Create a Map Visualization using Natural Earth Datasets.

M.Sc. Agriculture Analytics

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1. Introduction

Natural Earth is a public domain dataset that provides a comprehensive collection of geographic data at different scales (1:10m, 1:50m, and 1:110m). It's designed to be a starting point for creating a variety of maps, from small-scale world maps to large-scale regional maps.

1.1 Key Features

- **Public Domain:** Free to use, modify, and distribute for any purpose.
- **Multiple Scales:** Offers data at different levels of detail to suit various mapping needs.
- **Vector and Raster Data:** Includes both vector (points, lines, polygons) and raster (images) data.
- **Consistent and Accurate:** Data is meticulously curated and processed for consistency and accuracy.
- **Wide Range of Data:** Covers physical, cultural, and socioeconomic features, including:

    - Administrative boundaries
    - Rivers, lakes, and coastlines
    - Elevation data
    - Population density
    - Land cover and land use
    - Transportation networks

❖ **Dependencies:**

✓ Tomcat & Geoserver

✓ VS Code & Live Server Extension in it

✓ Postgres SQL

2. Datasets

2.1Dataset Link

- Data Source Link: https://www.naturalearthdata.com/

❖ In consideration of our area of interest, we have chosen the following Data from Natural Earth:

1. Vector Data:
   - State Boundary of India

     India: District Boundary 2021 | India: District Boundary 2021 | Policy Maps (esri.in)
   - Rivers
   - Airports
   - Ports

2. Raster Data:
   - Cross Blended Hypso with Relief, Water, Drains, and Ocean Bottom

3. Methodology

3.1 Flowchart

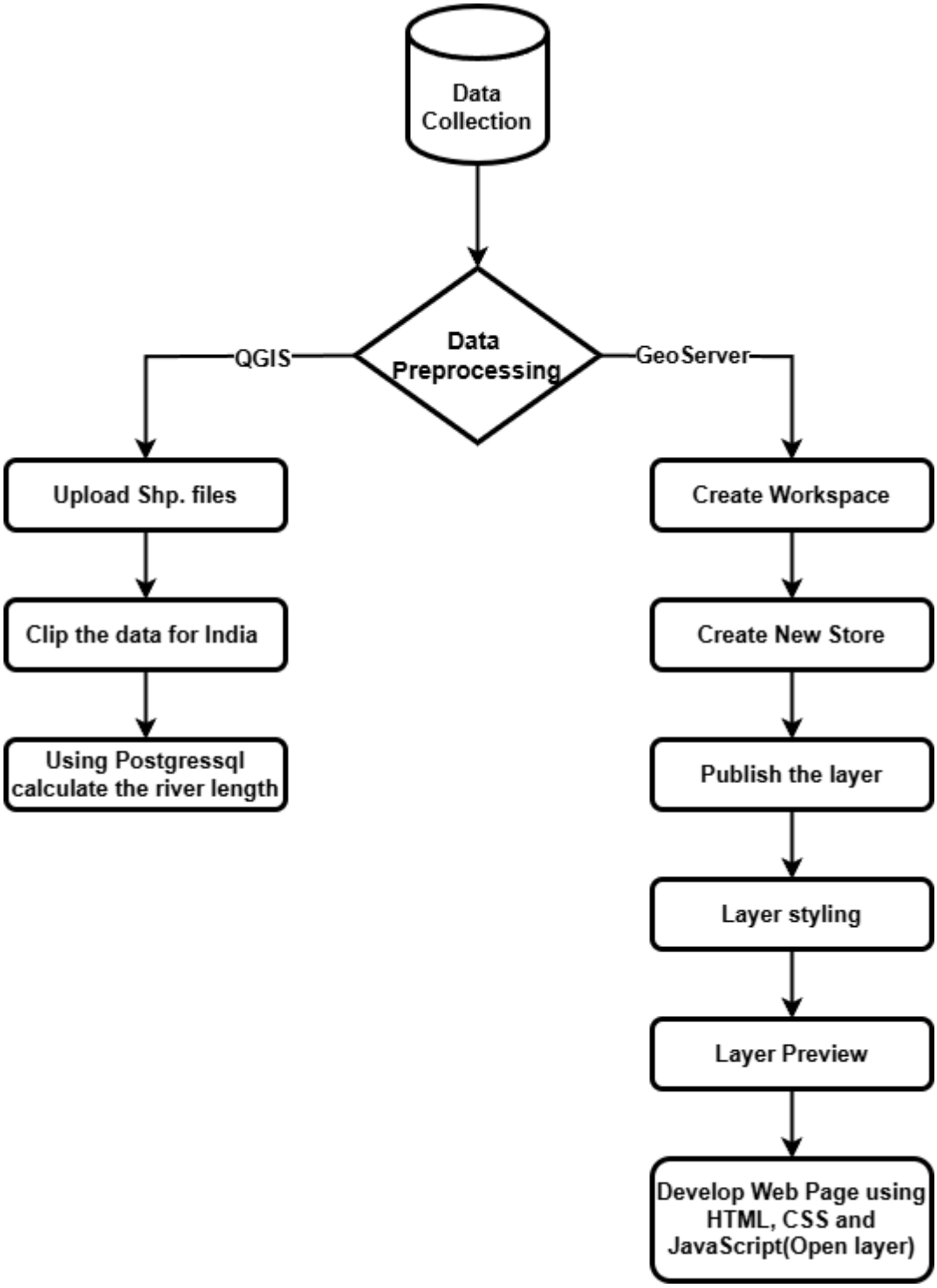


Figure 1 : Flow chart

3.2 Preparing the Natural Earth Datasets

1. **Download Natural Earth Datasets:**
    - Go to the Natural Earth website.
    - Download the datasets of river, ports, airports, state boundary and raster image of natural earth hypsometric tints of large scale data (1:10).
2. **Convert Datasets (if necessary):**
    - Ensure that the datasets are projected correctly (e.g., WGS84 for web maps).

3.3 Load Shapefiles and change attribute table in QGIS.

1. Load the Shapefile

- Go to Layer > Add Layer > Add Vector Layer.
- Browse and select your shapefile to load it into QGIS.
- Right-click on the shapefile layer in the Layers panel.
- Select Attribute table from the context menu.

2. Add State column in Airport & Port Using Intersection

- Go to Vector > Geoprocessing tool > Intersection
- Select vector file (airport, port) as input and state boundary as overlay layer

