

Developing Web based Geographic Information Systems Application

M.Sc. Agriculture Analytics

Visualizing Indian Census Data using WebGIS



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1. Introduction

The process of methodically gathering, documenting, and computing population data about the individuals within a certain population is known as a census. This phrase is primarily used in relation to national housing and population surveys; other popular surveys include those related to commerce, supply, agriculture, traditional culture, and transportation.

The Indian Census has been a valuable source of data for scholars and researchers in demography, economics, anthropology, sociology, statistics and many other disciplines. The decadal census, which has evolved into a tool for comprehending and researching India, does, in fact, highlight the great diversity of the country's population. The Office of the Registrar General and Census Commissioner of India, Ministry of Home Affairs, Government of India, is in charge of carrying out the decadal census.

2. Data Collection:

We have collected two types of data i.e. CSV and Shape file.

CSV Data has been collected from <https://censusindia.gov.in/census.website/data/census-tables>. This is the official website of the Census India managed by the “Office of the Registrar General & Census Commissioner, India” under the “Ministry of Home Affairs, Government of India”.

Census data is collected every 10 years in India and the first census was collected in the year 1881 and the latest data we have is of the year 2011. Due to COVID-19 restrictions in 2021, the recording of population data was forbidden because it required surveyors to visit every household. Still, it would only promote the spread of the disease.

The website gives us the choice to select from the years 1991, 2001 and 2011. We have selected 2011 as our period of interest. The attributes we have chosen to study and visualize are TOTAL POPULATION, HOUSEHOLDS, RELIGION and SEX.

Shape file has been downloaded for Gujarat state with district boundaries from the year 2011 because some of the districts which are currently present did not exist in 2011. It consisted of district boundaries, ID and the name of the district.

