL	11575576
6	w163205465	163205465	way	4	2019-03-26T11:...	290680	NULL	68536751
7	w163732759	163732759	way	3	2020-03-18T13:...	9627894	NULL	82350168
8	w163732761	163732761	way	3	2021-11-16T07:...	13984679	NULL	113838976
9	w163732763	163732763	way	3	2021-11-16T07:...	13984679	NULL	113838976
10	w163733747	163733747	way	1	2012-05-15T18:...	680104	NULL	11607699
11	w163733748	163733748	way	1	2012-05-15T18:...	680104	NULL	11607699
12	w163733750	163733750	way	1	2012-05-15T18:...	680104	NULL	11607699

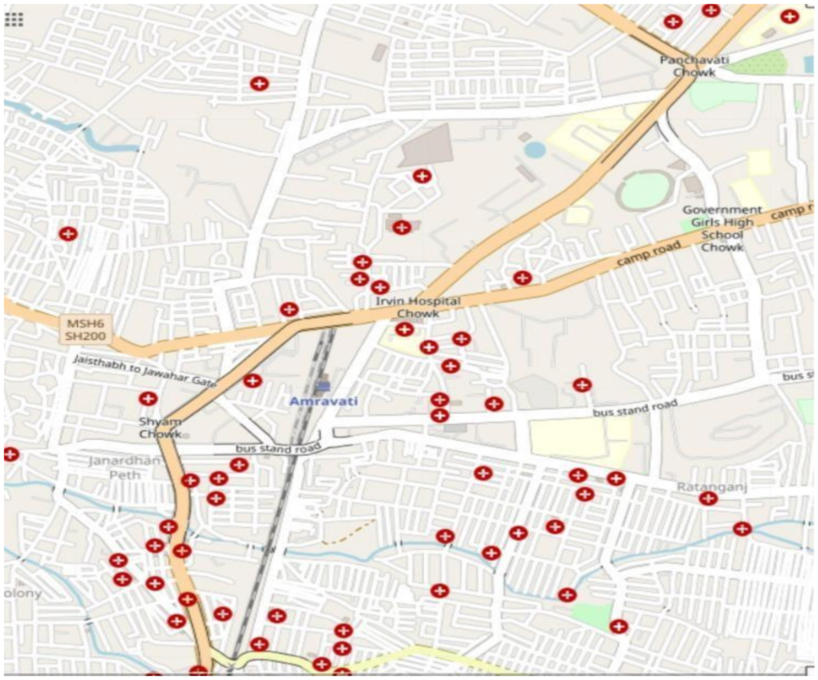
Show All Features

Explore data and compose maps

You can compose maps and interactively explore spatial data with a friendly GUI. The many helpful tools available in the GUI include:

- QGIS browser
- On-the-fly reprojection
- DB Manager
- Map composer
- Overview panel
- Spatial bookmarks
- Annotation tools
- Identify/select features
- Edit/view/search attributes

- Data-defined feature labeling
- Data-defined vector and raster symbology tools
- Atlas map composition with graticule layers
- North arrow scale bar and copyright label for maps
- Support for saving and restoring projects



Create, edit, manage and export data

You can create, edit, manage and export vector and raster layers in several formats. QGIS offers the following:

- Digitizing tools for OGR-supported formats and GRASS vector layers
- Ability to create and edit shapefiles and GRASS vector layers
- Georeferencer plugin to geocode images
- GPS tools to import and export GPX format, and convert other GPS formats to GPX or down/upload directly to a GPS unit (On Linux, usb: has been added to list of GPS devices.)
- Support for visualizing and editing OpenStreetMap data
- Ability to create spatial database tables from shapefiles with DB Manager plugin
- Improved handling of spatial database tables
- Tools for managing vector attribute tables
- Option to save screenshots as georeferenced images
- DXF-Export tool with enhanced capabilities to export styles and plugins to perform CAD-like functions

Analyse data

You can perform spatial data analysis on spatial databases and other OGR- supported formats. QGIS currently offers vector analysis, sampling, geoprocessing, geometry and database management tools. You can also use the integrated GRASS tools, which include the complete GRASS functionality of more than 400 modules. (See section *GRASS GIS Integration*.) Or, you can work with the Processing Plugin, which provides a powerful geospatial analysis framework to call native and third-party algorithms from QGIS, such as GDAL, SAGA, GRASS, fTools and more. (See section *Introduction*.)

Publish maps on the Internet

QGIS can be used as a WMS, WMTS, WMS-C or WFS and WFS-T client, and as a WMS, WCS or WFS server. (See section *Working with OGC Data*.) Additionally, you can publish your data on the Internet using a webserver with UMN MapServer or GeoServer installed.

Extend QGIS functionality through plugins

QGIS can be adapted to your special needs with the extensible plugin architecture and libraries that can be used to create plugins. You can even create new applications with C++ or Python!

Core Plugins

Core plugins include:

1. Coordinate Capture (Capture mouse coordinates in different CRSs)
2. DB Manager (Exchange, edit and view layers and tables; execute SQL queries)
3. Dxf2Shp Converter (Convert DXF files to shapefiles)
4. eVIS (Visualize events)
5. fTools (Analyze and manage vector data)
6. GDALTools (Integrate GDAL Tools into QGIS)
7. Georeferencer GDAL (Add projection information to rasters using GDAL)
8. GPS Tools (Load and import GPS data)
9. GRASS (Integrate GRASS GIS)
10. Heatmap (Generate raster heatmaps from point data)
11. Interpolation Plugin (Interpolate based on vertices of a vector layer)
12. Metasearch Catalogue Client
13. Offline Editing (Allow offline editing and synchronizing with databases)
14. Oracle Spatial GeoRaster
15. Processing (formerly SEXTANTE)
16. Raster Terrain Analysis (Analyze raster-based terrain)
17. Road Graph Plugin (Analyze a shortest-path network)
18. Spatial Query Plugin
19. SPIT (Import shapefiles to PostgreSQL/PostGIS)

20. Topology Checker (Find topological errors in vector layers)
21. Zonal Statistics Plugin (Calculate count, sum, and mean of a raster for each polygon of a vector layer)

External Python Plugins

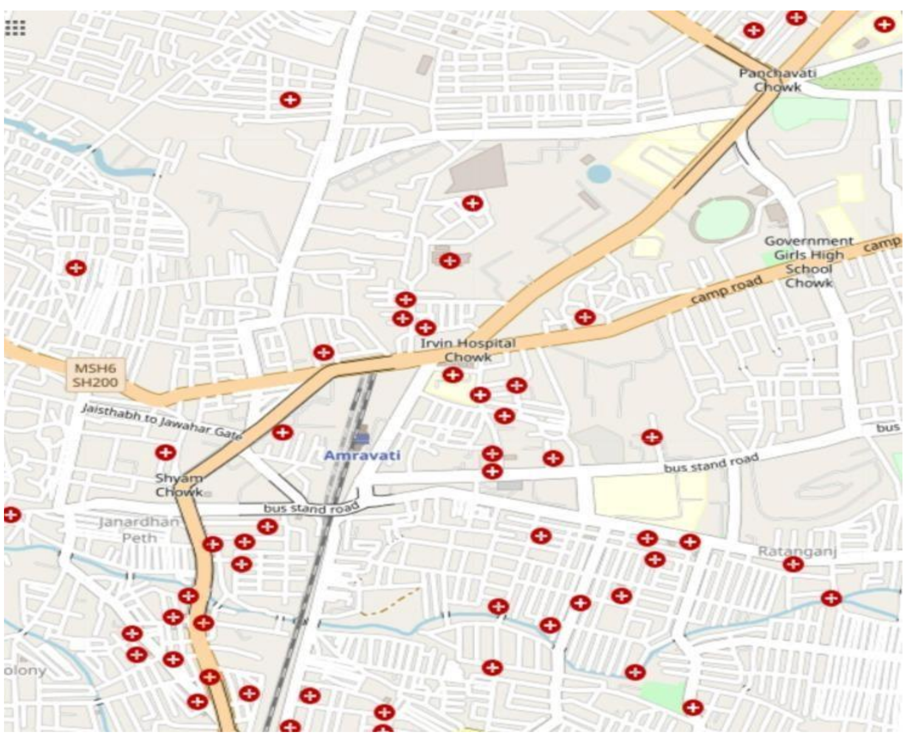
QGIS offers a growing number of external Python plugins that are provided by the community. These plugins reside in the official Plugins Repository and can be easily installed using the Python Plugin Installer. See Section *The Plugins Dialog*.

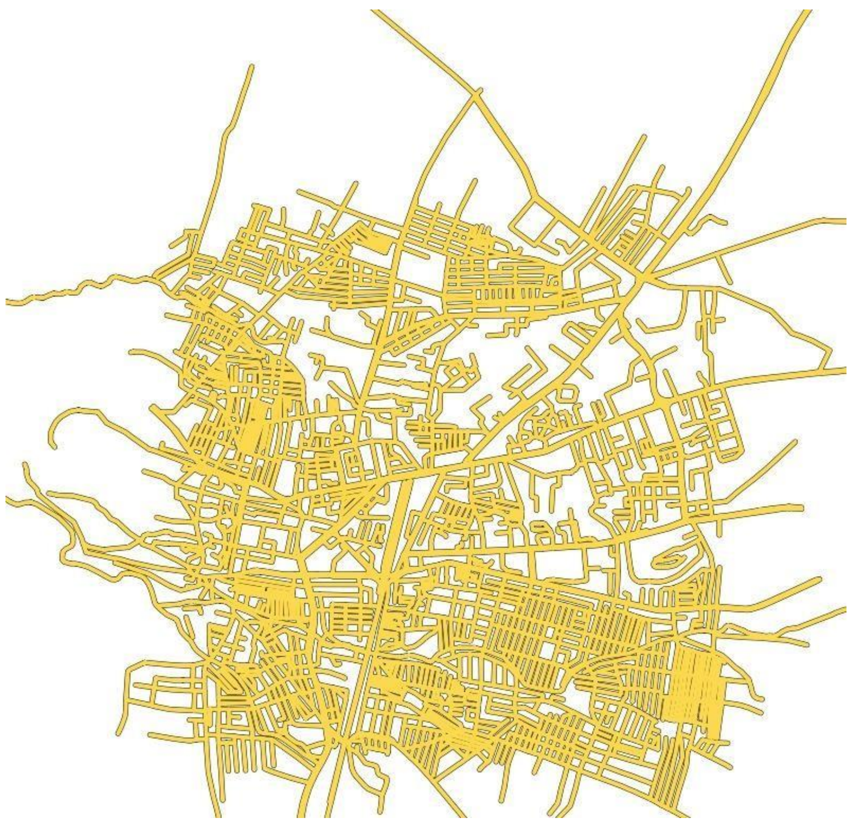
Python Console

For scripting, it is possible to take advantage of an integrated Python console, which can be opened from menu:
Plugins ‣ *Python Console*. The console opens as a non-modal utility window. For interaction with the QGIS environment, there is the `qgis.utils.iface` variable, which is an instance of `QgsInterface`. This interface allows access to the map canvas, menus, toolbars and other parts of the QGIS application. You can create a script, then drag and drop it into the QGIS window and it will be executed automatically.

Output:

Following are the features extracted from various data format as learn above:





CONCLUSION: Thus I have studied and implemented the various data formats to QGIS to build map and features

Practical no. 6

Aim: Working with basics of Spatial data analysis.

Theory:

Spatial Analysis:

- In the context of **spatial analysis**, the *analysis* focuses on the *statistical analysis* of patterns.
- Spatial analysis allows determining if the selected area is suitable for particular business activities, detecting changes, identifying tendencies, assessing risks, outlining possible outcomes, and preventing losses.
- Up-to-date tools and spatial analysis techniques provide more accurate analytics than decades ago.
- Examples of spatial analysis include measuring distances and shapes, setting routes and tracking transportations, establishing correlations between objects, events, and places via referring their locations to geographical positions (both live and historical).
- Through spatial analysis you can interact with a GIS to answer questions, support decisions, and reveal patterns. Spatial analysis is in many ways the crux of a GIS, because it includes all of the transformations, manipulations, and methods that can be applied to geographic data to turn them into useful information.
- While methods of spatial analysis can be very sophisticated, they can also be very simple. The approach will take is to regard spatial analysis as spread out along a continuum of sophistication, ranging from the simplest types that occur very quickly and intuitively when the eye and brain look at a map, to the types that require complex software and advanced mathematical knowledge. There are many ways of defining spatial analysis, but all in one way or another express the fundamental idea that information on locations is essential.

- Basically, think of spatial analysis as "a set of methods whose results change when the locations of the objects being analyzed change." For example, calculating the average income for a group of people is not spatial analysis because the result doesn't depend on the locations of the people. Calculating the center of the United States population, however, is spatial analysis because the result depends directly on the locations of residents.

Types of Spatial Analysis:

Types of spatial analysis vary from simple to sophisticated. In this course, spatial analysis will be divided into six categories: queries and reasoning, measurements, transformations, descriptive summaries, optimization, and hypothesis testing.