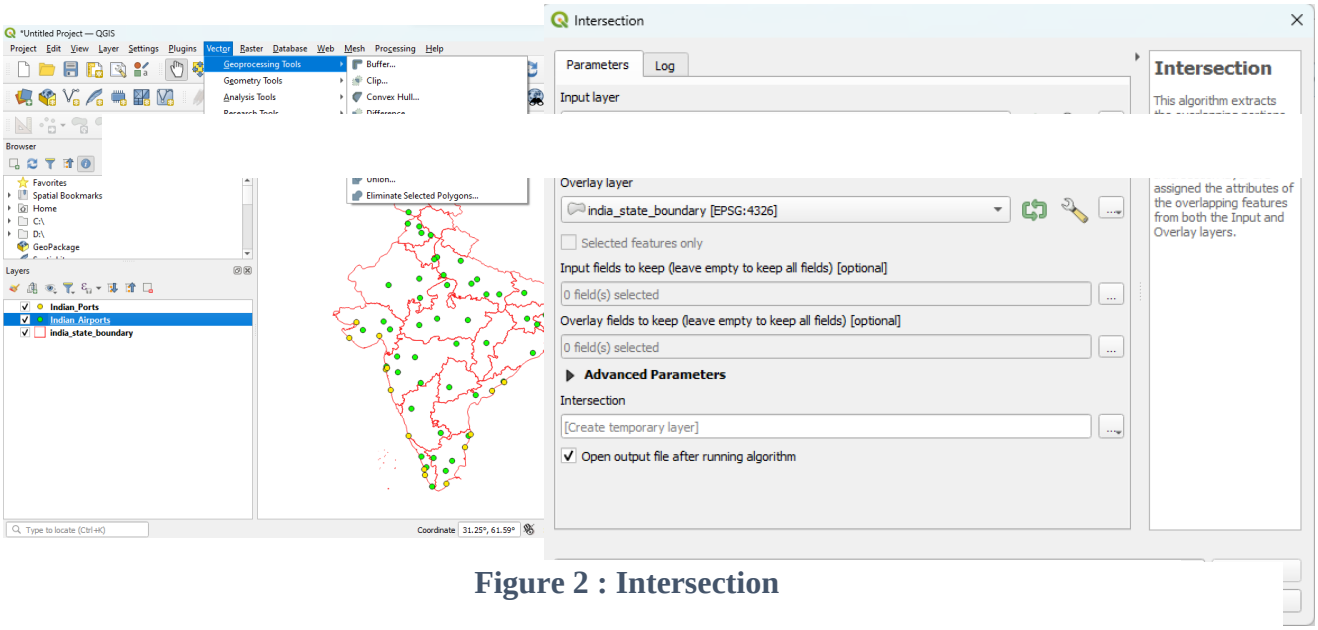
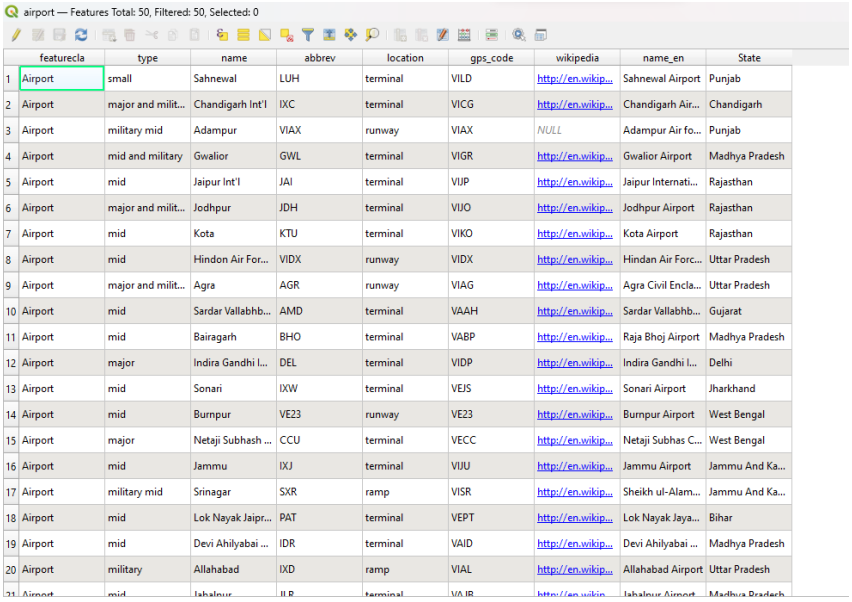


Figure 2 : Intersection

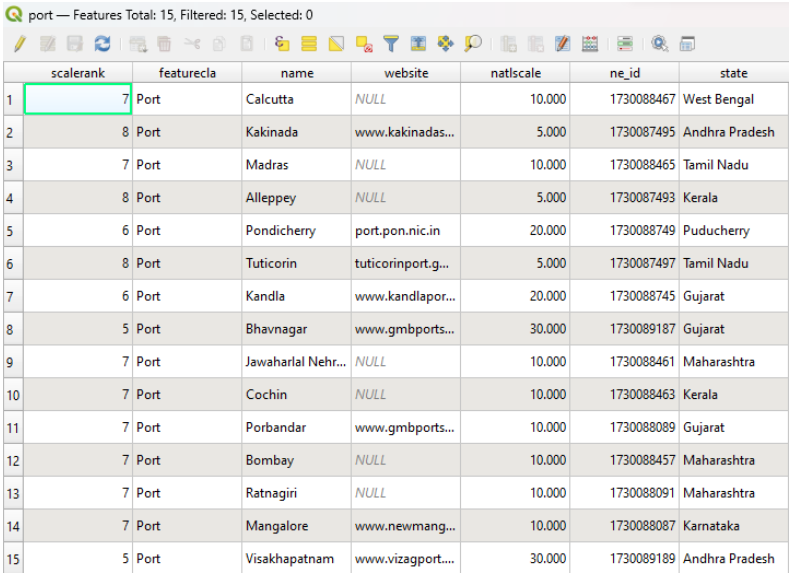
- After intersection airport and state boundary attributed table intersect based on geometry.
- Then in attributed table other than state column delete other column of state boundary table.
- Same as for Port Layer



airport — Features Total: 50, Filtered: 50, Selected: 0

	featurecla	type	name	abbrev	location	gps_code	wikipedia	name_en	State
1	Airport	small	Sahnewal	LUH	terminal	VILD	http://en.wikip...	Sahnewal Airport	Punjab
2	Airport	major and milit...	Chandigarh Int'l	IXC	terminal	VICG	http://en.wikip...	Chandigarh Air...	Chandigarh
3	Airport	military mid	Adampur	VIAX	runway	VIAX	NULL	Adampur Air fo...	Punjab
4	Airport	mid and military	Gwalior	GWL	terminal	VIGR	http://en.wikip...	Gwalior Airport	Madhya Pradesh
5	Airport	mid	Jaipur Int'l	JAI	terminal	VIJP	http://en.wikip...	Jaipur Internati...	Rajasthan
6	Airport	major and milit...	Jodhpur	JDH	terminal	VIJO	http://en.wikip...	Jodhpur Airport	Rajasthan
7	Airport	mid	Kota	KTU	terminal	VIKO	http://en.wikip...	Kota Airport	Rajasthan
8	Airport	mid	Hindon Air For...	VIDX	runway	VIDX	http://en.wikip...	Hindan Air Forc...	Uttar Pradesh
9	Airport	major and milit...	Agra	AGR	runway	VIAG	http://en.wikip...	Agra Civil Encla...	Uttar Pradesh
10	Airport	mid	Sardar Vallabhb...	AMD	terminal	VAAH	http://en.wikip...	Sardar Vallabhb...	Gujarat
11	Airport	mid	Bairagarh	BHO	terminal	VABP	http://en.wikip...	Raja Bhoj Airport	Madhya Pradesh
12	Airport	major	Indira Gandhi I...	DEL	terminal	VIDP	http://en.wikip...	Indira Gandhi I...	Delhi
13	Airport	mid	Sonari	IXW	terminal	VEJS	http://en.wikip...	Sonari Airport	Jharkhand
14	Airport	mid	Burnpur	VE23	runway	VE23	http://en.wikip...	Burnpur Airport	West Bengal
15	Airport	major	Netaji Subhash ...	CCU	terminal	VECC	http://en.wikip...	Netaji Subhas C...	West Bengal
16	Airport	mid	Jammu	IXJ	terminal	VIJU	http://en.wikip...	Jammu Airport	Jammu And Ka...
17	Airport	military mid	Srinagar	SXR	ramp	VISR	http://en.wikip...	Sheikh ul-Alam...	Jammu And Ka...
18	Airport	mid	Lok Nayak Jaipr...	PAT	terminal	VEPT	http://en.wikip...	Lok Nayak Jaya...	Bihar
19	Airport	mid	Devi Ahilyabai ...	IDR	terminal	VAID	http://en.wikip...	Devi Ahilyabai ...	Madhya Pradesh
20	Airport	military	Allahabad	IXD	ramp	VIAL	http://en.wikip...	Allahabad Airport	Uttar Pradesh
21	Airport	mid	Jabalpur	JLR	terminal	VAJB	http://en.wikip...	Jabalpur Airport	Madhya Pradesh