3. Methodology

3.1 Flow Chart:

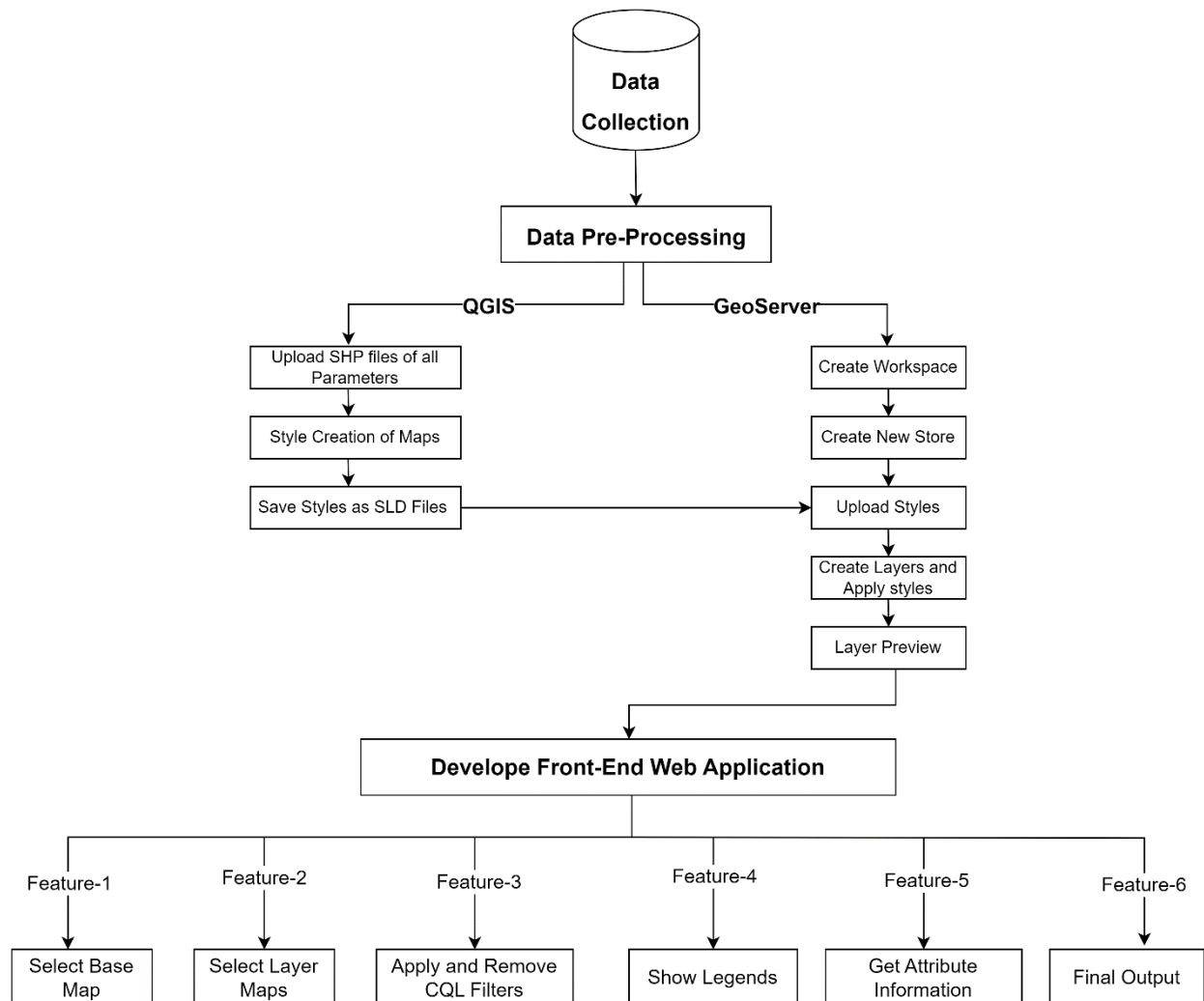


Figure 1: Flow Chart

4. Data Pre-processing:

From the census website, we downloaded the raw data for the aforementioned attributes. Then we have Prepared common CSV of all the parameters like District Code, Area Name, Total Population, Total Male Population, Total Female Population, and Households.

Next, we combined this CSV file with the Shape file. Subsequently, incorporate three additional columns to represent the male, female, and household percentages, by using field calculator:

$$(100 * \text{Total male/female/household}) / (\text{Total Population}).$$

Following that, we made separate shape files for each of the four characteristics needed to construct maps. Separate SHP files for each set of parameters simplify future work flow. The attribute table of each of the four separate SHP files has four columns: state, district, id, and corresponding parameter.

	ST_NM	DISTRICT	ID	POPULATION
1	Gujarat	Mahesana	471	2035064
2	Gujarat	Panch Mahals	484	2390776
3	Gujarat	Porbandar	478	585449
4	Gujarat	Surat	492	6081322
5	Gujarat	Surendranagar	475	1756268

	ST_NM	DISTRICT	ID	MALE	MALE_PER
1	Gujarat	Mahesana	471	1056520	52
2	Gujarat	Panch Mahals	484	1226961	51
3	Gujarat	Porbandar	478	300209	51
4	Gujarat	Surat	492	3402224	56
5	Gujarat	Surendranagar	475	909917	52

	ST_NM	DISTRICT	ID	FEMALE	FEMALE_PER
1	Gujarat	Mahesana	471	978544	48
2	Gujarat	Panch Mahals	484	1163815	49
3	Gujarat	Porbandar	478	285240	49
4	Gujarat	Surat	492	2679098	44
5	Gujarat	Surendranagar	475	846351	48

	ST_NM	DISTRICT	ID	HH_number	HOUSEHOLD
1	Gujarat	Mahesana	471	423463	21
2	Gujarat	Panch Mahals	484	446049	19
3	Gujarat	Porbandar	478	124117	21
4	Gujarat	Surat	492	1319820	22
5	Gujarat	Surendranagar	475	342144	19

Figure 2:Attributes of SHP files

5. Workflow:

5.1 Step-1: Style Creation in QGIS

We have created maps and styled them in QGIS according to many factors, such as labels, Color gradients, the number of classes, etc. And saved this style as SLD files.