- **Queries and reasoning** are the most basic of analysis operations, in which the GIS is used to answer simple questions posed by the user. No changes occur in the database and no new data are produced.
- **Measurements** are simple numerical values that describe aspects of geographic data. They include measurement of simple properties of objects, such as length, area, or shape, and of the relationships between pairs of objects, such as distance or direction.
- **Transformations** are simple methods of spatial analysis that change data sets by combining them or comparing them to obtain new data sets and eventually new insights. Transformations use simple geometric, arithmetic, or logical rules, and they include operations that convert raster data to vector data or vice versa. They may also create fields from collections of objects or detect collections of objects in fields.
- **Descriptive summaries** attempt to capture the essence of a data set in one or two numbers. They are the spatial equivalent of the descriptive statistics commonly used in statistical analysis, including the mean and standard deviation.
- **Optimization techniques** are normative in nature, designed to select ideal locations for objects given certain well-defined criteria. They are widely used in market research, in the package delivery industry, and in a host of other applications.
- **Hypothesis testing** focuses on the process of reasoning from the results of a limited sample to make generalizations about an entire population. It allows us, for example, to determine whether a pattern of points could have arisen by chance based on the information from a

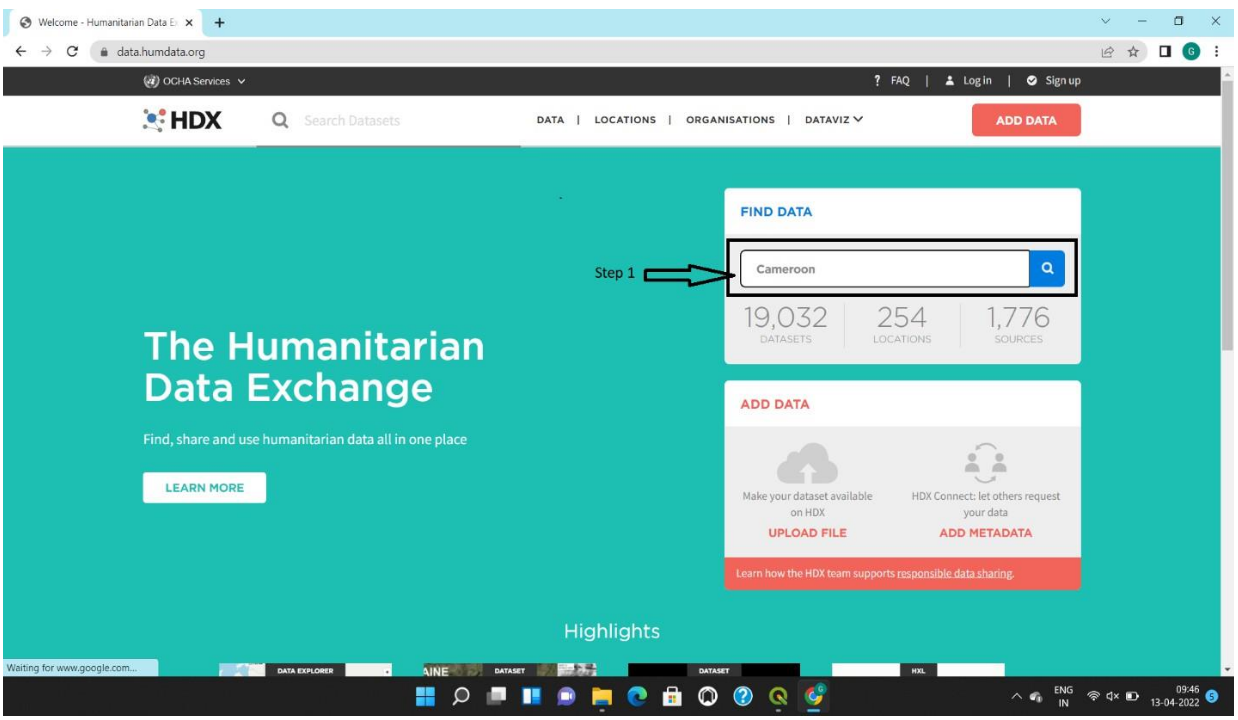
sample. Hypothesis testing is the basis of inferential statistics and forms the core of statistical analysis, but its use with spatial data can be problematic.

Spatial analysis stages:

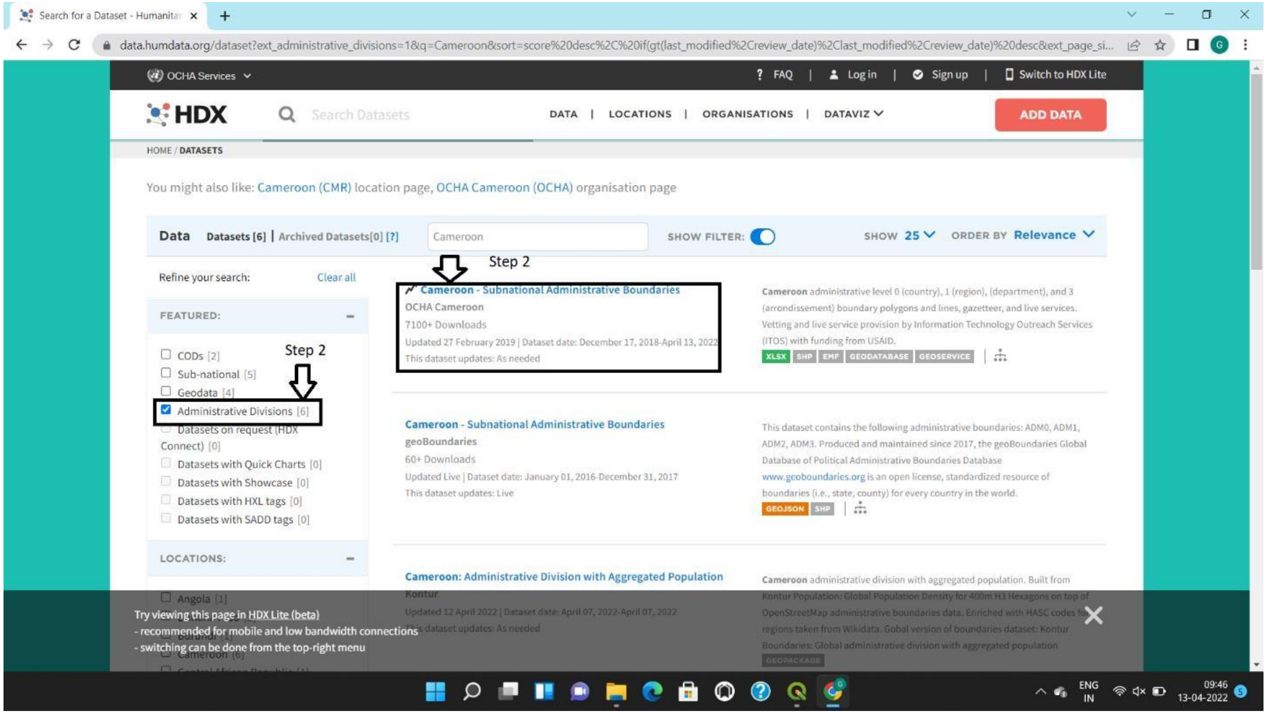
- understanding your goal
- Preparing data
- Choosing suitable tools and technique
- Performing the research
- And estimating results.

Example: Representation of COVID-19 data for Cameroon on the map of Cameroon.

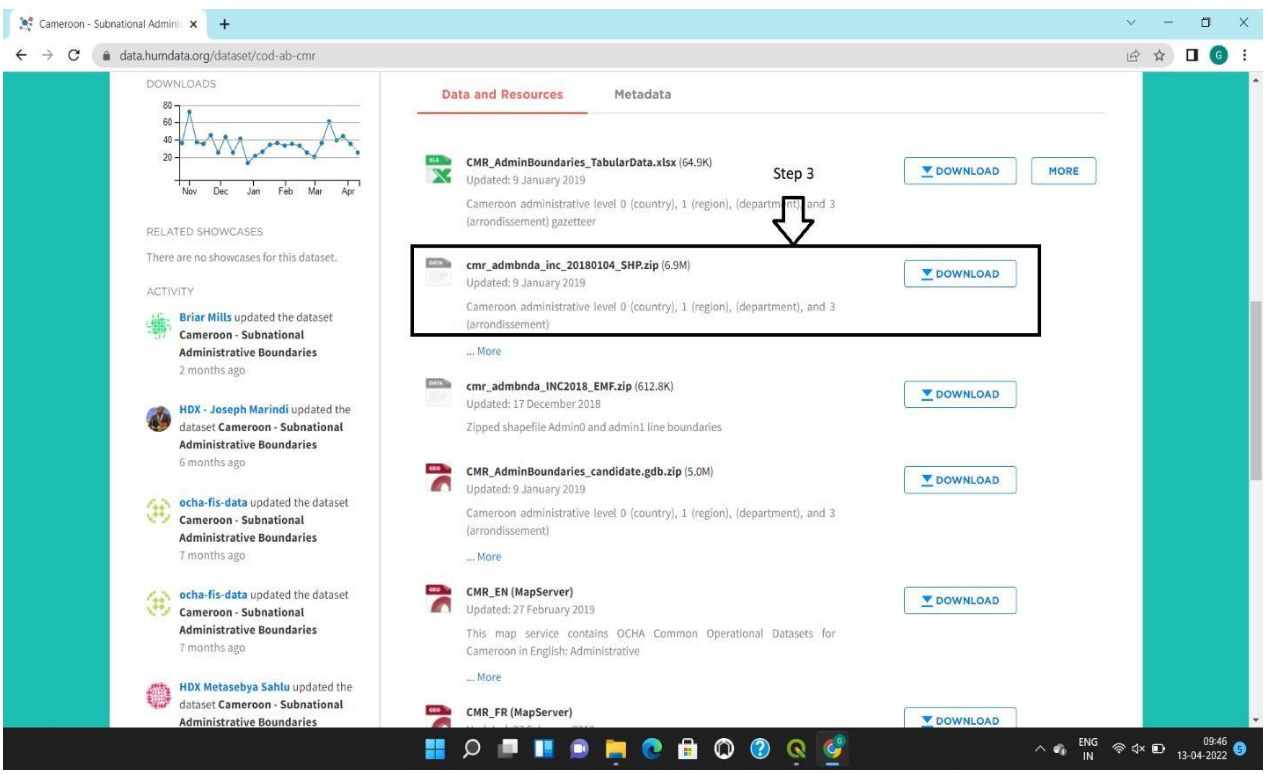
Step 1: Download the shape files of COVID-19 data for Cameroon from https://data.humdata.org/



Step 2: Check checkbox i.e, Administrative divisions from featured section and click on "Cameroon - Subnational Administrative Boundaries".

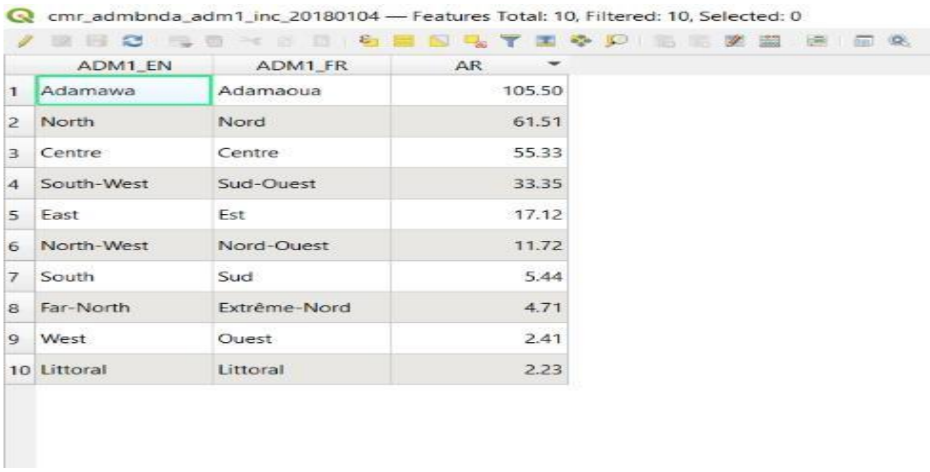


Step 3: Click on download button.



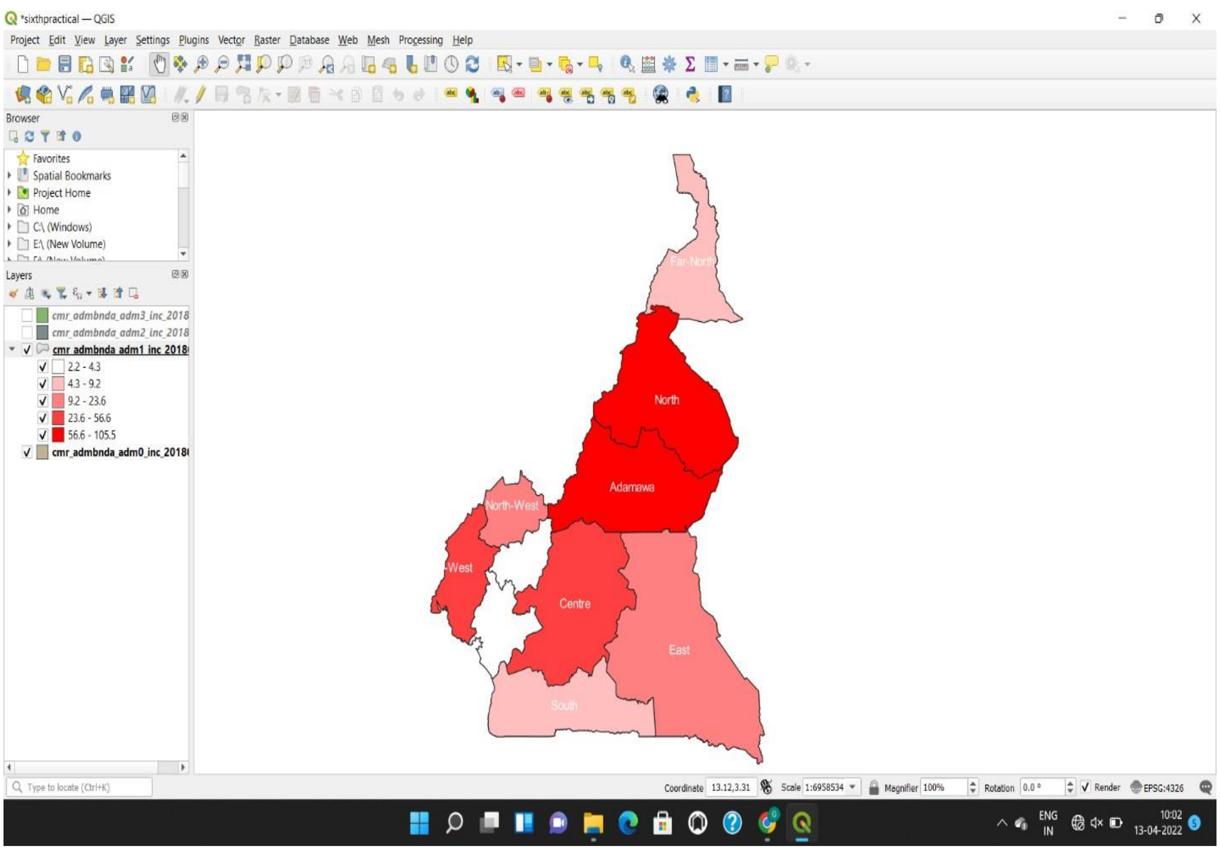
Step 4: Create new project in QGIS and drag these downloaded shape files into the project.