Figure 3 : Airport Attribute Table



port — Features Total: 15, Filtered: 15, Selected: 0

	scalerank	featurecla	name	website	natlscale	ne_id	state
1	7	Port	Calcutta	NULL	10.000	1730088467	West Bengal
2	8	Port	Kakinada	www.kakinadas...	5.000	1730087495	Andhra Pradesh
3	7	Port	Madras	NULL	10.000	1730088465	Tamil Nadu
4	8	Port	Alleppey	NULL	5.000	1730087493	Kerala
5	6	Port	Pondicherry	port.pon.nic.in	20.000	1730088749	Puducherry
6	8	Port	Tuticorin	tuticorinport.g...	5.000	1730087497	Tamil Nadu
7	6	Port	Kandla	www.kandlapor...	20.000	1730088745	Gujarat
8	5	Port	Bhavnagar	www.gmbports...	30.000	1730089187	Gujarat
9	7	Port	Jawaharlal Nehr...	NULL	10.000	1730088461	Maharashtra
10	7	Port	Cochin	NULL	10.000	1730088463	Kerala
11	7	Port	Porbandar	www.gmbports...	10.000	1730088089	Gujarat
12	7	Port	Bombay	NULL	10.000	1730088457	Maharashtra
13	7	Port	Ratnagiri	NULL	10.000	1730088091	Maharashtra
14	7	Port	Mangalore	www.newmang...	10.000	1730088087	Karnataka
15	5	Port	Visakhapatnam	www.vizagport....	30.000	1730089189	Andhra Pradesh

Figure 4 : Port Attribute Table

3. Connect PostGIS with postgres SQL.

- To calculate first we have to change the projection system of river .shp file into EPSG : 3857 from current projection
- We use PostGIS postgres SQL to calculate the length of River from shp file.
- Go to DB Manager > PostGIS > daiict_connection_2024 > public > Import Layer
- In input give select river and check the box which show in below image.

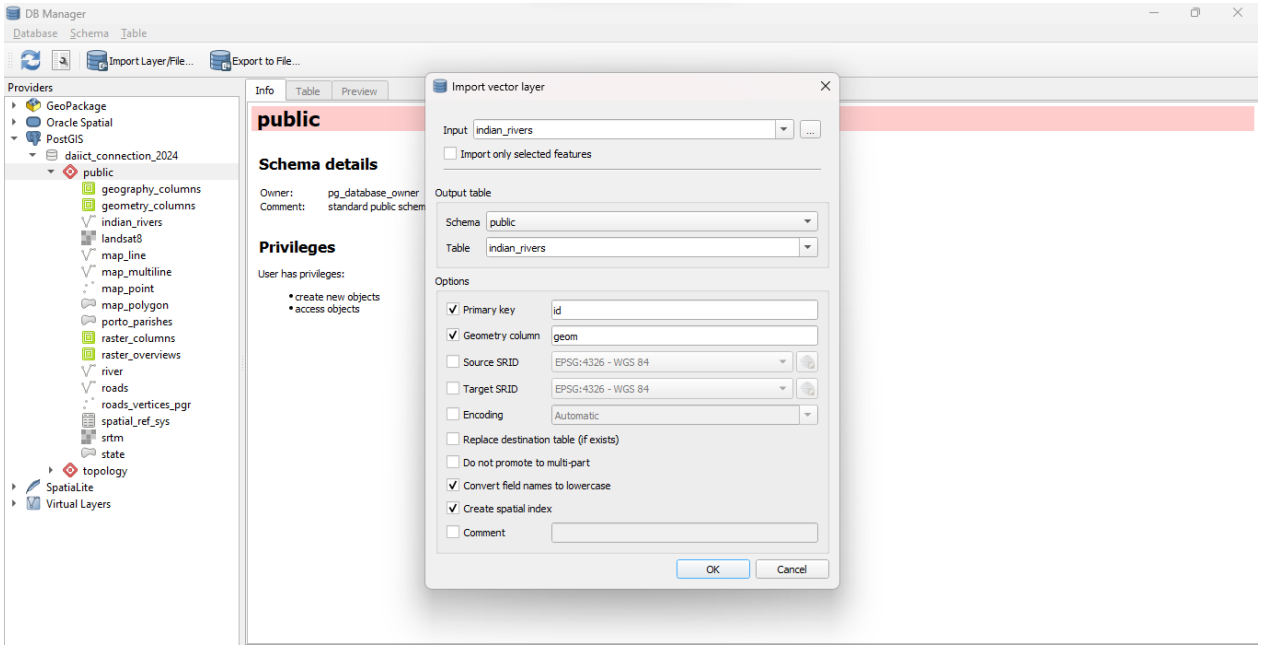


Figure 5 : Import Data in Postgre SQL

- Now in pgAdmin in river table add new column as river_length_km with data type: double precision
- And than writer query show as below image.

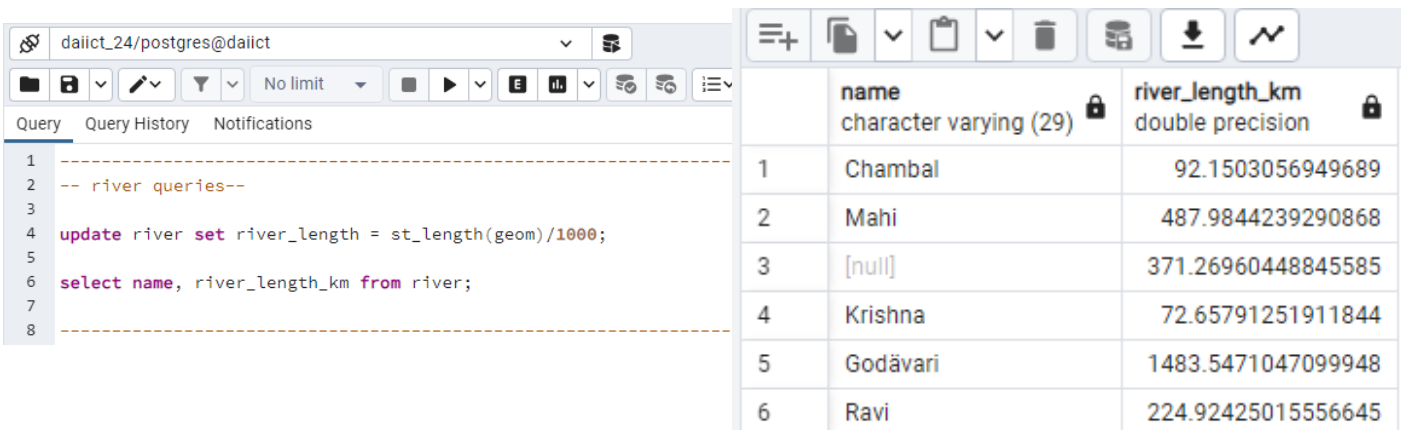


Figure 6 : Query Output

- After calculate the length we have to add new river layer in QGIS and and export in EPSG:4326
- Go to AddLayer > Add PostGIS Layer >connect with your database connection > select river layer > click on Add