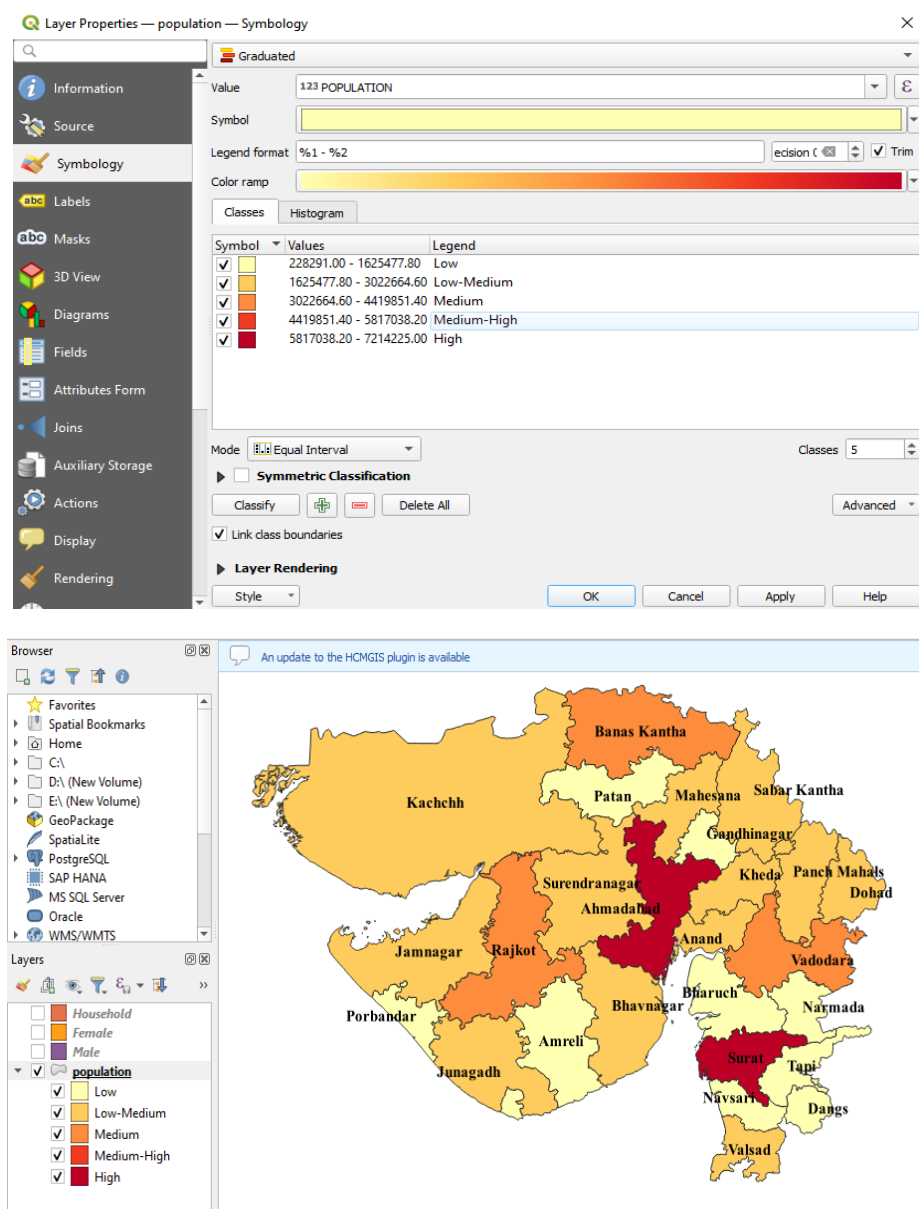


Figure 3: Style in QGIS

5.2 Step-2: Publishing Maps on GeoServer:

5.2.1 Create Workspace on Geoserver:

After logging into Geoserver, we must first establish our workspace.

- Click on “workspace”.
- Click on “Add new Workspace”.
- Then type localhost in “Namespace URL”.
- Click “Save” to save your workspace.

The screenshot shows the GeoServer web interface. On the left, the 'Workspaces' link under the 'Data' section is highlighted with a red box. The main panel is titled 'New Workspace' and contains a form to 'Configure a new workspace'. The 'Basic Info' tab is selected. The 'Name' field is filled with 'drashti' and the 'Namespace URI' field is filled with 'localhost'. Both fields are highlighted with a red box. Below these fields, there are two checkboxes: 'Default Workspace' and 'Isolated Workspace', both of which are unchecked. At the bottom of the form, the 'Save' button is highlighted with a red box, and the 'Cancel' button is visible next to it.

Figure 4: Create Workspace in Geoserver

5.2.2 Create New Store:

- Click on “stores”.
- Click on “Add new Store”.
- Click on “Directory of spatial files (shapefiles)”.
- Select your Workspace.
- Add Data source name and then browse and select folder containing all SHP files.
- Click save to upload SHP files.