Step 5: Classify the Cameroon country data on the basis of COVID-19 attack rate.


cmr_admbnda_adm1_inc_20180104 — Features Total: 10, Filtered: 10, Selected: 0

	ADM1_EN	ADM1_FR	AR
1	Adamawa	Adamaoua	105.50
2	North	Nord	61.51
3	Centre	Centre	55.33
4	South-West	Sud-Ouest	33.35
5	East	Est	17.12
6	North-West	Nord-Ouest	11.72
7	South	Sud	5.44
8	Far-North	Extrême-Nord	4.71
9	West	Ouest	2.41
10	Littoral	Littoral	2.23

Step 6: Different countries get classify into the groups on the basis of "Attack rate".



Conclusion:

In this practical, I have successfully implemented spatial data analysis for representing COVID-19 attack rate in Cameroon.

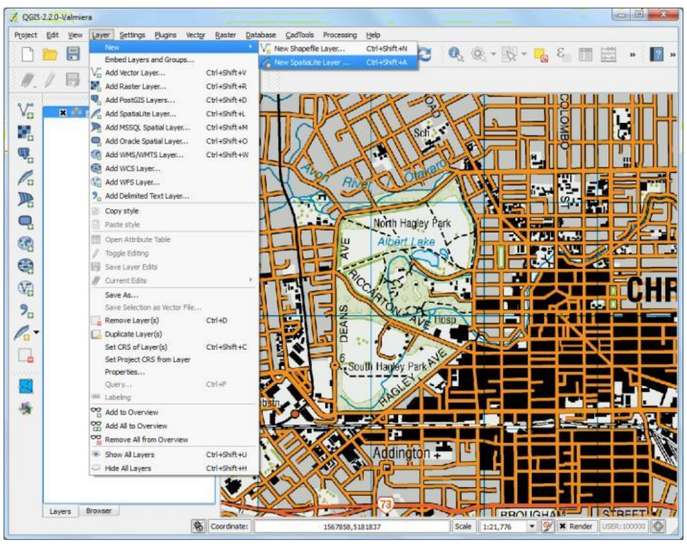
Practical No: 07

Aim: Working with multiple layer of digital maps and complex query analysis.

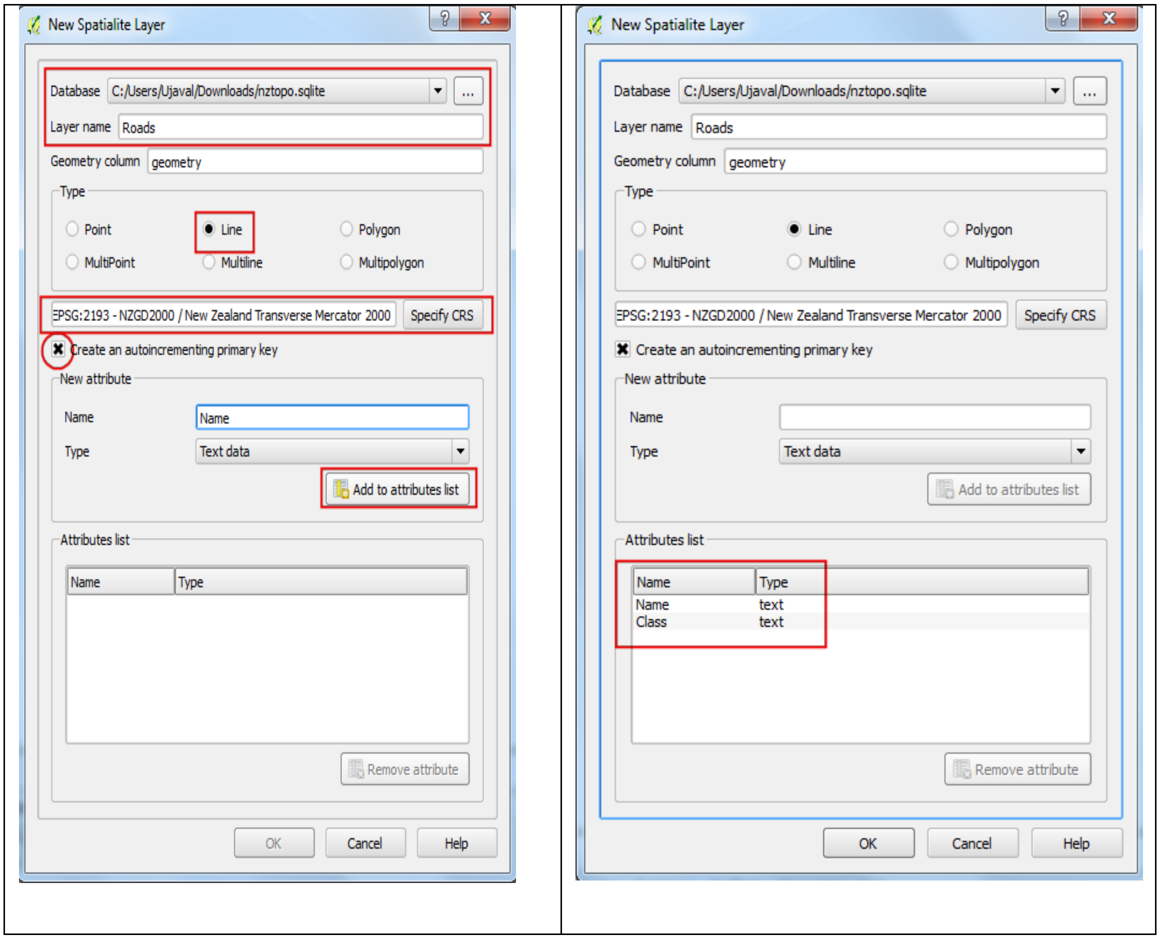
Theory:

Steps for creating multiple layers of digital maps:

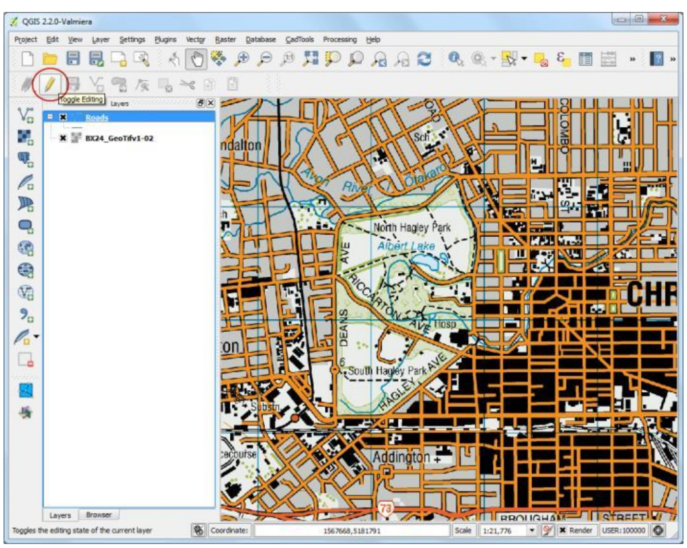
1. Go to Layer ‣ Add Raster Layer. Locate the .tif file and click Open.
2. Select Layer ‣ New ‣ New Spatialite
   Spatialite is an open database format similar to ESRI's geodatabase format. Spatialite database is contained within a single file on your hard drive and can contain diferent types of spatial (point, line, polygon) as well as non-spatial layers.



3. When creating a GIS layer, you must decide on the attributes that each feature will have. Since this is a roads layer, we will have 2 basic attributes - Name and Class. Enter Name as the Name of the attribute in the New attribute section and click Add to attribute list.

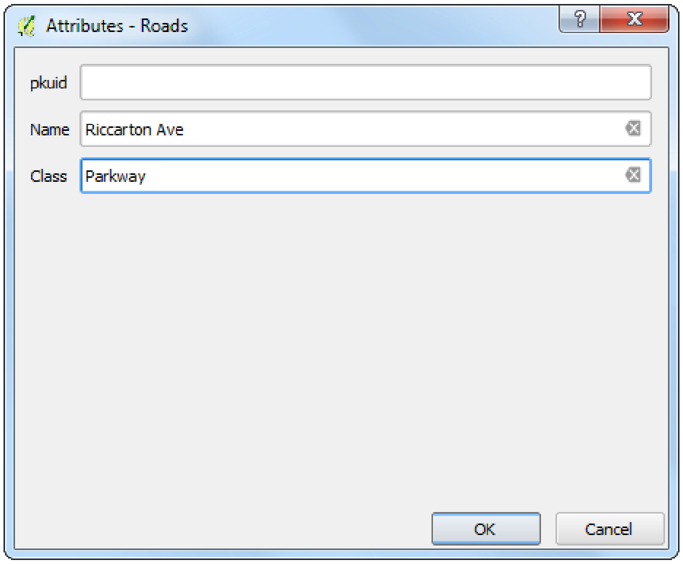


4. Similarly create a new attribute Class of the type Text data. Click OK.
5. Once the layer is loaded, click the Toggle Editing button to put the layer in editing mode.

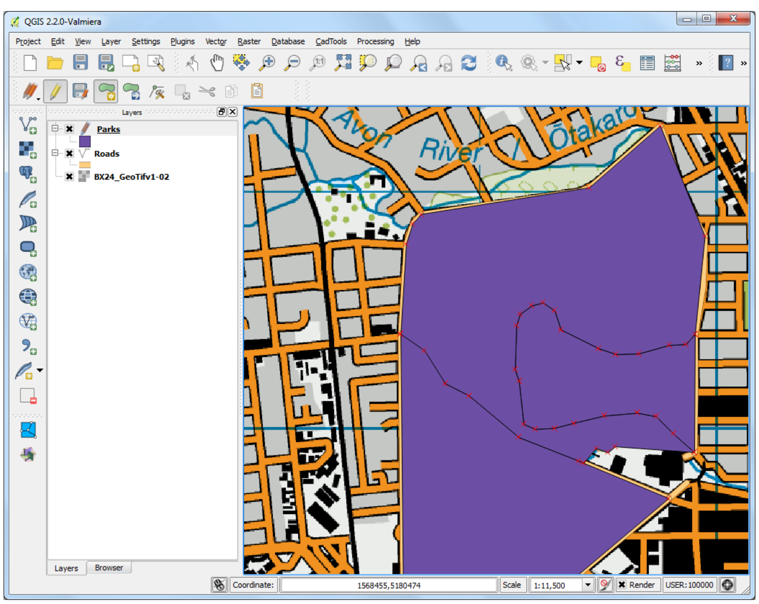


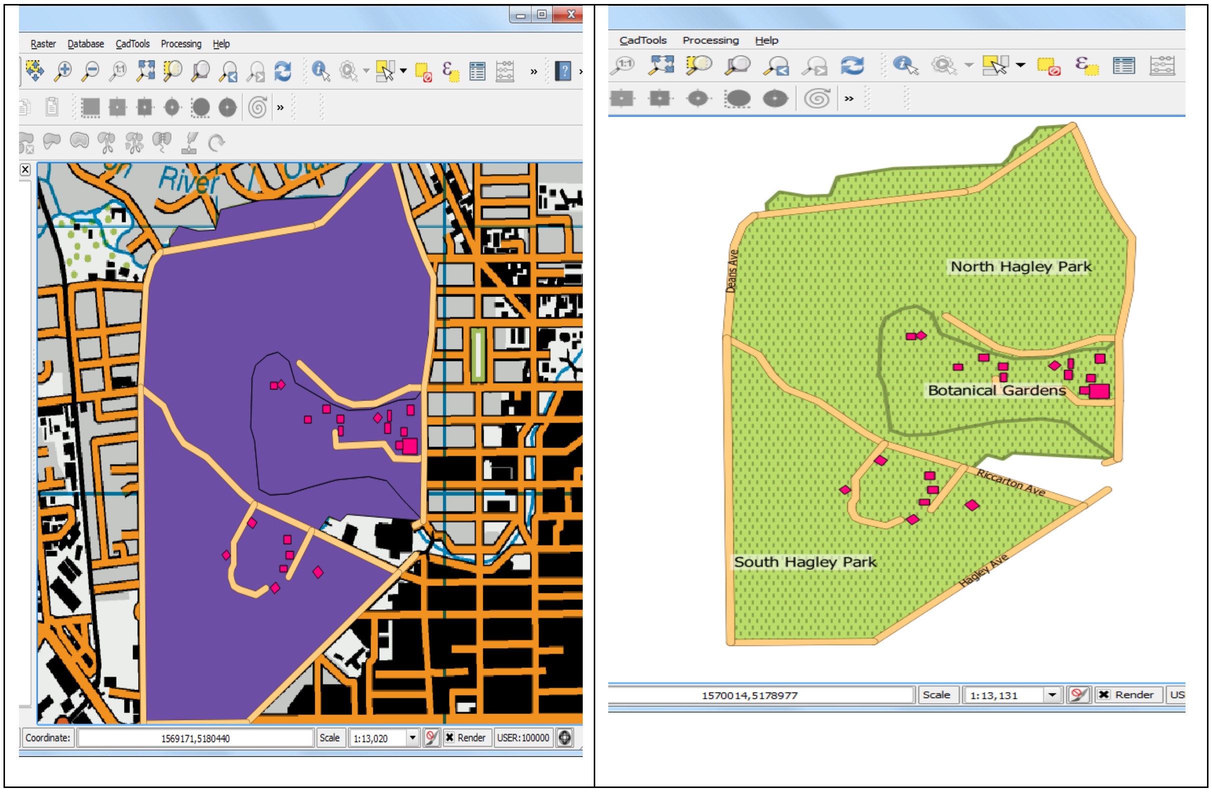
6. Click the Add feature button. Click on the map canvas to add a new vertex. Add new vertices along the road feature. Once you have digitized a road segment, right-click to end the feature

7. After you right-click to end the feature, you will get a pop-up dialog called Attributes. Here you can enter attributes of the newly created feature. Since the **pkuid** is an auto-incrementing field, you will not be able to enter a value manually. Leave it blank and enter the road name as it appears on the topo map. Optionally, assign a Road Class value as well. Click OK.