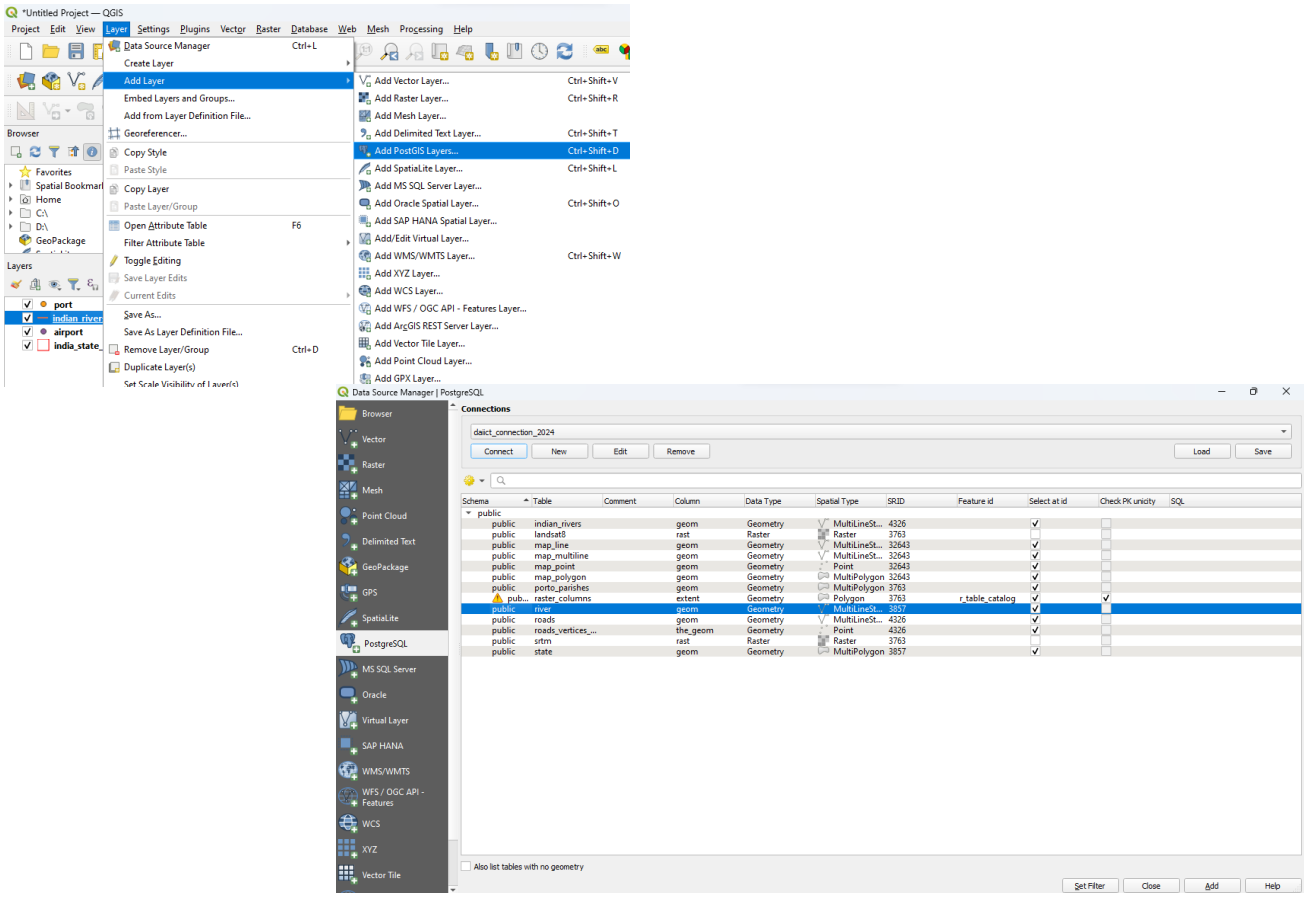


Figure 7 : Viewing Data in QGIS, Imported from Postgre SQL

3.4 Uploading Shapefiles to Geo Server

1. Start Geo Server

- Open your web browser and navigate to the Geo Server web interface.
- **http://localhost:8080/geoserver**

2. Log In

- Enter your username and password to access the Geo Server dashboard.

3. Create a Workspace

- Go to the `Data` section.
- Click on `Workspaces` under the `Data` menu.
- Click `Add new Workspace`.
- Enter a name and optionally a namespace URI for the workspace.
- Click `Save` to create the workspace.

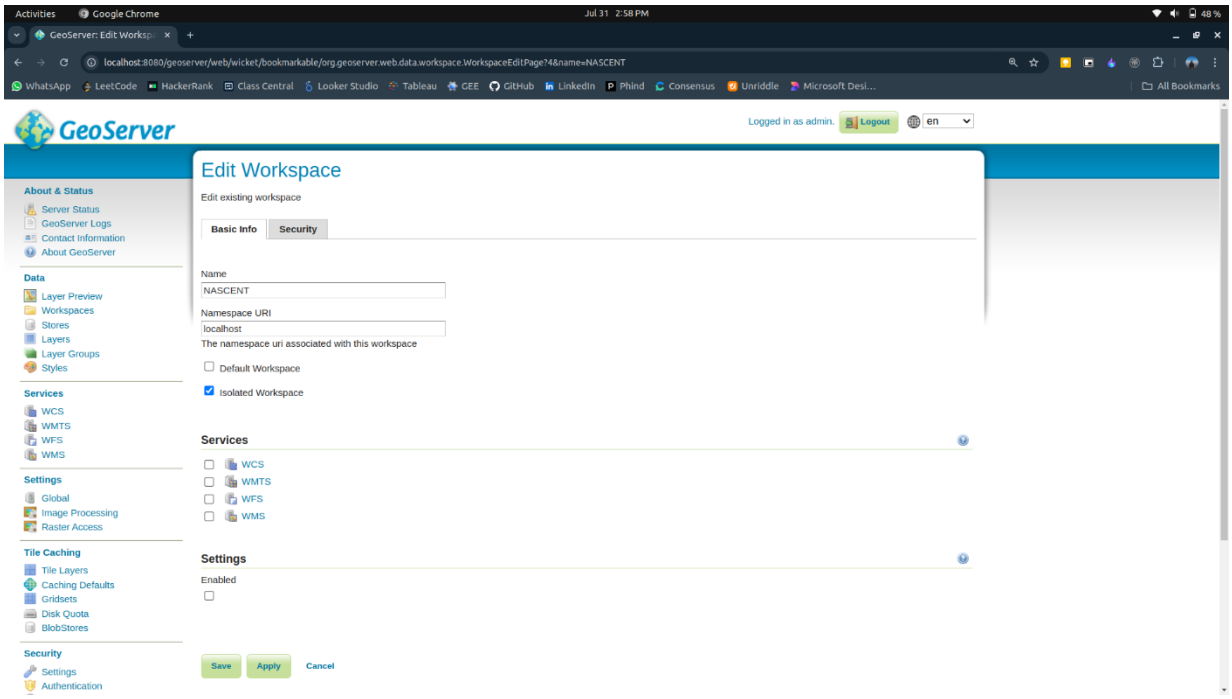


Figure 8 : Create a new Workspace

4. Add a New Store

- After creating the workspace, navigate to the `Stores` section under the `Data` menu.
- Click `Add new Store`.
- Choose `Shapefile` from the list of available data sources.
- Select the workspace created earlier.
- Provide a name for the data store.
- Click the `Browse` button to select and upload your shapefile.
- Click `Save` to upload and process the shapefile.

