From Drought to Floods: A Step-by-Step Guide

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This project was carried out through the Impact Seed Fund (ISF), an initiative by the Pulitzer Center.

The same analysis that we performed in this guide for Ciudad del Plata could easily be replicated using open datasets from your own country. By following the step-by-step process laid out here and adapting it to locally available geospatial, environmental, and census data, you can identify and analyze vulnerable areas in the face of climate change.

Warning
This guide is designed to help you understand and use some basic functions of Geographic Information System (GIS) software. The example case presented is for instructional purposes only. The final results obtained from this guide should be considered as an approximation to the topic of study and not as definitive or corroborated conclusions. To properly interpret the results and apply the knowledge effectively, it is highly recommended to involve subject matter experts. We emphasize the importance of this recommendation to ensure rigorous and accurate analysis.

Step 1: Create a Base Map

A base map is a starting point for any geographical analysis, as it provides the spatial context needed to interpret the data to be analyzed or visualized. It serves as a canvas on which additional layers of information are overlaid, allowing users to understand the location, extent, and spatial relationships of the data. For journalists, having a clear and well-designed base map helps convey complex stories in a visual, comprehensible, and accurate way, highlighting patterns, connections, or areas of interest within a broader geographical context.

Google Map as base map

Using a Google Maps satellite map as a base is a convenient choice due to its high level of detail and constant updates, ensuring an accurate and reliable representation of the terrain. Its familiarity to the public makes it easier to interpret and contextualize the presented information, as it serves as a widely recognized reference. Moreover, its satellite view provides a level of visual realism that is particularly useful for analyses requiring the identification of specific environmental features, such as infrastructure, vegetation, or urban areas, offering a clear and accessible perspective to enhance journalistic analysis.

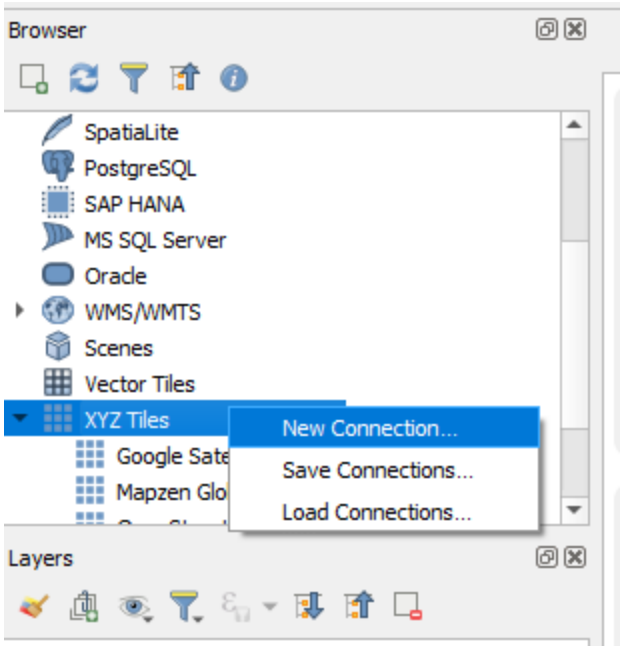
1.1 In the Browser panel:

In QGIS, look for the “XYZ Tiles” option in the Browser on the left side of the screen.