8. The default style of the new line layer is a thin line. Let's change it so we can better see the digitized features on the canvas. Right click the Roads layer and select Properties.
9. Select the Style tab in the Layer Properties dialog. Choose a thicker line style such as Primary from the predefined styles. Click OK.
10. Now you will see the digitized road feature clearly. Click Save Layer Edits to commit the new feature to disk.





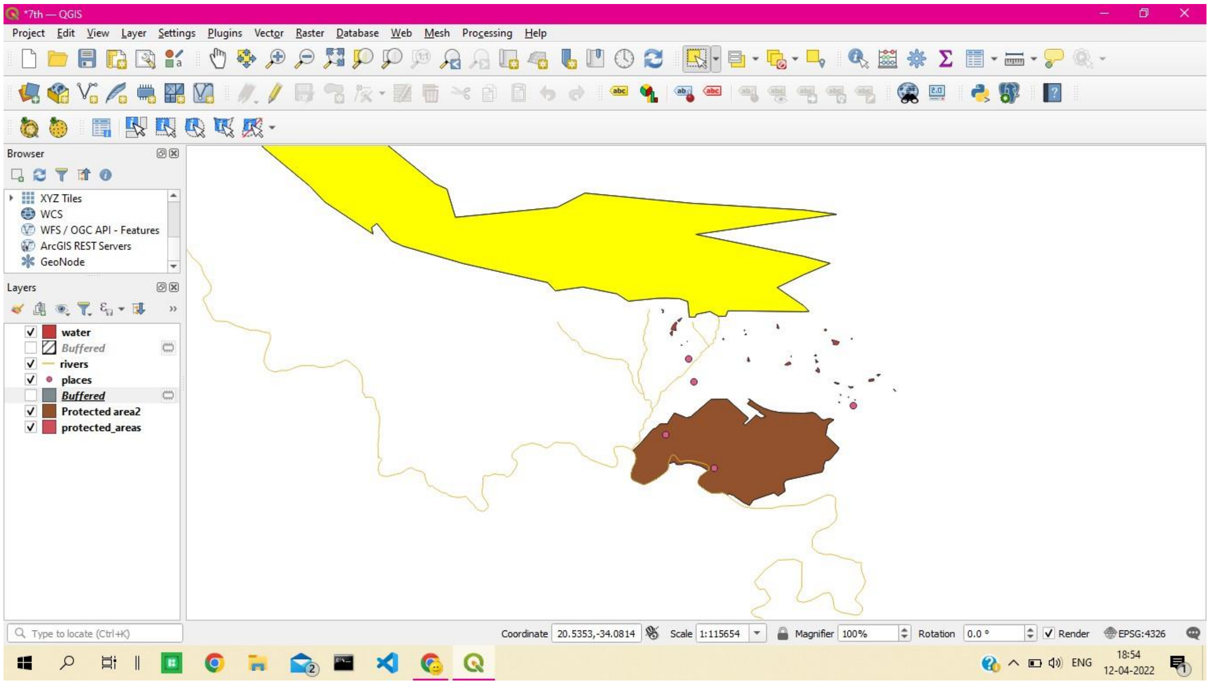
Steps for complex query analysis:

Procedure

1. Once you have downloaded the data, open QGIS. Go to Layer ‣ Add Vector Layer.

2. Click Browse and navigate to the folder where you downloaded the zip files.

3. You will be asked to choose a layer Select .shp files and click OK. Repeat the same for other one. You will see both the shapefiles now loaded in QGIS



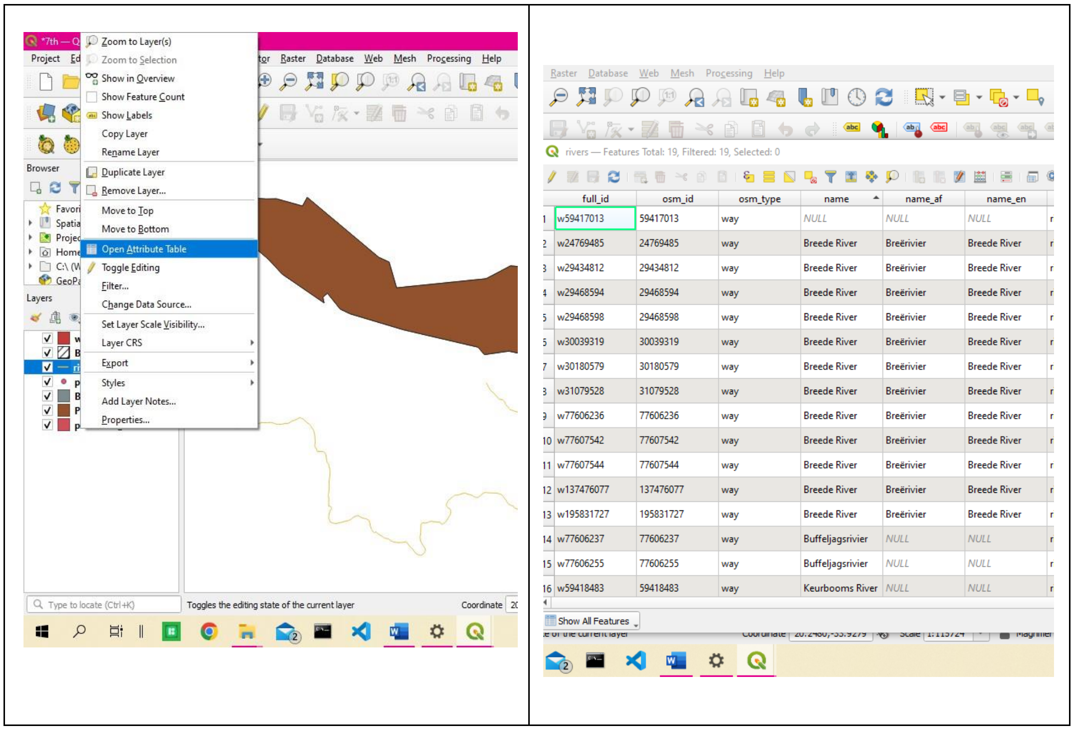
4. We will be created buffers around the point and line layers. The *Buffer* geoprocessing tool in QGIS uses *layer units* to calculate buffer distances. The layers we have are in *Geographic Coordinate Reference System (CRS)* with the unit of *degrees*. To achive this, we must re-project our layers to a *Projected Coordinate Reference System (CRS)*. Right-click on the one of the simple layer and choose Save As -> file location name as reprojected.shp->click on browse next to CRS. Repeat the same for next file.

5. Now you will have 4 layers in your Layers Panel. Un-check the boxes next to the original layers to display only the re-projected layers.

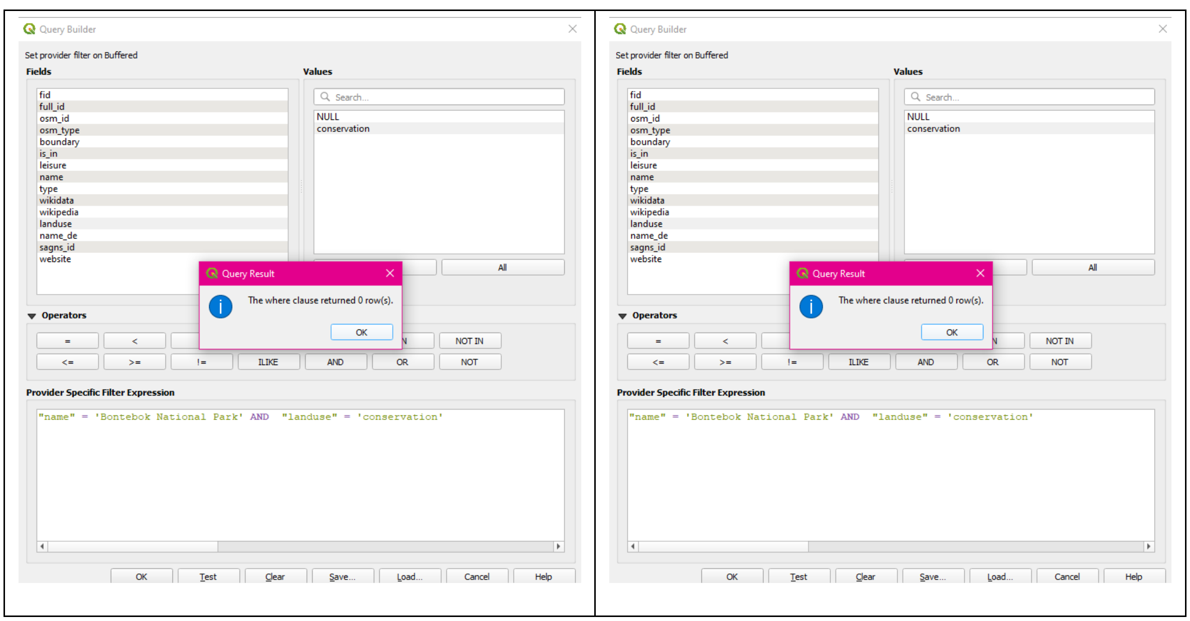
6. Now you will see the data in the layer's CRS. We will now create buffers for both the datasets. Click Vector ‣ Geoprocessing Tools ‣ Buffer.

7. The rivers_lake_buffer contains features that are both rivers as well as lakes. Our analysis calls for using only river features, so we will run a query to select only river features. Right-click on the rivers_lake_buffer layer and select Open Attribute Table.

8. You will see that the *name* attribute contains the information we can use to select the river features. Click on *Select features using an expression* button.



9. Now we are ready to perform the spatial query. You need to enable the *Spatial Query plugin* to use this functionality. See Using Plugins for more details. Once enabled, go to Vector ‣ Spatial Query ‣ Spatial Query. Enter the expression *"Name"* = *"River"* and click Select and then click Close to back to the main QGIS window.



CONCLUSION: Thus I have studied and works with multiple layer of digital maps and complex query analysis.

Practical 8

Aim : Developing web pages for webGIS.

Theory :

Esri Maps for Office

Esri Maps for Office provides mapping capabilities in Microsoft Office through a Microsoft Add-in. You can use this add-in with Microsoft Excel to mash up your services from ArcGIS Server and create web maps that show data from your spreadsheets in ArcGIS Online or Portal for ArcGIS. Additionally, an add-in for PowerPoint allows you to embed these web maps into your presentations.

You can download Esri Maps for Office from the Esri website.

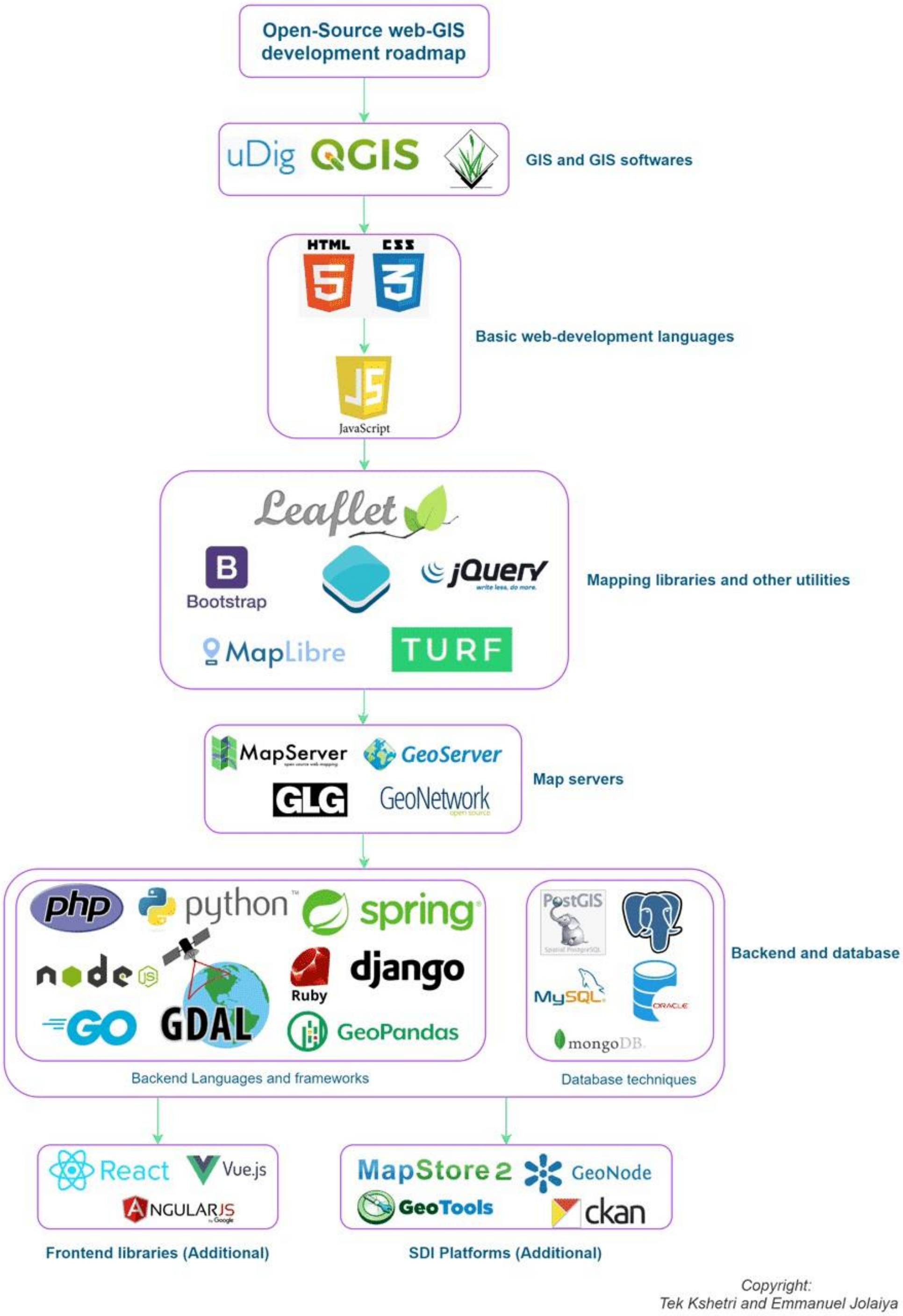
Esri Maps for SharePoint

Esri Maps for SharePoint provides mapping capabilities in Microsoft SharePoint through a map Web Part for SharePoint pages. You can use this to display services from ArcGIS Server in your SharePoint pages. It also includes workflows that allow you to spatially-enable and Geoenrich SharePoint lists or external data through Business Connectivity Services (BCS).