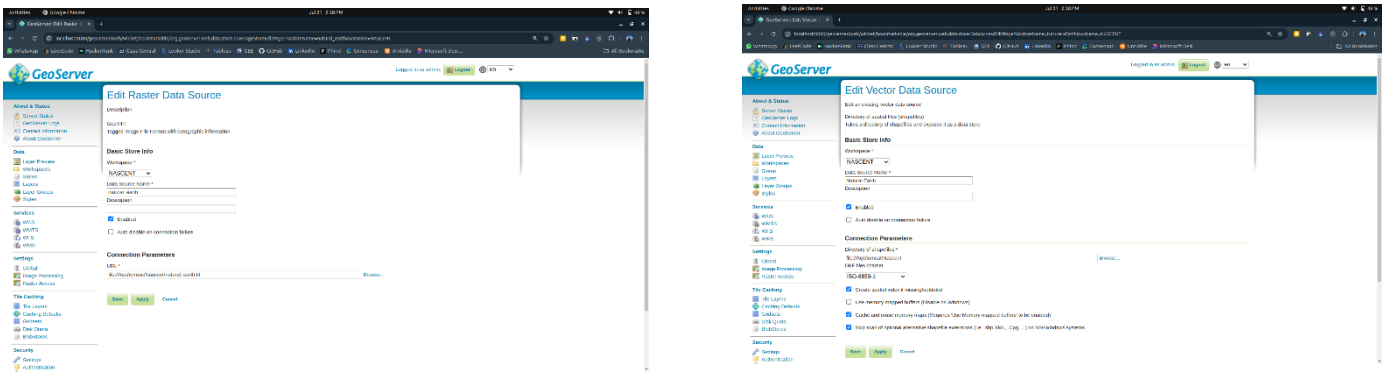


Figure 9 : Create a new Store

5. Publish a New Layer

- Go to the `Layers` section under the `Data` menu.
- Click `Add a new Layer`.
- Select the newly added shapefile store and choose the shapefile to publish.
- Click `Publish`.
- Provide a name for the layer.
- Optionally, add a title for the layer.
- Ensure the correct CRS is selected.
- Adjust additional settings as needed, such as bounding boxes and styles.
- Click `Save` to publish the layer.

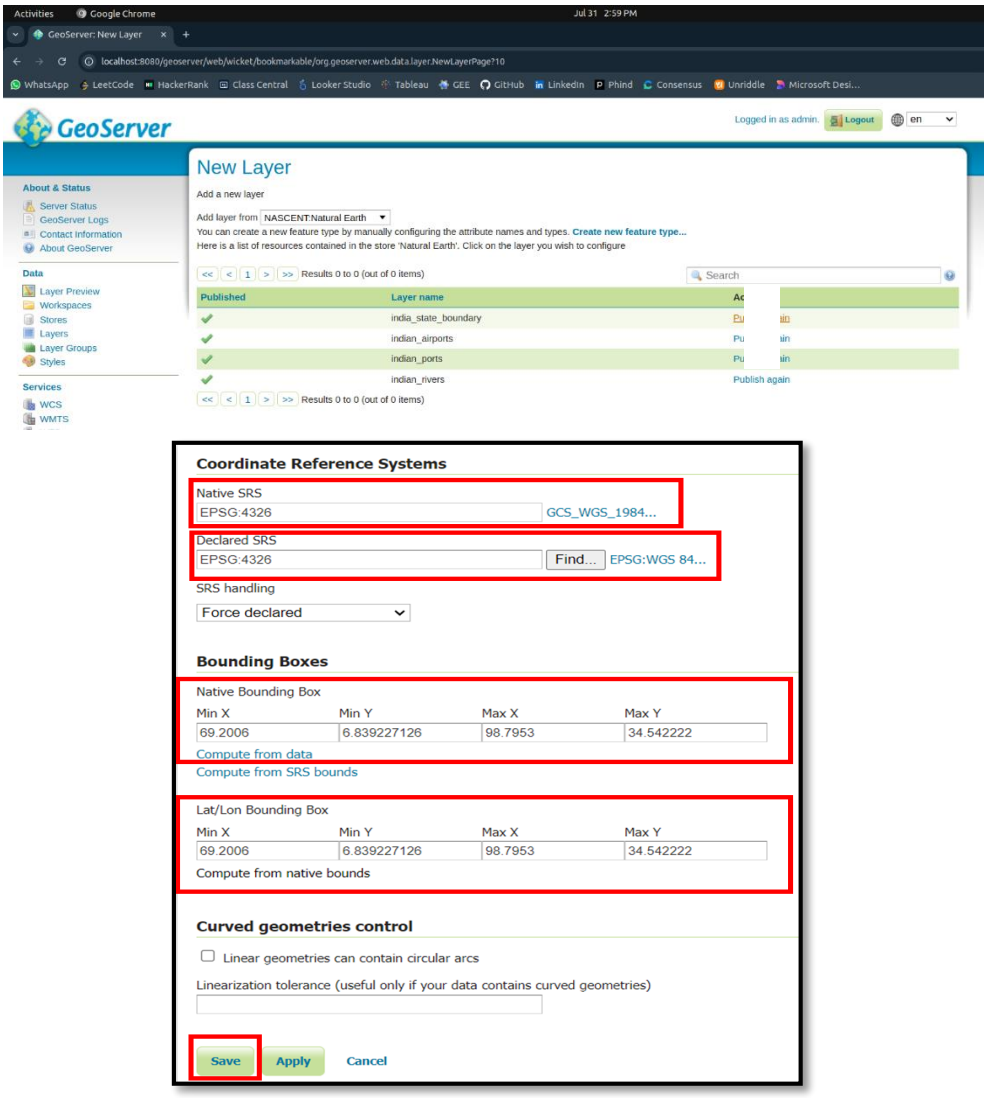


Figure 10 : Publish a new Layer

3.5 Uploading SLD Styles in Geo Server

1. Navigate to Styles

- In the Geo Server dashboard, go to the Styles section under the Data menu.

2. Add a New Style

- Click Add a new style.

3. Upload the SLD File

- Enter a name for the new style.
- Click the Browse button to select and upload the .sld file.
- Click Submit to upload and save the style.
- We do styling using .sld for river only for aiport and port we do styling in OpenLayer.