The screenshot shows the GeoServer web interface. On the left sidebar, under the 'Data' section, the 'Stores' link is highlighted with a red rectangle. The main panel is titled 'New Vector Data Source'. Below the title, it says 'Add a new vector data source' and 'Directory of spatial files (shapefiles)'. The 'Basic Store Info' section contains a 'Workspace' dropdown menu with 'drashti' selected and a 'Data Source Name' text field with 'gujarat' entered. The 'Connection Parameters' section has a 'Directory of shapefiles' text field with 'file:///E:/drashti/Nescent_project/Data/shp file' entered. At the bottom of this section, there are several checkboxes: 'Enabled' (checked), 'Auto disable on connection failure' (unchecked), 'Create spatial index if missing/outdated' (checked), 'Use memory mapped buffers (Disable on Windows)' (unchecked), 'Cache and reuse memory maps (Requires 'Use Memory mapped buffers' to be enabled)' (checked), and 'Clip area of optional alternative shapefile extensions (i.e. .sho.XML, .Coo, ...) on Not-Windows systems' (checked). A red rectangle highlights the 'Save' button at the bottom of the form.

Figure 5: Create Store in Geoserver

5.2.3 Upload Styles:

- Click on “Styles”.
- Click on “Add new style”.
- Give name to style.
- Select your Workspace and format to style file.
- Click on choose file and then upload.
- Than click on preview legends to validate.
- Then Click on save to upload style.

New style

Type a new style definition, or use an existing one as a template, or upload a ready made style from your file system. The editor can provide syntax highlighting and autom formatting. Click on the "validate" button to verify the style is a valid style document.

Data

Style Data

Name: TotalPopulation

Workspace: drashti

Format: SLD

Legend

Add legend

Preview legend

Low

Low-Medium

Medium

Medium-High

High

Style Content

Generate a default style: Choose One

Copy from existing style: Choose One

Upload a style file: Choose File (No file chosen)

Font: 12pt | Height: 300px

```
<?xml version="1.0" encoding="UTF-8"?>
<styleLayerDescriptor xmlns="http://www.opengis.net/sld" xmlns:xsi="http://www.w3.org/2001/XMLSchema-Instance" version="1.1.0"
xmlns:ogc="http://www.opengis.net/ogc" xsi:schemaLocation="http://www.opengis.net/sld
http://schemas.opengis.net/sld/1.1.0/StyledLayerDescriptor.xsd" xmlns:xlink="http://www.w3.org/1999/xlink"
xmlns:se="http://www.opengis.net/se">
  <namedLayer>
    ...
  </namedLayer>
</styleLayerDescriptor>
```

Validate Save Apply Cancel

Manage the Styles published by GeoServer

+ Add a new style - Removed selected style(s)

<< < 1 > >> Results 1 to 4 (out of 4 matches from 31 items)

drashti Clear

<input type="checkbox"/>	Style Name	Format	Workspace
<input type="checkbox"/>	Female	SLD 1.1	drashti
<input type="checkbox"/>	Household	SLD 1.1	drashti
<input type="checkbox"/>	Male	SLD 1.1	drashti
<input type="checkbox"/>	TotalPopulation	SLD 1.1	drashti

Figure 6:Upload Style in Geoserver

5.2.4 Create Layers:

- Click on “Layers”.
- Click on “Add new Layer”.
- Select Store where you have uploaded SHP files.
- Click on “publish”.
- Give name to your Layer.
- Then adjust bounding Box.
- Click on “publishing”.
- Select the style you have uploaded for that particular layer.

New Layer

Add a new layer

Add layer from: **drashti:guj**

You can create a new layer by configuring the attribute names and types. [Create new feature type...](#)

Here is a list of resources contained in the store 'guj'. Click on the layer you wish to configure

Published	Layer name	Action
	gujarat	Publish

Results 0 to 0 (out of 0 items)

Edit Layer

Configure the resource and publishing information for the current layer

Basic Resource Info

Store Name: guj

Native Name: gujarat

Name: **TotalPopulation**

Bounding Boxes

Native Bounding Box

Min X	Min Y	Max X	Max Y
68.1862489922762	20.120943019834737	74.47662991936565	24.708482440404783

Compute from data

Compute from SRS bounds

Lat/Lon Bounding Box

Min X	Min Y	Max X	Max Y
68.1862489922762	20.120943019834737	74.47662991936565	24.708482440404783

Compute from native bounds

Layer Settings

☒ Queryable

☐ Opaque

Default Style: **drashti:TotalPopulation**

☐ Low

☐ Low-Medium

☐ Medium

☐ Medium-High

☐ High

Additional Styles

Available Styles
burg
capitals
...