You can download Esri Maps for SharePoint from the Esri website.

Web GIS Learning Guide

Below is a flowchart that summarizes the whole learning guide to become a Web GIS developer.



1. Start with GIS and a GIS Software

Web-GIS can be considered as a variant of GIS, therefore it is expedient to have a solid understanding of what GIS itself entails. Knowledge of a GIS software is also highly recommended because sometimes, these software helps in making our development work easier and faster, they can also act as a testing environment.

The underlying concepts of most of these software are the same, therefore it's important not to shy away from the fundamentals of GIS. It's as important as learning to code, because this knowledge would help you in decision making , doing what is right and following best practices.

Recommendation: Learn GIS and play with QGIS for about a month.
Resources:

- **QGIS Tutorial**
- **GIS Introduction**
- **Book: GIS Fundamentals**

2. Then Pickup HTML and CSS

HTML is a markup language for documents designed to be displayed in a web browser. HTML is used to create pages and make them functional. The CSS is the style sheet language used to create the visual appearance of HTML.

HTML and CSS are easy to understand, simple to edit, supported by all browsers. You can create pages with HTML and CSS (eg. login/sign up page, contact us page) and build small projects (eg. facebook login page, youtube clone etc) on it.

Recommendation: Learn the important concepts of HTML and CSS in a week or two.
Resources:
Here are some useful resources & projects for learning HTML and CSS:

- W3schools HTML
- W3schools CSS
- Create a contact form (youtube video)
- Create a navbar with flexbox (youtube video)
- Make facebook login page (youtube tutorial)

3. Learn JavaScript

JavaScript helps to add the interactivity to your HTML and CSS pages. It is mainly used for client-side purposes. Nowadays, people are using it in server-side (NodeJs), in games development (EaseJs), in mobile app development (React Native) as well.
But for the web-GIS developer roadmap, you just need to learn it's application on web development only. That means client-side and server-side only. JavaScript helps us to put logic in the rendering of the pages. Show or hide more information with the click of a button, Zooming in or zooming out on a map, displaying animation to the page etc are some use cases of the javascript.

Recommendation: Learn fundamentals of JavaScript for another 2 weeks or more.
Here are some useful resources & projects for learning JavaScript:

- W3schools JavaScript
- 17 JavaScript Projects for Beginner
- Learn JavaScript freeCodeCamp

4. Learn about mapping libraries and other required utilities

The most common thing required in a web-GIS portal is the data visualization interface. The data visualization interface can be built easily with the help of mapping libraries. Here are the lists of some most commonly used mapping libraries;

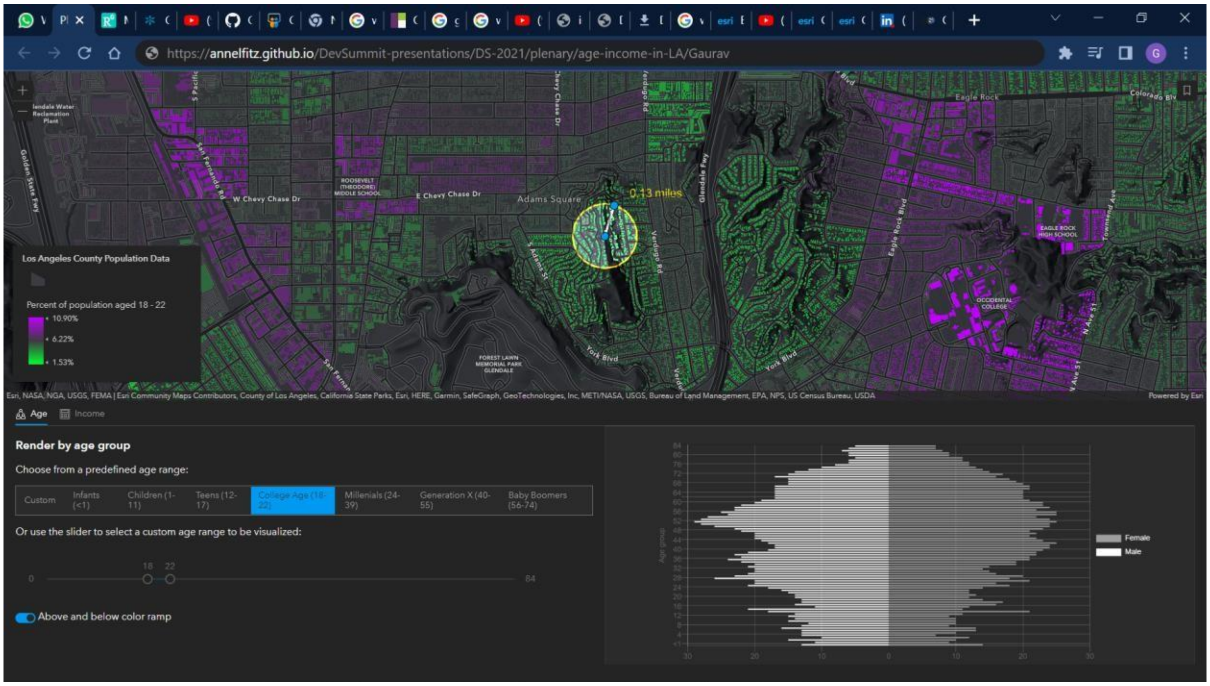
- LeafletJs**:** It is the open-source, lightweight javascript library
- OpenLayers: It is also an open-source javascript library (Related: OpenLayers: Geospatial JavaScript Library)
- Mapbox: It is an American provider of custom online maps for websites. It is not totally free. Check the mapbox pricing here.
- Google mapping API: It is the web mapping API provided by google. It is also not totally free. Check the google mapping api pricing here.
- Turf JS: Advanced geospatial analysis for browser and Node.js. etc

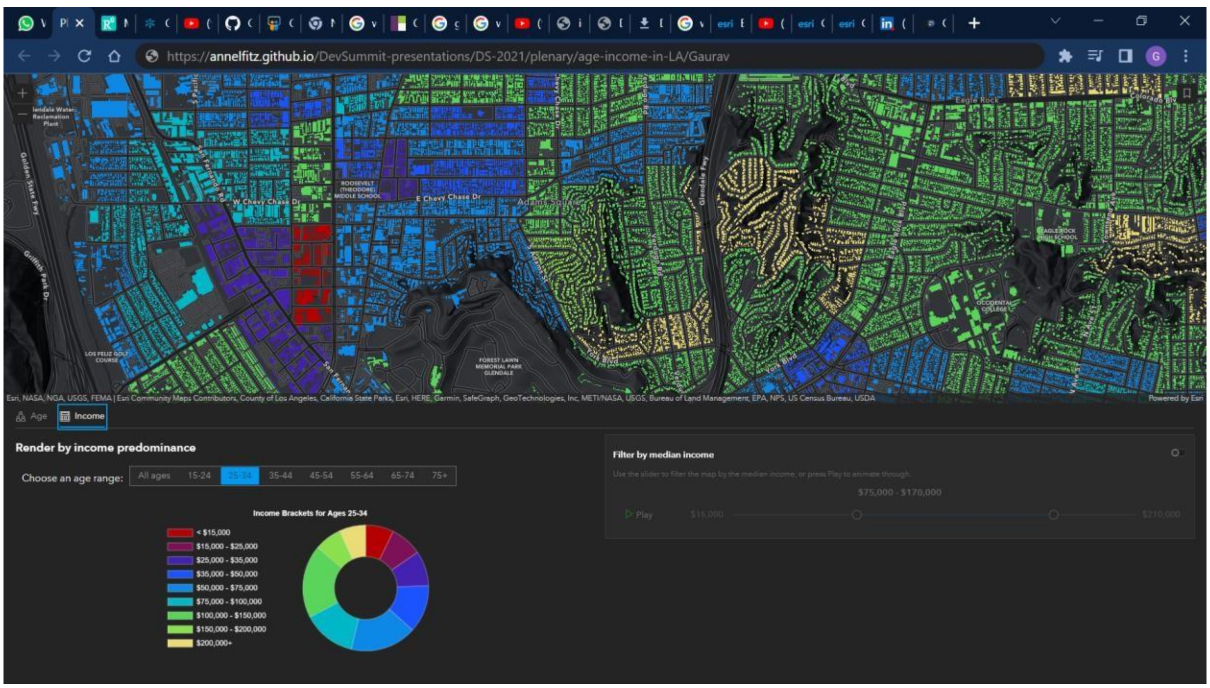
You can choose one of the above libraries for the visualization of the spatial data. You don't need to learn all the libraries listed above. We recommend you to learn leaflet or open-layers.

Also along with that you can learn some other utilities such as bootstrap, jquery, as well. These utilities are totally optional. You can also move forward after reading the mapping libraries only. But if you learn about these utilities then it will help to develop the interface rapidly and easily.
Recommendation: Learn about mapping libraries for another 3 weeks. Instead of learning the basics of all libraries, master one. If you consider learning other utilities as well, spend additional days on them.
Here are the some project ideas that can help you to improve your knowledge

- Visualization of administrative boundary dataset (district, region etc) into map
- Build web-GIS basic tools (eg. get coordinate, get current position, full screen view, custom zoom in/zoom out button etc)
- Create the simple portal for geospatial data visualization

Web Pages For Web GIS :





Conclusion :

Thus we understand concept of WebGis and its creation.

Practical 9

Aim : Working with scripting languages for dynamic webGIS contents

Theory :

Overview of Programming Languages for GIS

An essential element in designing many geospatial systems is the choice of what programming language (or languages) to use. Most of the exciting projects we can envision will involve at least some programming to customize existing tools or to develop completely new ones.

There is an astounding variety of programming languages that are useful for geospatial professionals today. Wikipedia lists over 600 languages(link is external), which excludes the byzantine variety of dialects of BASIC (link is external)past and present.
Characterizing Programming Languages

One important means of characterizing programming languages is according to their type systems, that is, the rules by which one can assign meaning to variables or objects. One fundamental divide is between static and dynamic typing. Statically typed languages such as C, C++, C#, and Java evaluate type information at compilation time, and reject code that is not well-formed. The advantage of this is that many errors can be caught at compilation time instead of run-time, and errors can be caught/fixed earlier in the process. The disadvantage of static typing is that it makes the code more verbose, and you can sometimes spend a lot of time "making the compiler happy." Dynamically typed languages such as Python, JavaScript, PHP, and Ruby delay type checking until run-time. Therefore, you often don't have to specify the type of a variable before you use it. The advantage of dynamic typing is in the ease of programming; the disadvantage is that some errors will slip through until you run the program, and these errors can then be difficult to pin down in your code.

Common Programming Languages used with GIS

There is a large number of programming languages in use today, and there is no “best” option, really. We focus here on those that are the most relevant to contemporary geospatial systems. The table below compiles several recent lists of languages from 2019 and 2018. The first 3 columns are based on surveys of use/users, and the basis of ordering for the last 3 columns was not explicit. Only one of the lists (from GoGeomatics), is specific to GIS, and that one represents the opinion of a single developer. The most important takeaways from this table are that: (1) there are many popular languages and diverse opinions on their relative merits, and (2) Python, Java, and JavaScript are in the top 5 on every list, with C++ and C# on 5 of 6 lists, PHP on 4 of 6, and C, R, Ruby, Rust, Shell, SQL, and TypeScript trailing the others with 2 lists each. For those interested in trends over time in programming language popularity, check out the 2002-present TIOBE Programming Community Index timeline(link is external).

Common Programming Languages in the Geospatial Industry

Rank	Business Insider - ranking based on GitHub	IEEE Survey of members (2018)	Stack Overflow Developer Survey (2019)	GoGeomatices: Top Languages in the GIS World	Full Stack Academy (9 best to learn)	Women Who Code
1	JavaScript	Python	JavaScript	Python	JavaScript	Python
2	Java	C++	HTML/CSS	JavaScript	Swift	Java
3	Python	Java	SQL	R	Java	JavaScript
4	PHP	C#	Python	SQL	C/C++	Rust
5	C++	R	Java	Java	Python	Kotlin
6	C#	PHP	Bash/Shell	C/C++	PHP	_
7	TypeScript	JavaScript	C#	C#	Ruby	_
8	Shell	Go	PHP	-	C#	-
9	C	Assembly	C++	-	Rust	-
10	Ruby	Matlab	TypeScript	-	-	-

Below, we provide a brief description of the programming languages that show up on two or more of the lists. The first group (in alphabetical order) are those showing up on 5 or more lists, thus the ones that are generally most popular across the range of developers. Then (also in alphabetical order) we outline key features of those showing up on fewer (but at least 2) lists. These descriptions are followed by a perspective on making application-specific choices of languages that are well suited to particular GIS (and other geospatial) development tasks.