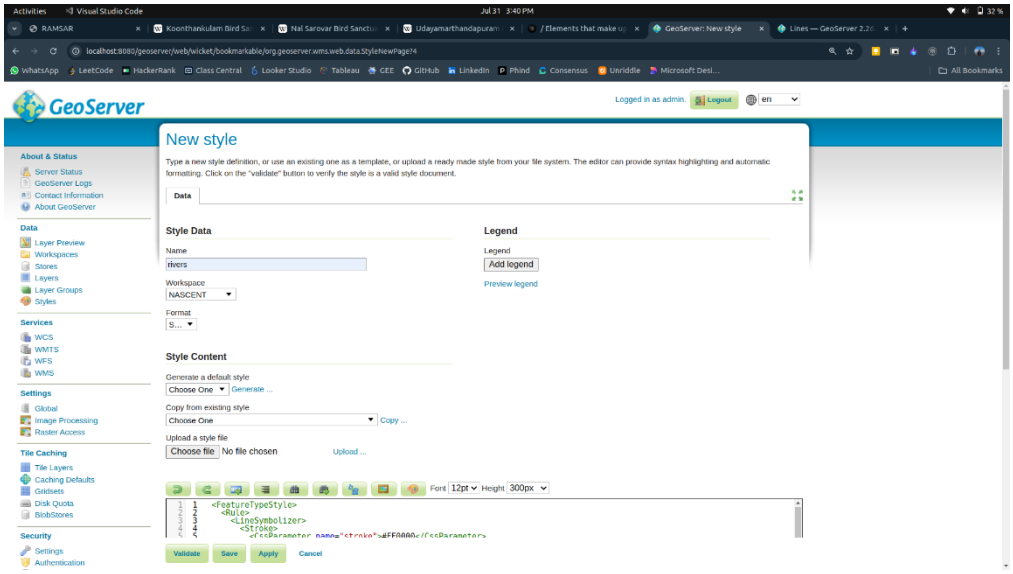


Figure 11 : Upload Style (SLD file) in Geo Server

3.6 Publishing Styles for a Specific Shapefile

1. Navigate to Layers

- Go to the Layers section under the Data menu.

2. Select the Layer

- Find and click on the layer that corresponds to the shapefile to style.

3. Edit the Layer

- Edit to access the layer settings.

4. Apply the Style

- In the Publishing tab, locate the Default Style section.
- Choose the newly uploaded style from the drop-down menu.

5. Save Changes

- Click Save to apply the style to the layer.

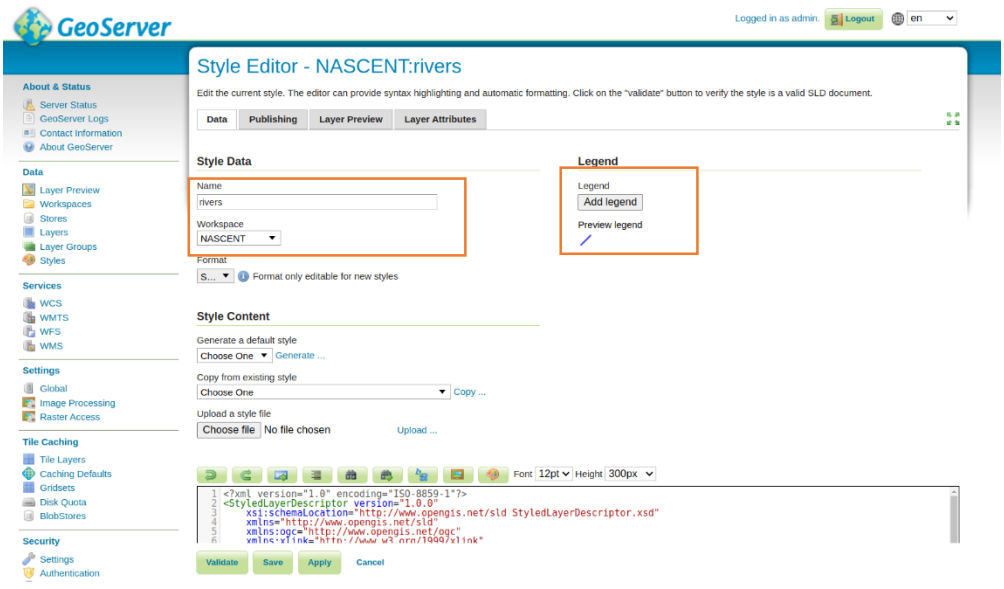


Figure 12 : Publish Style for particular SHP file

3.7 Layer Preview in Geo Server

- In the Geo Server dashboard, go to the Layer Preview section under the Data menu.
- In the Layer Preview page, we will see a list of all published layers.
- Find the layer to preview.
- Click on the Open Layers link.
- A new browser window or tab will open displaying an interactive map with selected layer rendered using Open Layers.

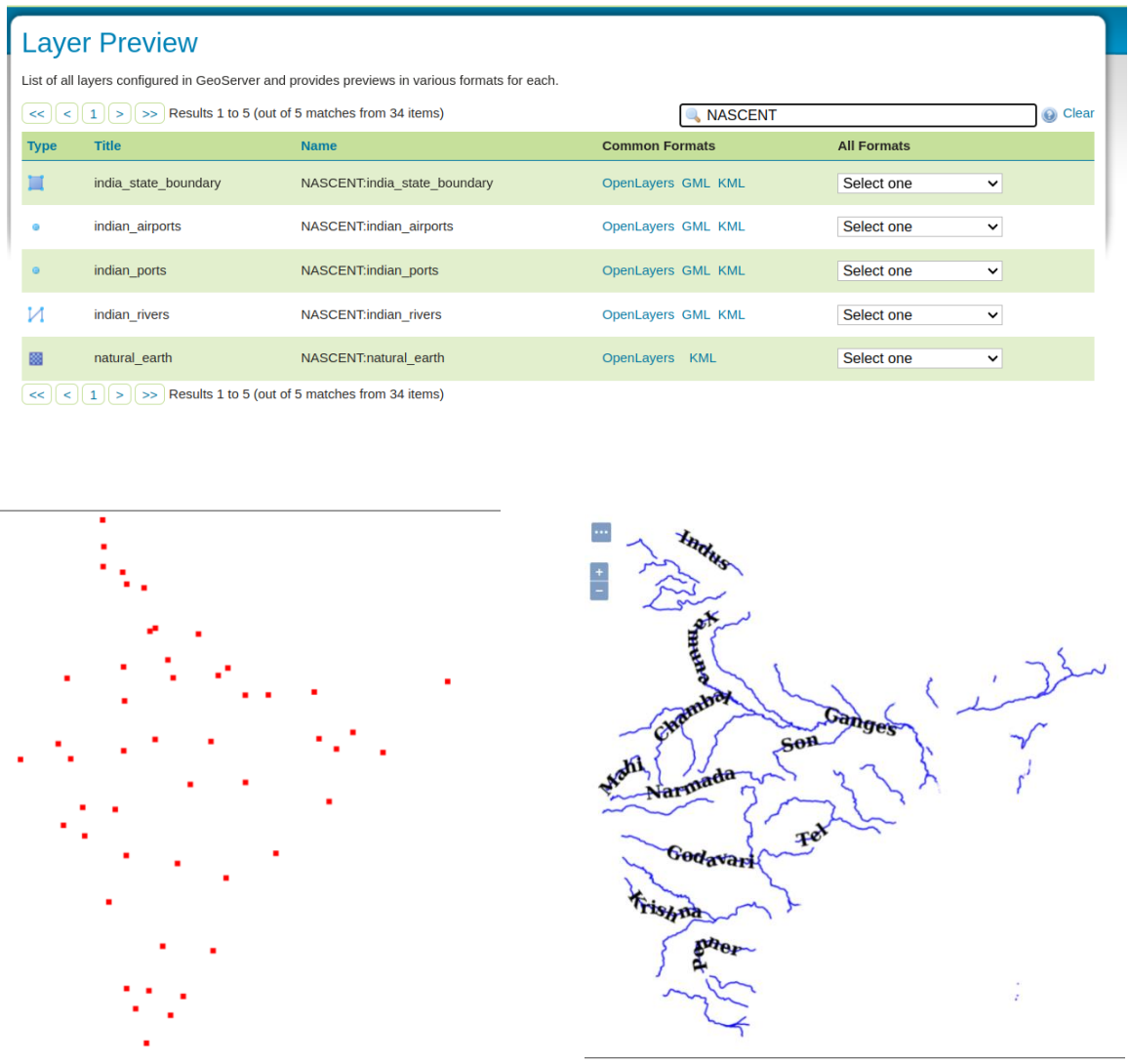


Figure 13 : Layer Preview in Geo Server

3.8 Installing CORS Extension:

To install the Google Chrome extension's CORS extension, which is necessary to manage Geo Server pop-ups. Secure cross-origin queries are made possible via the CORS extension, which improves interoperability across various online services. Applications for Geo Server that need to interface with different external resources without encountering security constraints may find this especially helpful. After installation, the CORS extension makes it possible to retrieve and interact with data quickly and smoothly, guaranteeing that pop-ups and other dynamic content from Geo Server work without a hitch.