Save Apply Cancel

Results 1 to 4 (out of 4 matches from 28 items)

Type	Title	Name	Store	Enabled	Native SRS
<input type="checkbox"/>	Female	drashti:Female	shape	✓	EPSG:4326
<input type="checkbox"/>	Household	drashti:Household	shape	✓	EPSG:4326
<input type="checkbox"/>	Male	drashti:Male	shape	✓	EPSG:4326
<input type="checkbox"/>	population	drashti:TotalPopulation	shape	✓	EPSG:4326

Figure 7: Add Layers to Geoserver

5.2.5 Layer Preview:

- Click on “Layer Preview” to open the maps or layer uploaded by you.
- Click on open layers to preview the layers.

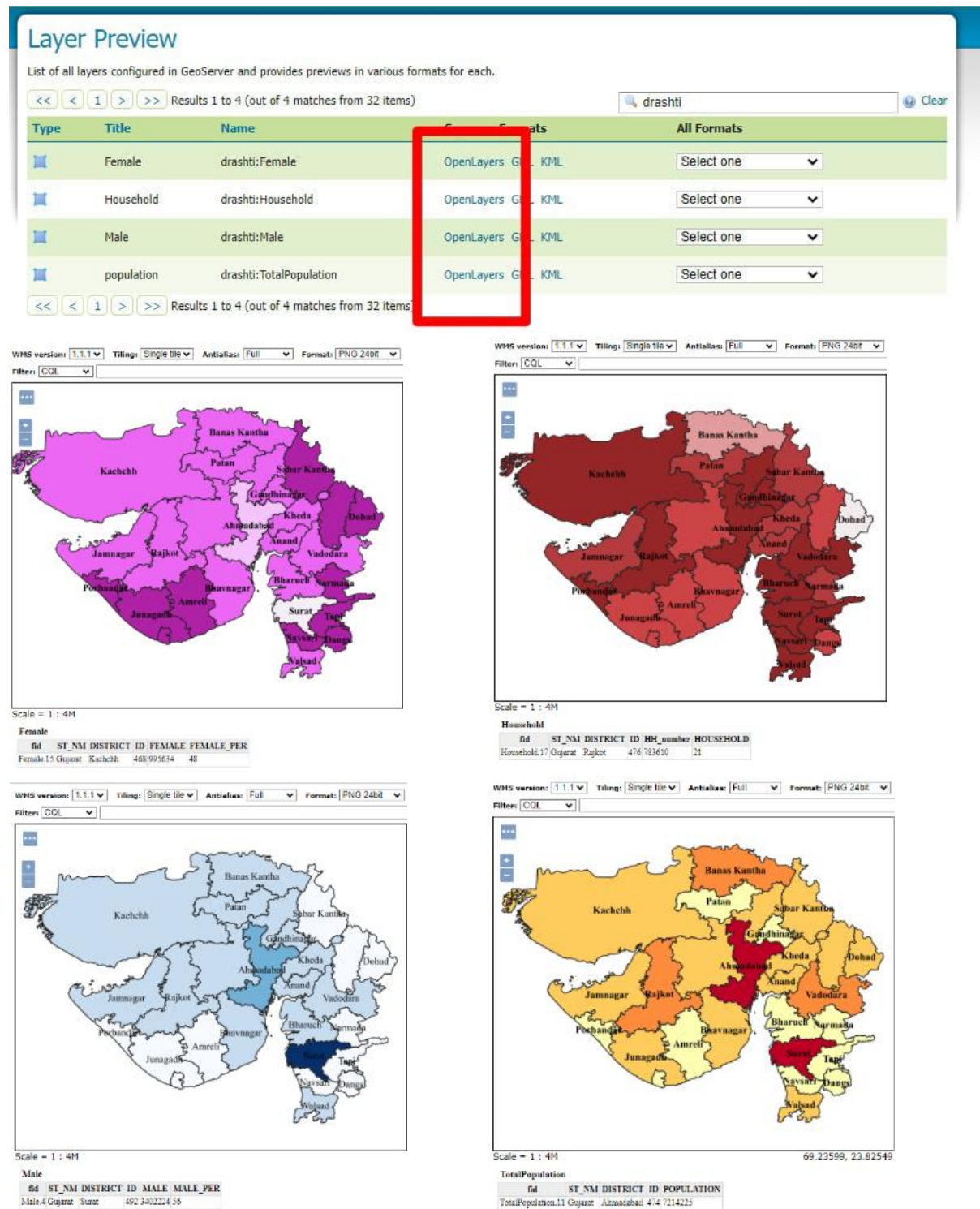


Figure 8: Layer Preview on Geoserver

5.3 Step-3: Installing CROS Extension:

To install the Google Chrome extension's CROS extension, which is necessary to manage Geo Server pop-ups. Secure cross-origin queries are made possible via the CROS 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 CROS 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.