If you see any languages you feel are relevant for GIS but are missing here, or you have good examples of an effective geospatial application that leverages any of the languages, please sing out by making a comment in the Canvas General Questions Discussion Forum!

Popular Programming Languages

1. **Python** — Python is very popular today, and is the primary scripting language in use in both ArcGIS and QGIS. Python is frequently considered to be a good "glue" language, and it is generally easy to work with. It has many extensions, such as SciPython and Numerical Python.

2. **JavaScript** — JavaScript is a current leader for User Interfaces in web applications. Google Maps is a heavy user of JavaScript, Esri's ArcGIS API for JavaScript supports web map development, and leading open source web map clients (OpenLayers, Mapbox GL JS) are also based on JavaScript. D3(link is external) is a very popular web visualization library that underpins quite a lot of interactive web maps you see today.

3. **C#** — C# was Microsoft's answer to Java (see below), and is the flagship programming language for .NET. So, if you were starting to write a new add-on to ArcGIS using the .NET SDK(link is external), you'd be working in C#.

4. **C++** — C++ is a general-purpose programming language (derived from C), with both procedural and object-oriented features, that is often used in embedded systems. Developed in 1985, its popularity has been in general decline since about 2004 (probably due to a steep learning curve and general complexity), but it has held on to a significant share of projects all the same. Many software applications you use every day were written in C++ or use C++ for at least part of the implementation (ArcGIS, Windows OS, Firefox, MS Office, etc., etc.), so it isn't going away anytime soon.

5. **Java** — Java remains a popular choice, although its popularity is declining by most measures year-over-year. Java is used in the GeoServer(link is external) and Java Topology Suite (JTS(link is external)) projects, for example.

Other Important Programming Languages

1. **C** — C is the elder of the family. When you need top performance, you use C, as it is "close to the metal." This is great if you need to code a device driver, but not so great if you need to create a web app. Many open source GIS projects are written in C. For example, the GDAL(link is external) (Geospatial Data Abstraction Library) is written in a combination of C and C++.

2. **PHP** — PHP is one of the best ways to whip up an interactive website and, thus, it is quite popular.

3. **R and S** — R and S are scripting statistical languages with a lot of very sophisticated spatial statistics that can use some of the output from ArcGIS. Plus, on its own, there are many spatial extensions to R that support a wide range of geospatial capabilities (e.g., see: CRAN Task View: Analysis of Spatial Data(link is external), Spatial Data Science with R(link is external), and r-spatial(link is external).

4. **Ruby** — Ruby is an older language that has become more popular recently. Ruby got major traction due to Ruby on Rails, which made it easy to set up a database-backed application. This has been extended to web maps by GeoCommons. Some other interesting neogeography sites such as OpenStreetMap and WeoGeo utilize Ruby.

5. **Rust** — Rust is an open source language supported by developers with the Mozilla Foundation. It is conceptually related to C++, but designed to be safer in relation to security threats. Women who Code(link is external) say Rust has "loads of promise for game engines, VR simulation engines, VR controllers," thus as more GIS-based VR develops, Rust may become more popular in our community.

6. **Shell** — Shell is a scripting language for use in Unix (and Linux and Mac OS) environments. It allows a user to chain Unix commands together, having the system execute them as an event. For one example of using Shell with GIS, see this guide for Shell scripting with the GRASS GIS(link is external).

7. **SQL** — SQL is used as a database access and control language. SQL is at the heart of many GIS operations. SQL is a great example of a language that has survived for a long time. It has survived so long because it is declarative instead of procedural. That is, SQL statements tell *what* you want to happen, not *how* you want it to happen. Therefore, implementation details are hidden and can change over time. This means SQL is set to remain relevant in a world of cloud computing, which we will discuss in this week's tech trend.

8. **TypeScript** — TypeScript is an object-oriented programming language that is a superset of JavaScript. It has been described as "JavaScript that scales(link is external)". As with JavaScript, support exists for using TypeScript with the ArcGIS for JavaScript API and the and the Google Maps JavaScript API. There is also support for TypeScript with the Bing Maps SDK and for using Leaflet in TypeScript, among others.

Making Application-Dependent Choices

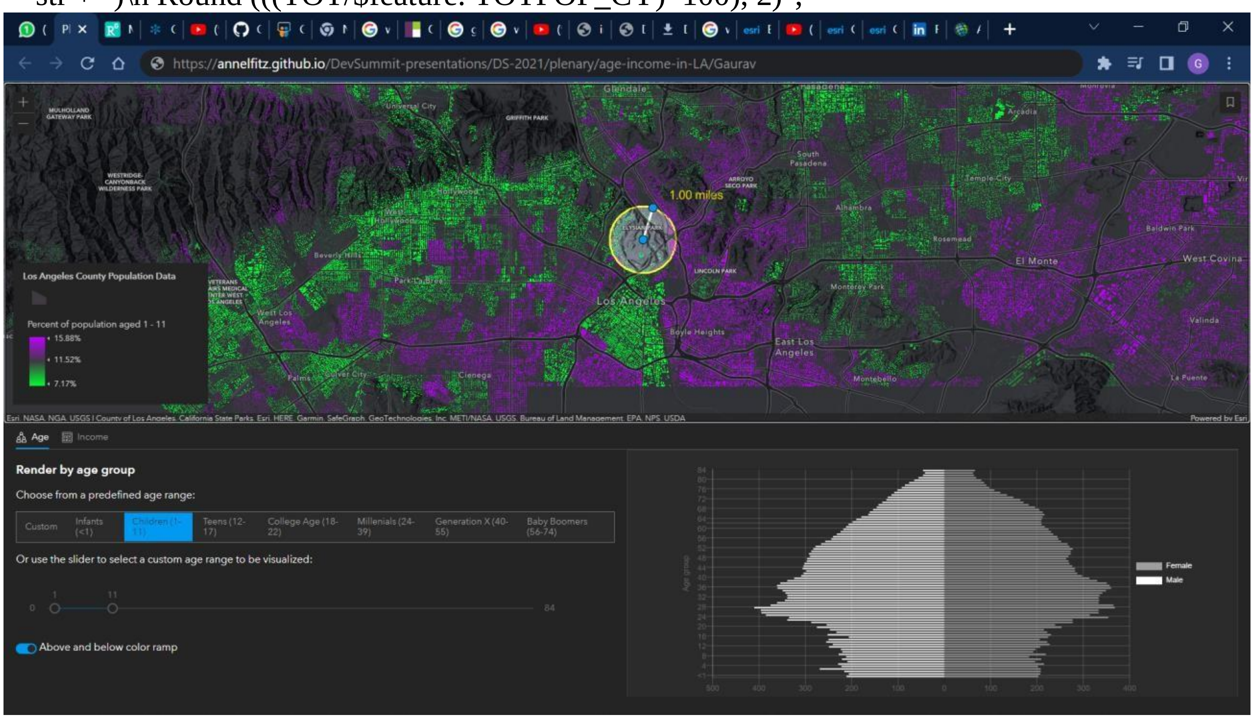
Many GIS projects leverage more than one of the languages detailed above. This is because different tasks in GIS are better supported by some of the languages than others. While different developers have varying opinions on the best match of languages to tasks, one Task-Language list (link is external)worth a look (specific to GIS-related work) is produced in 2016 by Florin-Daniel Cioloboc.

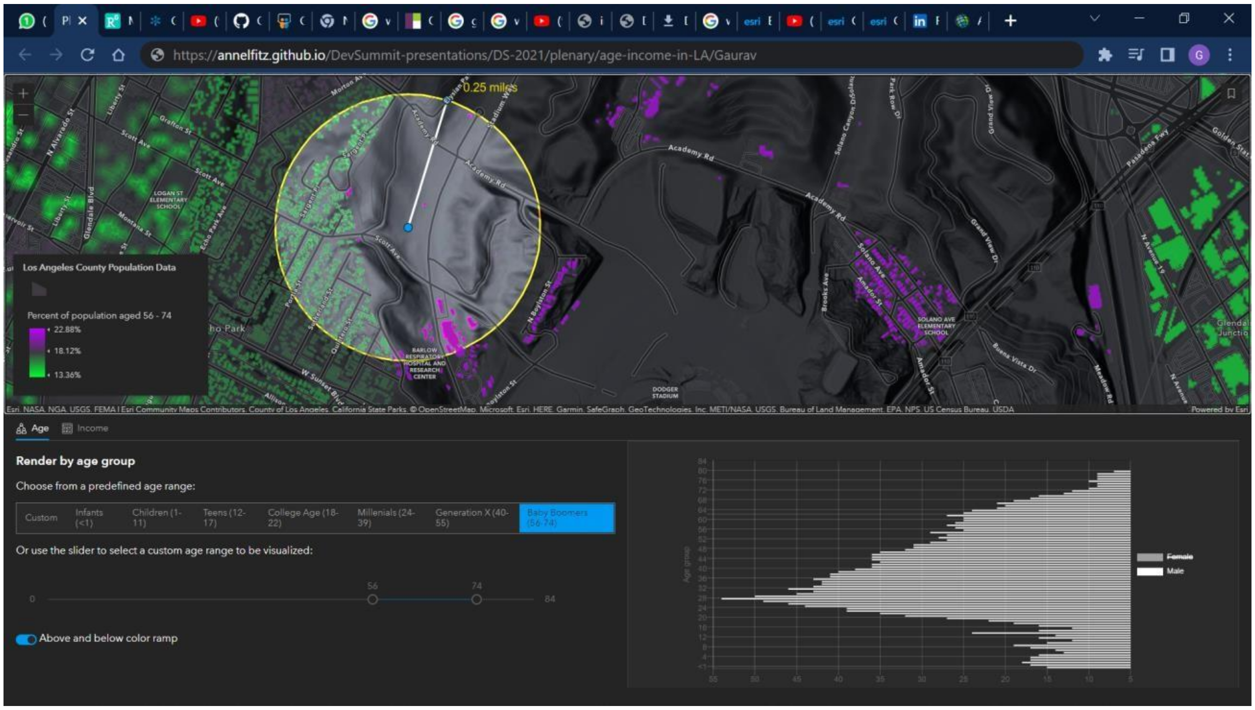
- GIS Scripting and applications (Python, R)
- Data processing, analysis, and modeling (Python, R)
- Web Mapping (JavaScript, Python)
- Geospatial databases (SQL)
- MapServers (Java, C# .NET, C++)
- GIS heavy-weight development (Java, C/C++, C#)
- Mobile development (Android, iOS, JavaScript)
- Geospatial libraries (JavaScript, Python, Java, R, C/C++)

Working on dynamic WEBGIS :

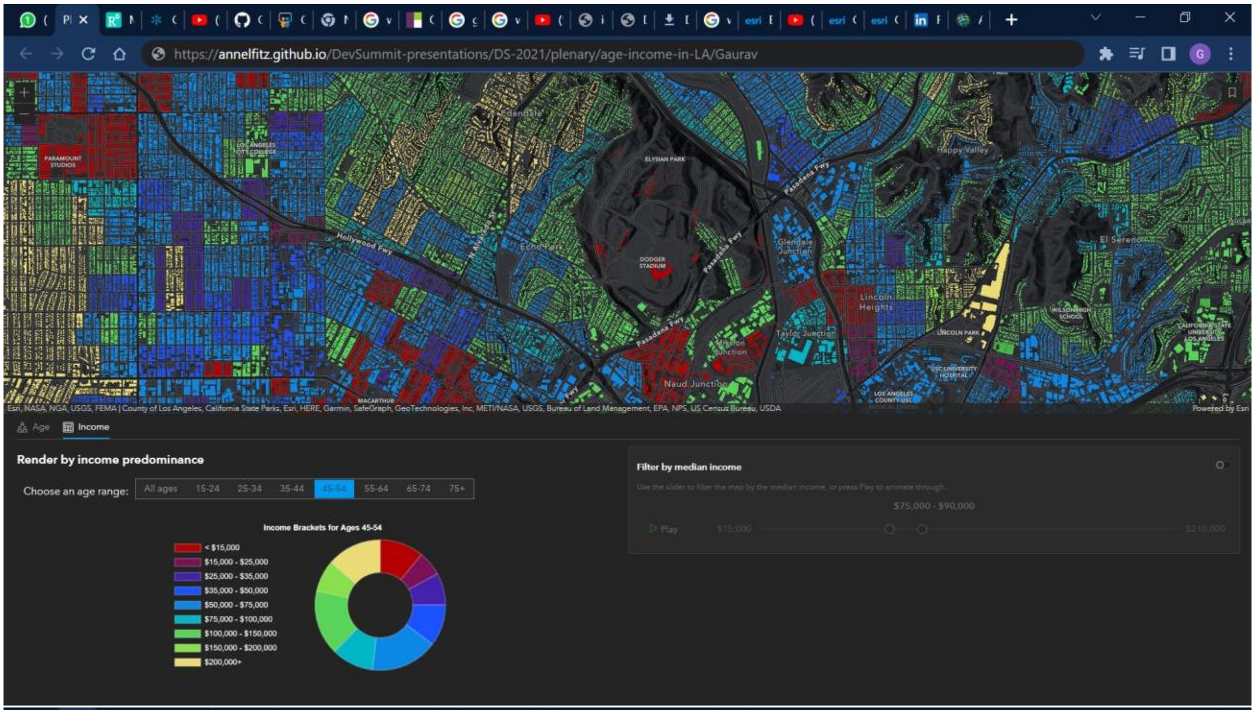
```
function queryLayerViewAgeStats (buffer)

const query = featureLayerView.createQuery(); query.outStatistics = statDefinitions; // defined
earlier from each of the age

query.geometry = buffer;

// Query the features on the client using FeatureLayerView.queryFeatures return
featureLayerView

.queryFeatures (query)

.then(function (results) {

// Parse results

// Return information, seperated by gender

return [femaleAgeData, maleAgeData;

})
```