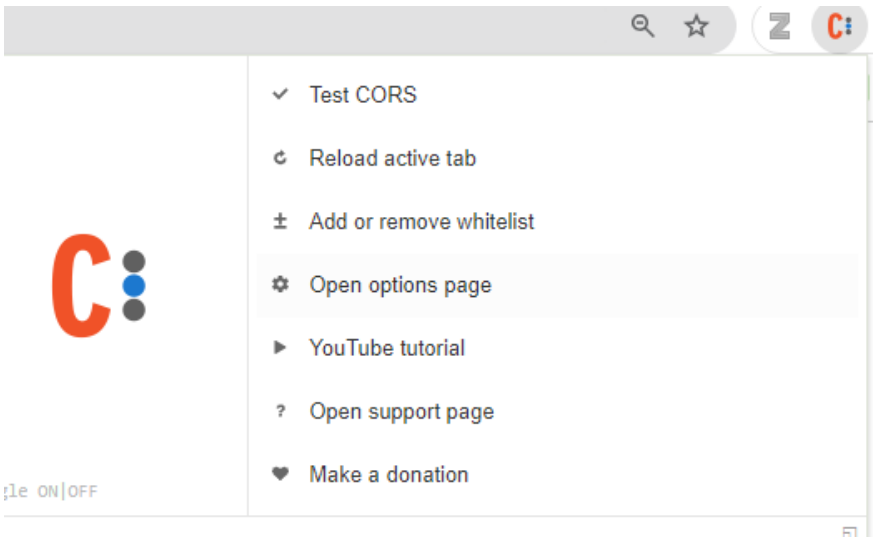


Figure 14 : CORS Extension

3.9 Create Code for an Interactive Map Visualization Application

Now that all the maps have been published on the server, we have to create a front-end web page which will allow the user to browse through the maps through multiple conditions and also change base maps and showing feature information. This was done using Hypertext Mark-up Language (HTML), Cascading Style Sheets (CSS) and JavaScript (JS) on the local server.

3.9.1 Feature-1: Select base Map

Users can choose between three options: Google Satellite or OSM map and Natural Earth Raster.

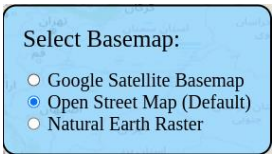


Figure 15: Select Base Map Button

3.9.2 Feature-2: Select Data Layers

Users can Select parameter Data layers: State Boundary, Airports, Rivers and Ports.

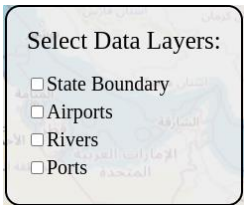


Figure 16: Select Data Layers Button

3.9.3 Feature-3: Show Legends

- This feature will allow users to view and hide the map's legend.
- There is hide and show button for legend to hide and view the legends in map.

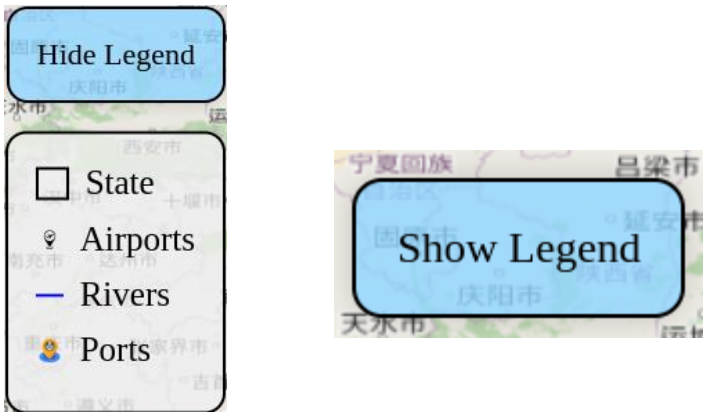


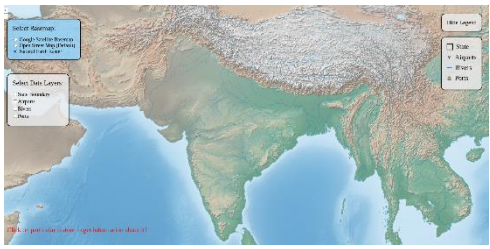
Figure 17 : Legend

4. Basemap and Data-Layer Display

4.1 Basemaps

OSM Map

Google Satellite



Raster Layer
(Natural Earth)