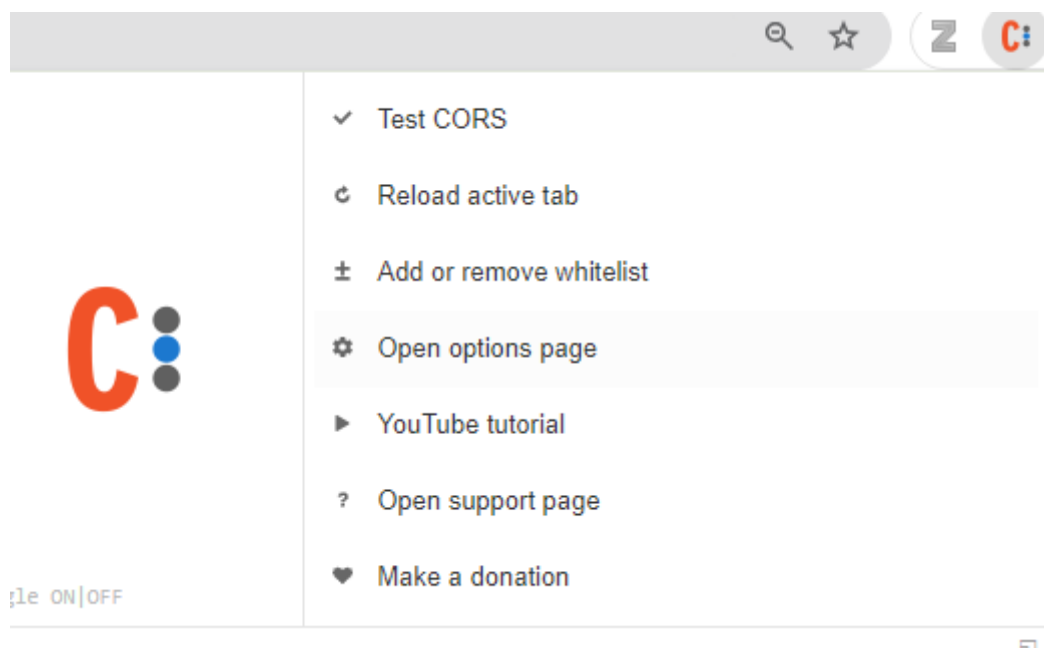


Figure 9: CROS Extension

5.4 Step-4: Front-end Web Application:

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

5.4.1 Feature-1: Select base Map

Users can choose between two options: Google Satellite or OSM maps.

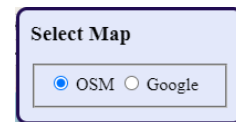


Figure 10: Select Map Button

5.4.2 Feature-2: Select Parameter Maps Layer

Users can Select parameter maps layer: Total Population, Percentage Male Population, Percentage Female Population and Percentage Household.

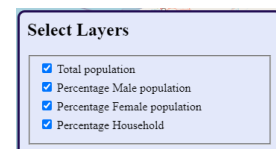


Figure 11: Select Layers Button

5.4.3 Feature-3: Apply and Remove CQL Filters

we have added feature to apply and remove CQL filters. criteria such as none, more than, equal to, and less than were made available to users. and the data will be filtered out, and the map will display appropriately, when the user enters the value of desire for filtration and clicks the apply filter button.