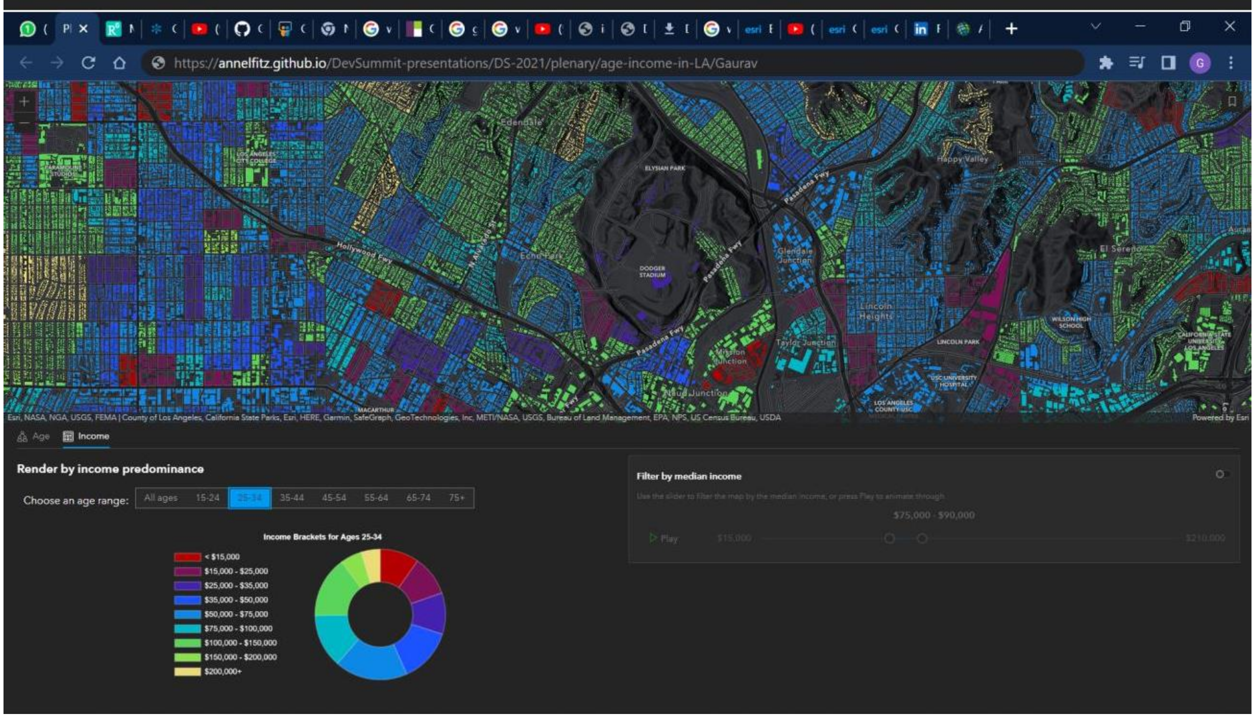
```
for (let age = low; age <= high; age++) {

    str +=

    "Number($feature.MAGE" +

    age +

    "_CY), Number($feature.FAGE" +

    age +

    "_CY)";

    if (age != high) { str += ",";

    }

    str + ")\n Round (((TOT/$feature. TOTPOP_CY)*100), 2)";
```






```
function createEffect(min, max) {

    featureLayerView.effect = {

        filter: {

            where: "MEDHINC_CY > " + min + " AND MEDHINC_CY < " + max
        },
        includedEffect: "bloom (150 %, 1px, 0.2) saturate (200%)",
        excludedEffect: "blur(1px) brightness (65%)"

    }
}
```





Conclusion:

Thus I understand the about the working of scripting languages for dynamic webGIS contents languages of QGIS

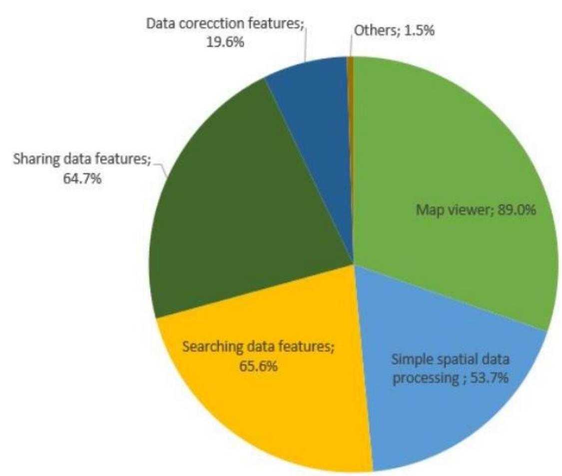
Practical 10

Aim : Accessing webGIS/Mobile through private/public hosting infrastructure using GeoNode

Theory :

Geo node is a web based application and platform for developing geospatial information system (GIS) and for deploying spatial data infrastructure It is designed to be extended and modified and can be integrated into existing platforms. InDITA was built not for a particular user group but the broadest possible community. This is because InDITA was built with the aim of being a web-app that can disseminate disaster information. To describe the user, based on the age composition, most respondents were from the 21-40 years age range (67.75% of respondents). Respondents from 41 to 60 were 19.8%, and those aged less than 20 years were 12.38%. The respondents are coming from civilians, academics, and government officials. Concerning disasters, it is known that 56.88% of respondents have accessed Disaster Information Systems. This shows that the community, especially in Indonesia, is starting to apprehend disaster information's importance.

User needs for InDITA Development are obtained from the assessment of the quality of content/information that is important to be developed in the InDITA application and the requirement for developing the system in InDITA application. Based on respondents' assessment of the quality of content/information that important to be developed in a disaster website, it is recognized that providing reliable and up-to-date data and information (69%) and the accuracy of data and information (74%) are the most important things to develop in the InDITA application (Figure 4). Furthermore, from Figure 5, 92% of respondents agreed that concerning developing InDITA web app as an application that is easy to use & learn (user friendly) and accessible from various platforms (web or mobile) is urgently needed.



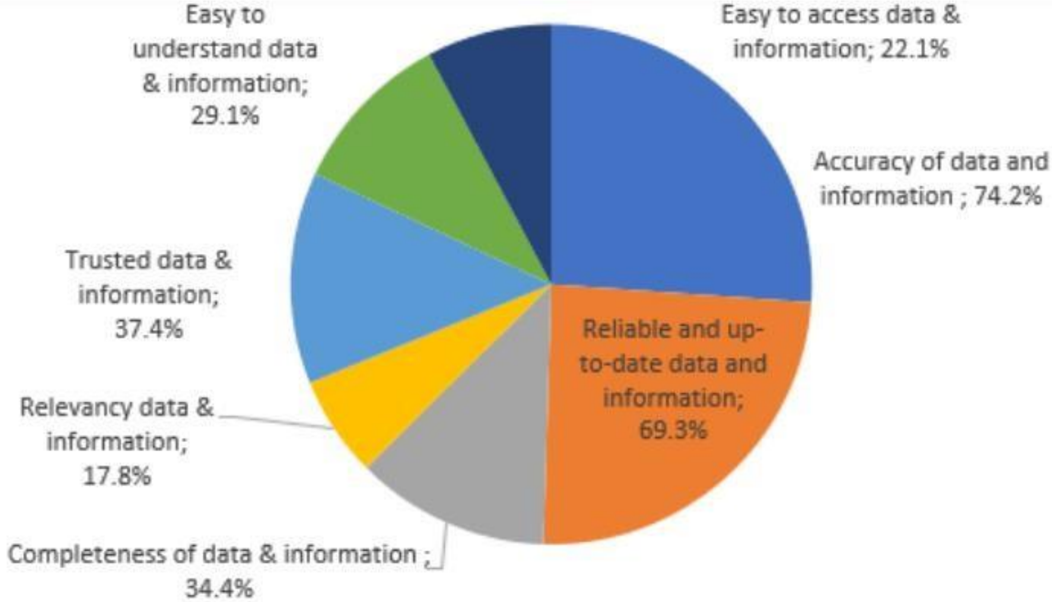
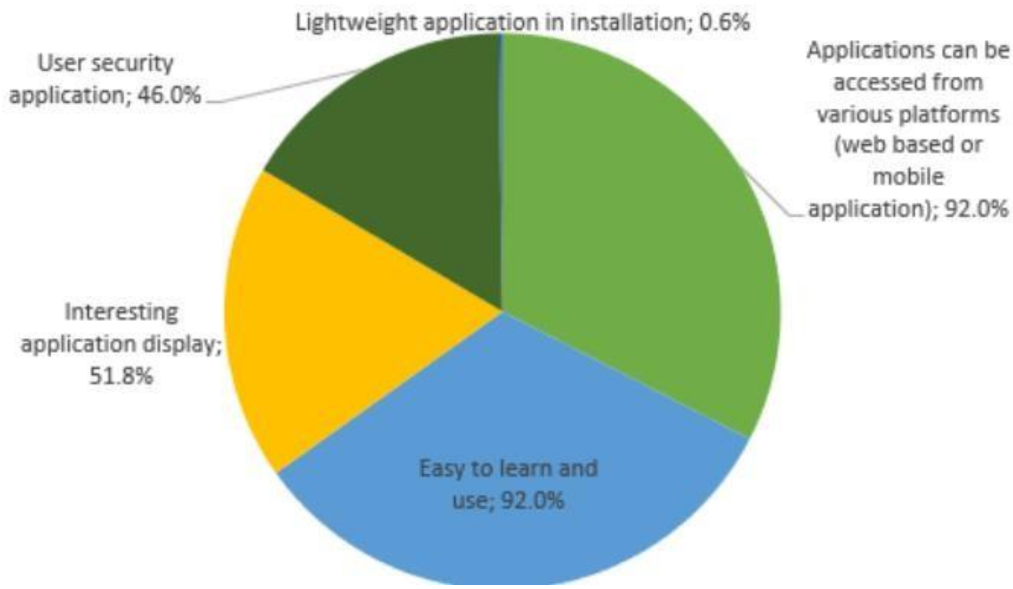


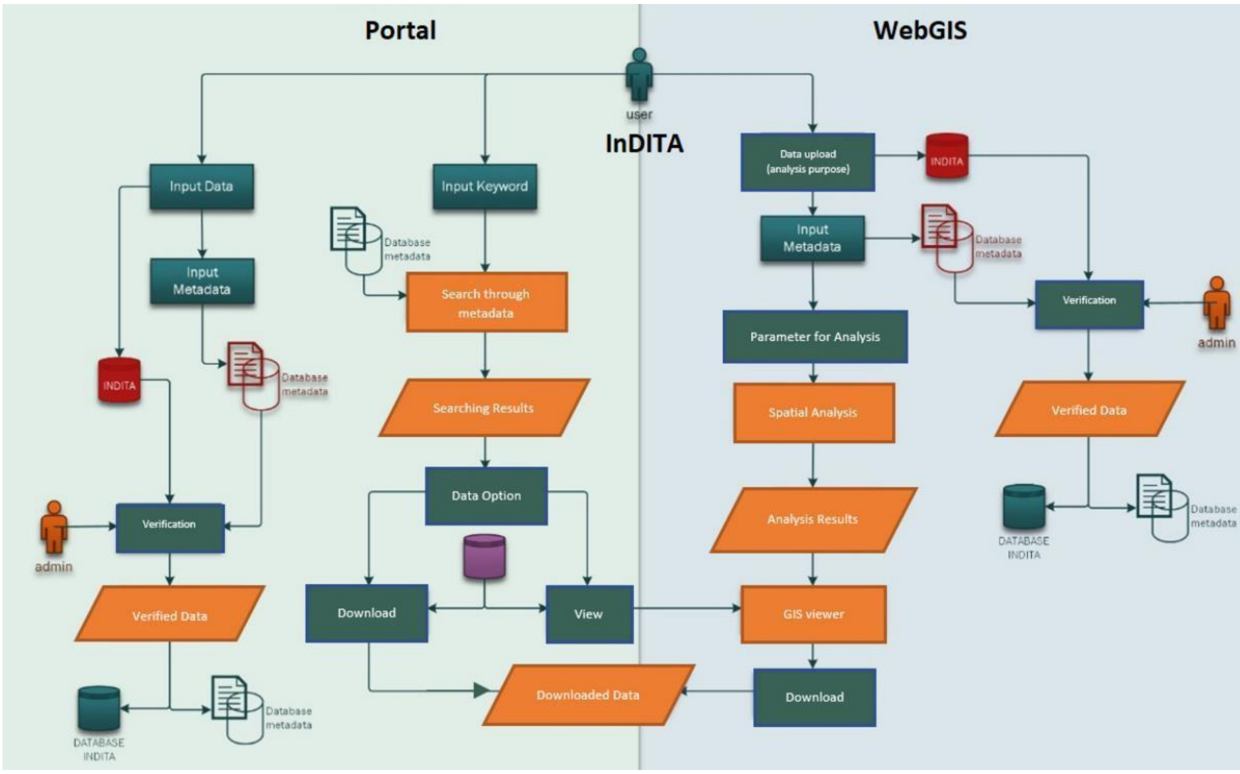
Fig. 4 The quality of content/information that important to be developed in the InDITA disaster application according to respondents' perspective