Figure 18 : Different Base Map

4.2 Data-Layer Display

❖ State Boundary Layer

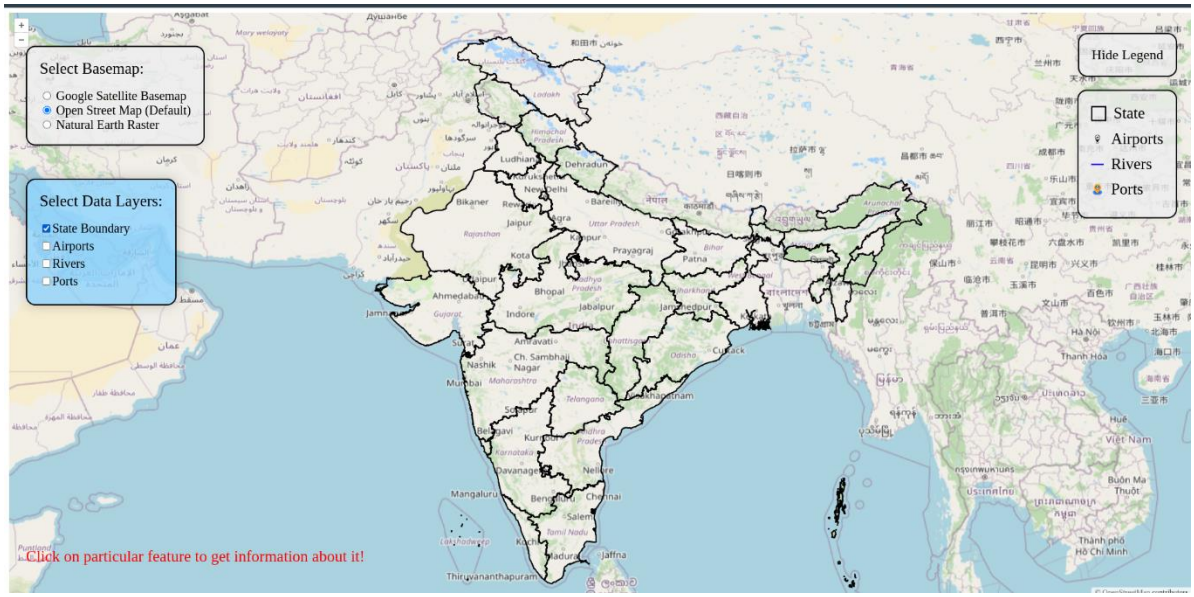


Figure 19: State Boundary Layer

❖ Airport Layer

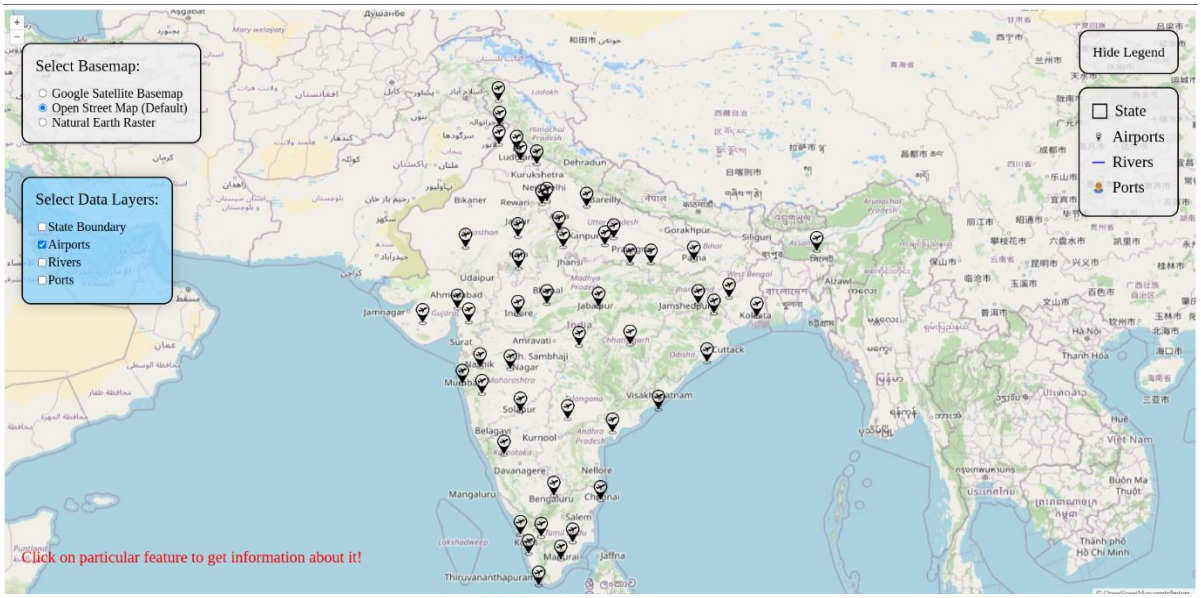


Figure 20 : Airport Layer

❖ River Layer

Figure 21 : River Layer

❖ Port Layer

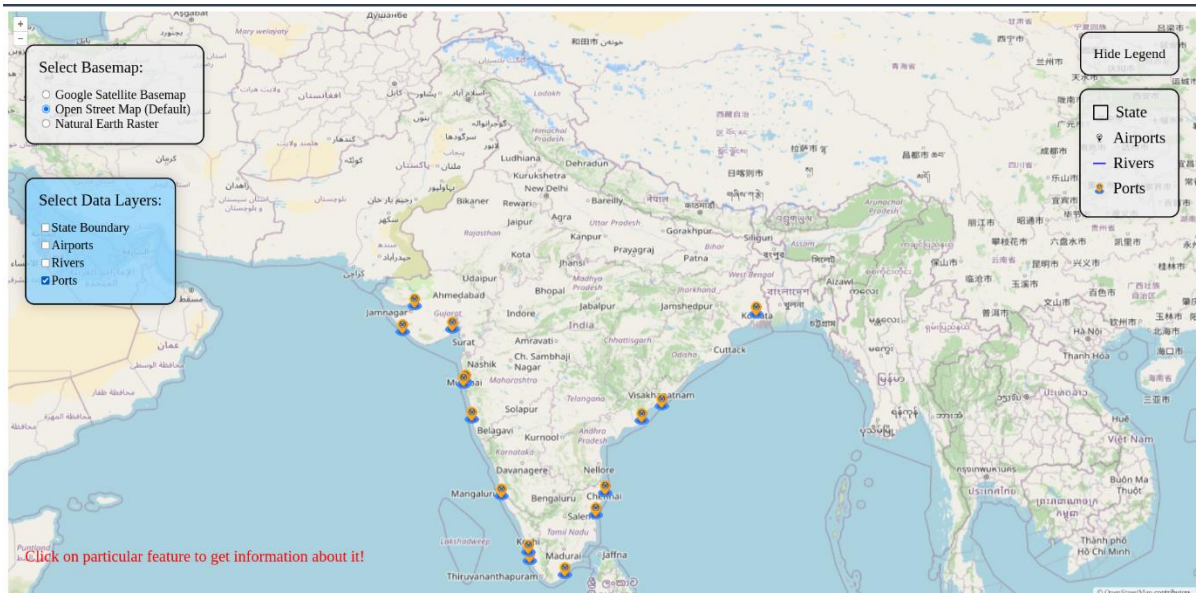
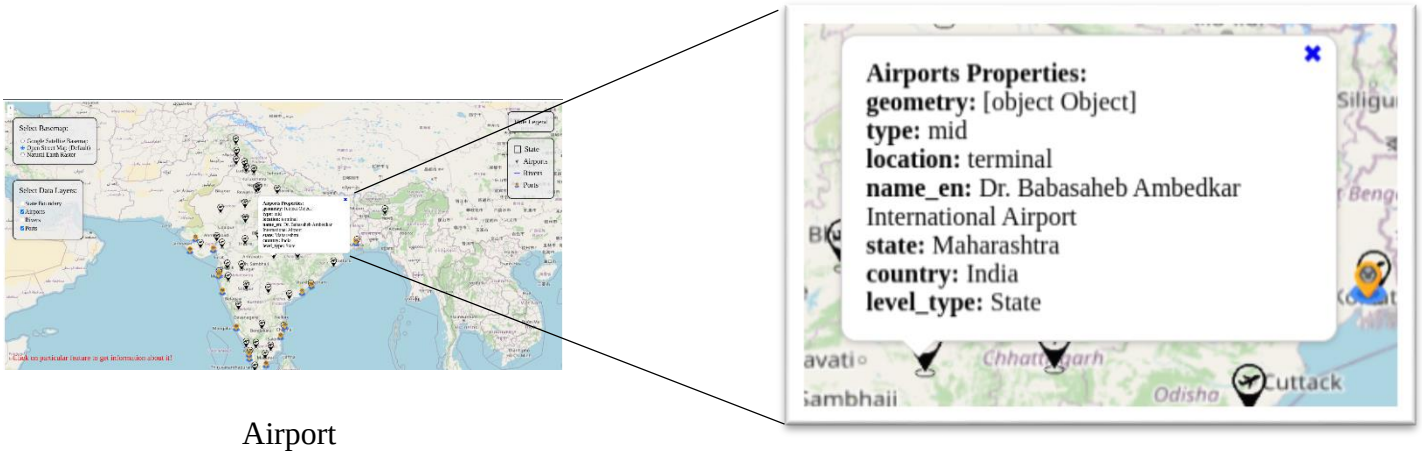


Figure 22 : Port Layer

❖ Combined All Layers

Figure 23 : Combined All Layers

4.3 Display Feature Information by Using Popup



Airport

Port

River

Figure 24: Display Feature Information

5 Project Demo (Video)

https://drive.google.com/file/d/1E8cv7IuPkrz9hvn3Gg3sMuGgblf3KIqm/view?usp=sharing