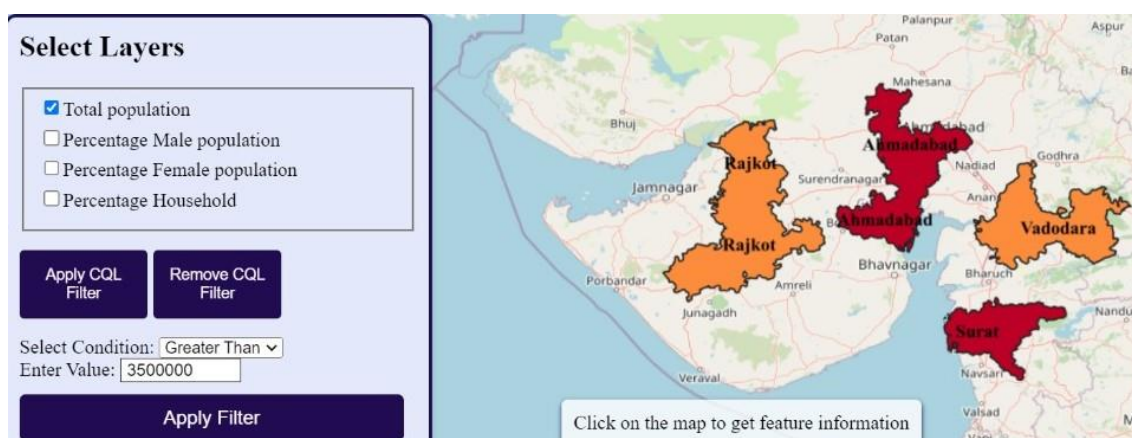


Figure 12: Apply and Remove CQL Filters

5.4.4 Feature-4: Show Legends

This feature will allow users to view the map's legends.

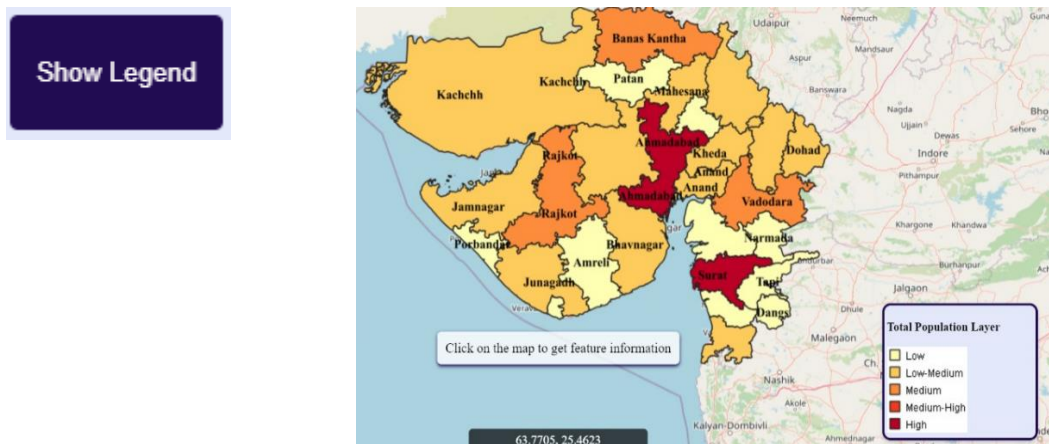


Figure 13: Show Legends

5.4.5 Feature-5: Get Attribute Information

When a user clicks on a particular district on the map, a table with the district's attributes and layer information is displayed.