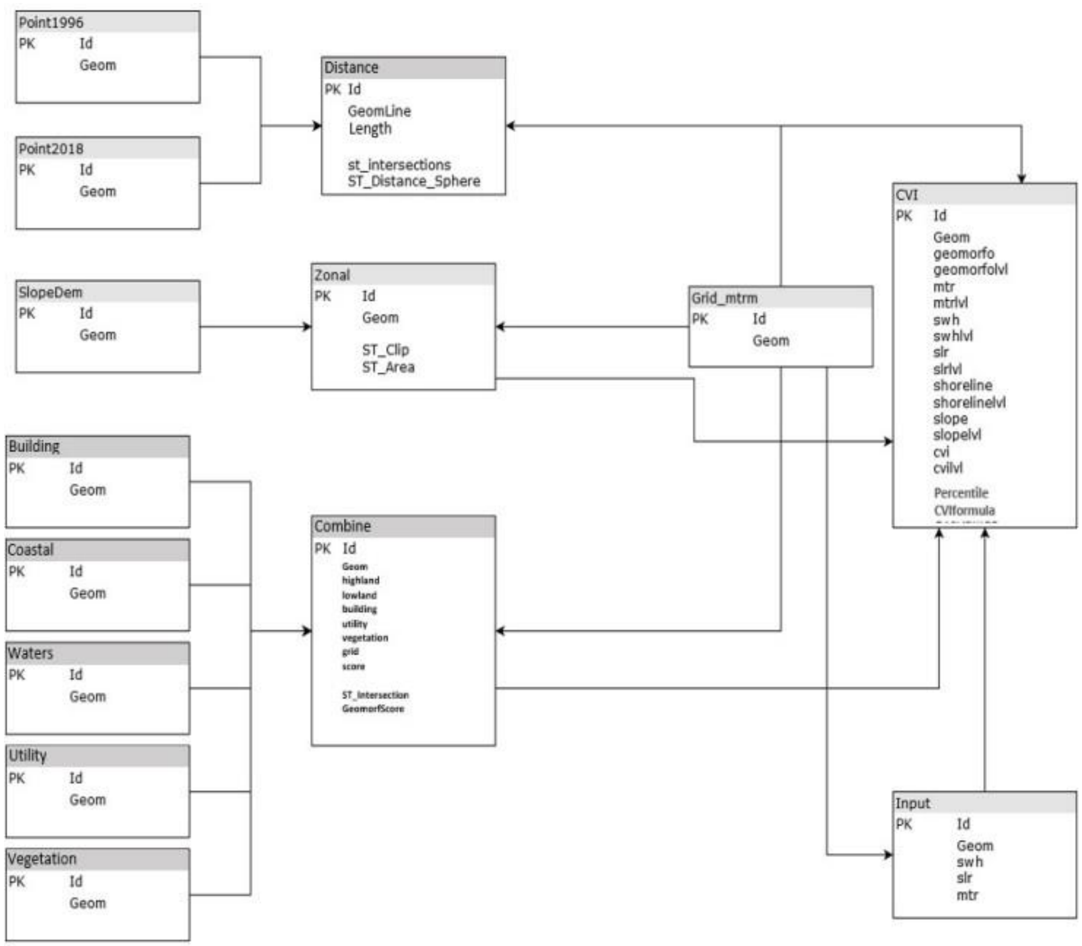


Regarding the option of the most important features to be performed in a disaster application as seen in Figure 6, 3 features get the highest score according to respondents are the spatial data display feature/map viewer (89%); data sharing feature (65%), and data searching features (66%). Based on the resume of user input as shown in Figure 4-6 and depth-interview results, the development of InDITA directed to be a web-app that can function as a portal and spatial data display which will be more informative if it has a spatial analysis function like Web GIS. B. InDITA Application Design Development 1) Architecture design: The InDITA concept and interface were improved based on provided input and feedback on needs and designs (by user), urging revisions to the interface's conceptual and functional requirements (utility), and finally leading to new prototypes. As a web-based GIS service prototype, InDITA is built to meet the need for geoportal and disaster information. This is closely related to the problem of providing geospatial information as the main thing in the spatial planning and disaster mitigation process. Thus, it needs special attention, especially in terms of easy access and spatial data center in either 2D or 3D format.

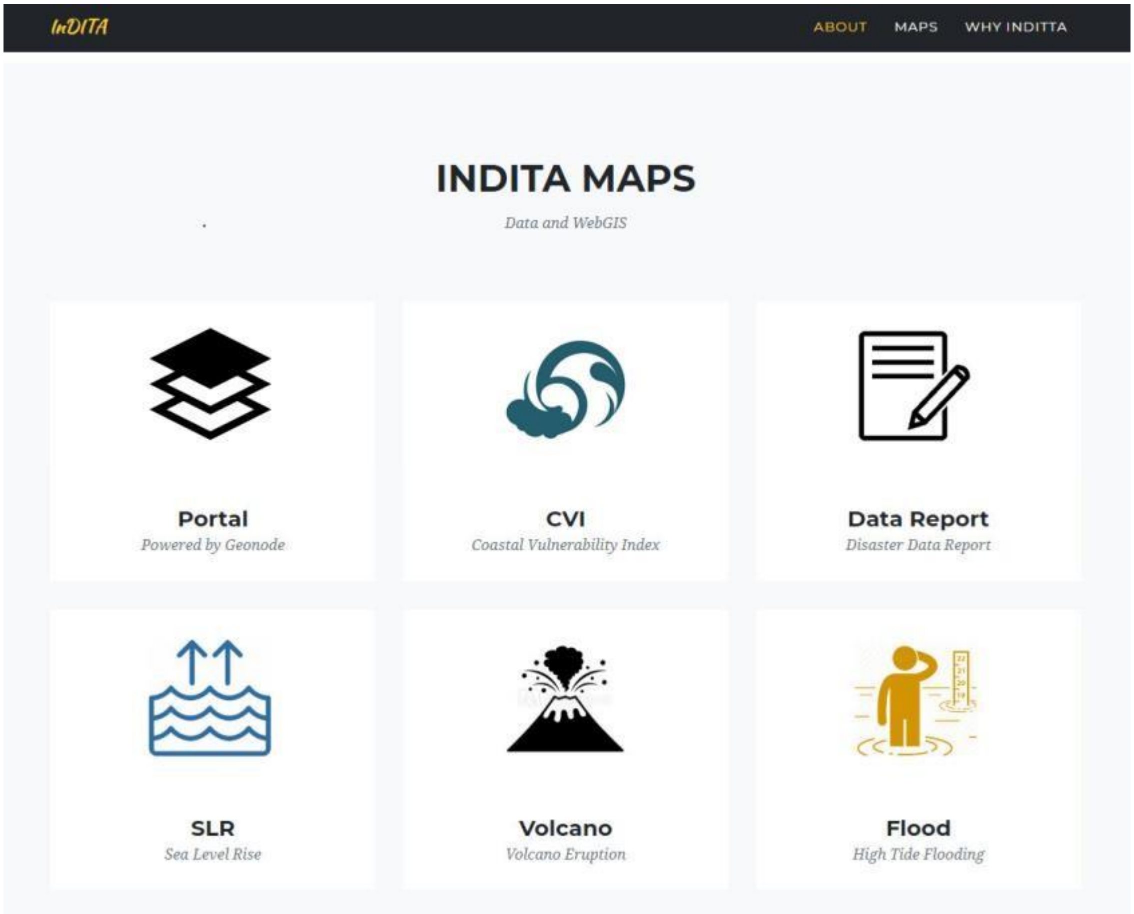
InDITA application design development is directed to be an application that has a function as a portal, viewer, webGIS operation by utilizing the open-source platform GeoNode 2.10. Also, InDITA owns an additional function so the user could report disaster events. The functions provision in InDITA is based on the user's demand for a disaster webapp as if (1) the importance of spatial data viewer feature; (2) accessibility; (3) interoperability; (4) updated data. GeoNode allows users to upload vector data (.shp, json, .csv, .kml or .kmz) and raster data in their original projections using a web form. While vector data is formatted into geospatial tables on a database, the raster data are retained as GeoTIFFs. For metadata, ISO 19139:2007/ISO19115 is given as standard metadata formats. Moreover, users also may upload a metadata XML document to fill key GeoNode metadata elements automatically. Customization using Mapstore2 REACT in GeoNode platform improving the functionalities of InDITA as a web GIS since it’s support ArcGIS layers and revamped Time Slider for temporal series. The InDITA architecture design as a data portal equipped with Web GIS features is pictured in Figure 7. When the data input manually into repository InDITA, the super administration will verify which data dan temporary metadata (red cylinder) will enter the permanent database. Moreover, data from any connected databases (local/regional/national/government official network node) could be stored in the portal (purple cylinder in Figure 7) through metadata harvesting.

As a portal, InDITA runs services. The portal system on InDITA will perform information seeking on the server metadata, users can make use of the information stored in the metadata. The query will automatically filter information related to the disaster. The metadata server will perform access to the connected metadata database. The metadata scheme used to store 12 types of information, namely metadata information, identification information, boundary information, genealogical information, content information, distribution information, reference system information, spatial representation information, portrayal catalog information, application metadata information, application schema information, metadata extension information, and metadata service information. After information about the data being sought is found, then data retrieval will perform and bring the user's result (information). Metadata is the backbone of a portal.

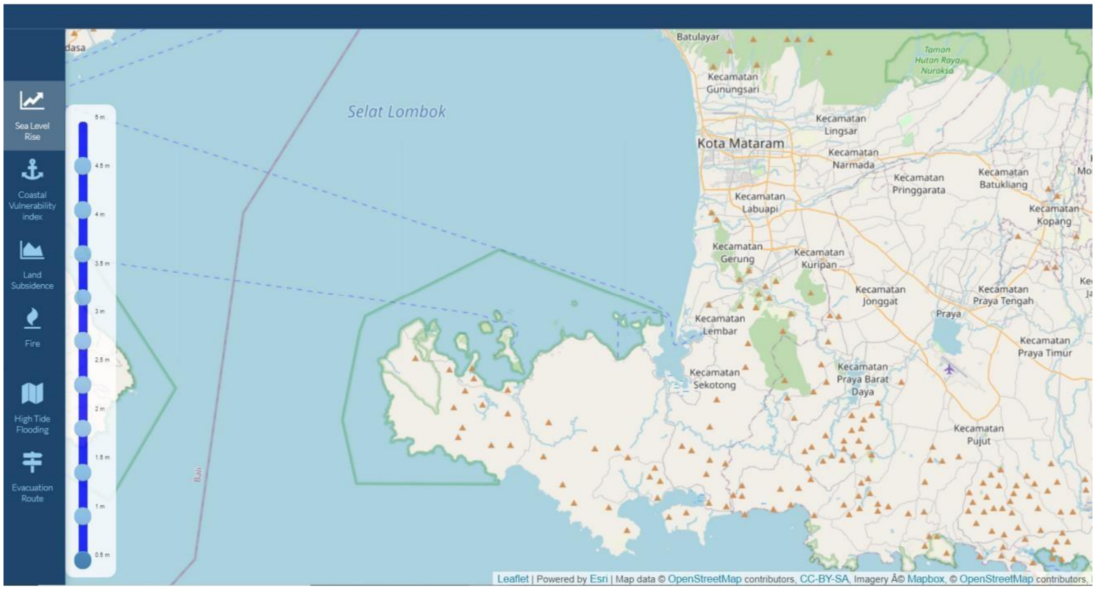

Portal
WebGIS
user
InDITA
Input Data
Input Keyword
Data upload
(analysis purpose)
INDITA
Input
Metadata
Database
metadata
Search through
metadata
Verification
admin
Parameter for Analysis
Spatial Analysis
Searching Results
Verified Data
Data Option
Analysis Results
DATABASE
INDITA
Download
View
GIS viewer
Downloaded Data


Point1996
PK Id
Geom
Point2018
PK Id
Geom
Distance
PK Id
GeomLine
Length
st_intersections
ST_Distance_Sphere
CVI
PK Id
Geom
geomorfo
geomorfolvl
mtr
mtrlvl
swh
swhlvl
slr
slrlvl
shoreline
shorelinelvl
slope
slopelvl
cvi
cvilvl
Percentile
CVIformula
SlopeDem
PK Id
Geom
Zonal
PK Id
Geom
ST_Clip
ST_Area
Grid_mtrm
PK Id
Geom
Building
PK Id
Geom
Coastal
PK Id
Geom
Combine
PK Id
Geom
highland
lowland
building
utility
vegetation
grid
score
ST_Intersection
GeomorfScore
Waters
PK Id
Geom
Utility
PK Id
Geom
Vegetation
PK Id
Geom
Input
PK Id
Geom
swh
slr
mtr

As a WebGIS , INDITA set features for data viewer and spatial analysis. As a viewer, information is displayed according to the type. The spatial data format (vector or raster) showed in the form of interactive maps. Images and text format displayed on the browser. The link information will be referenced to the corresponding URL and download menu also available in InDITA.



As a web application built with the purpose of hazard or disaster information systems, several features are made to enhance the functions, such as Portal, CVI Web GIS, SLR Web GIS, Volcano Web GIS, Flood Web GIS, and Data Report (Figure 9). The user interfaces for the menu on the InDITA home page is structured to make it easier for users to choose which operation functions to perform. It is subject to search for data in a warehouse, view data, or perform simple spatial analysis on available web GIS themes. However, the user interface for the last two web GIS is still in a development state



Users freely access all the web GIS in InDITA, but login are needed for activities in the repository (data management) and data reporting. The user interfaces for Sea Level Rise web GIS displayed in Figure 10. The Sea Level Rise simulation shows the coastal area inundated with a scenario of increasing seawater level in meters. The user interfaces for Coastal Vulnerability Index web GIS shown in Figure 11. The CVI parameters that have been uploaded into the INDITA application are coastline, slope, and geomorphology. While for other parameters, users can input manually.

Conclusion: Thus I have studied a and understand Accessing webGIS/Mobile through private/public hosting infrastructure using GeoNode.