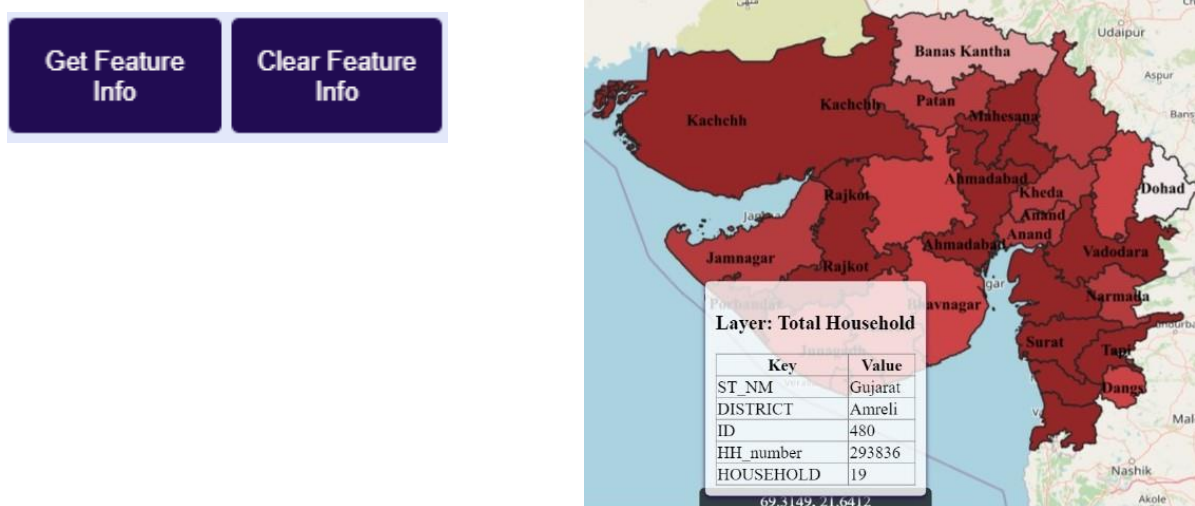


Figure 14: Get Attribute Information

5.4.6 Feature-6: Final Output

This is the final output. Here, user can select OSM or Google satellite Map. And can toggle through the different layers and on clicking a particular district, we can get the information about it like name of district, district ID and data on attribute selected.

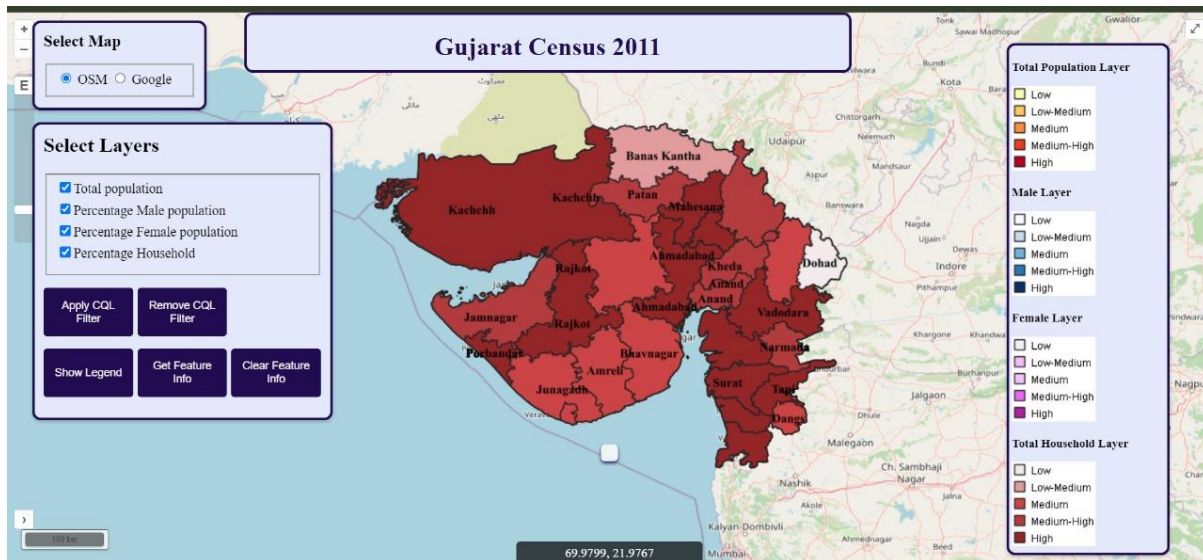


Figure 15: Final Output

Home Page Of Application:



Figure 16: Home Page Of Application

6. Outcomes:

This course has provided us with a comprehensive understanding of WebGIS, covering its concepts, applications, and use cases. After learning how to develop and implement web-based geographic information systems, we now have a better understanding of the practical uses of WebGIS. The hands-on project was especially helpful since it showed us how to create a simple web application from scratch. Our theoretical knowledge was strengthened by this experience, which also improved our technical proficiency. With every aspect considered, the training has been quite helpful in providing us with the skills and information we need to use WebGIS efficiently in a variety of situations.