1.2 Create a New Connection:

1.2.1 Right-click on “XYZ Tiles”.

1.2.2 Select “New Connection”.

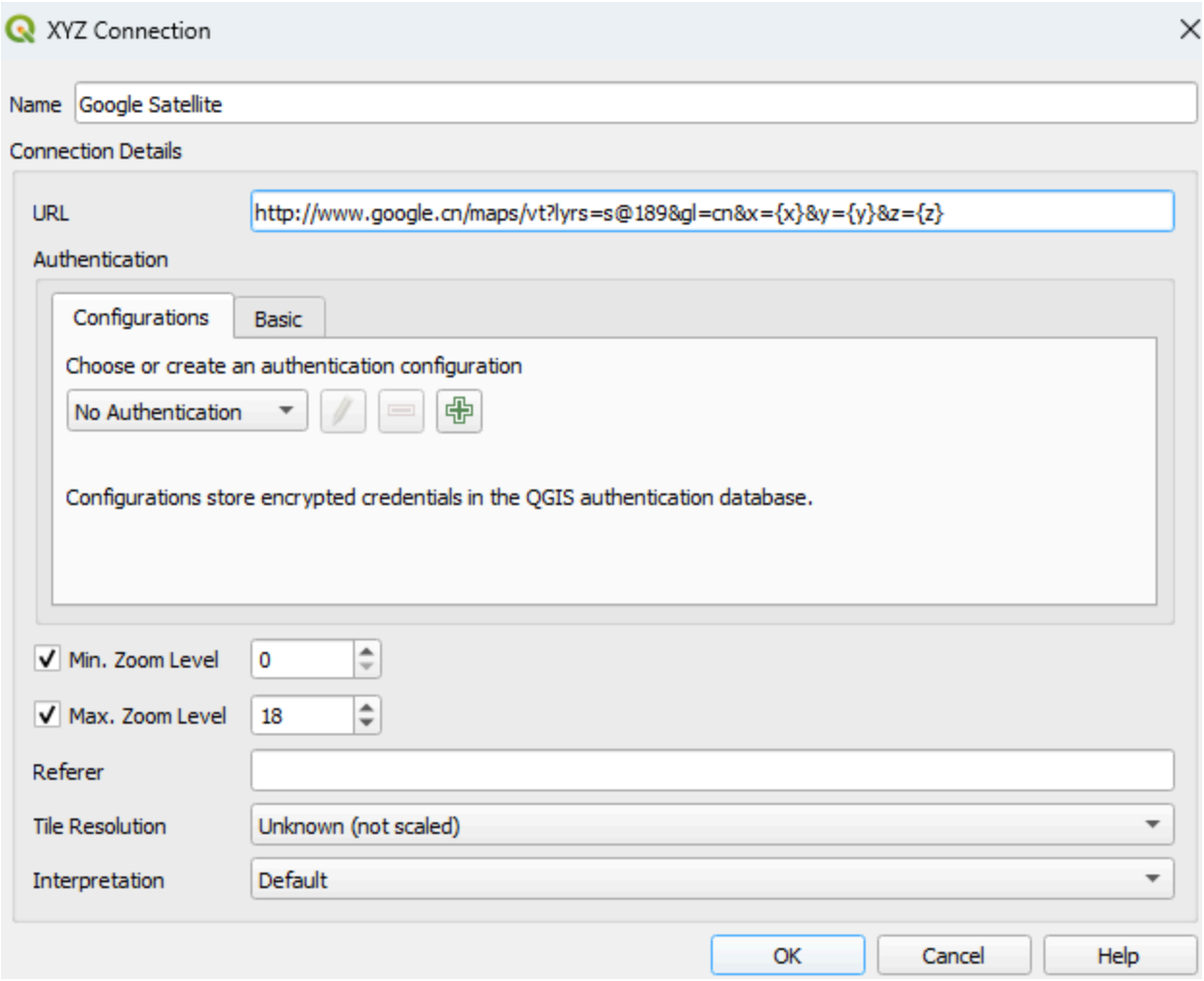


1.3 Configure the XYZ Connection:

1.3.1 In the “XYZ Connection” window that appears, fill in the fields as follows:

- Name: Google Satellite
- URL: http://www.google.cn/maps/vt?lyrs=s@189&gl=cn&x={x}&y={y}&z={z}

1.3.2 Leave the other fields with their default values and click OK.



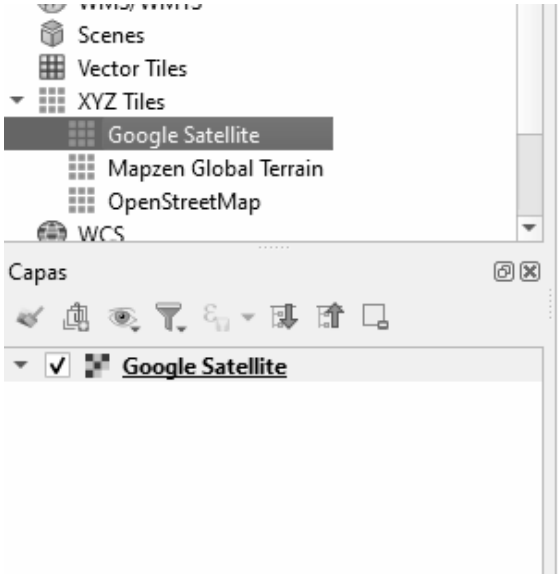
1.4 Add the Google Satellite Layer:

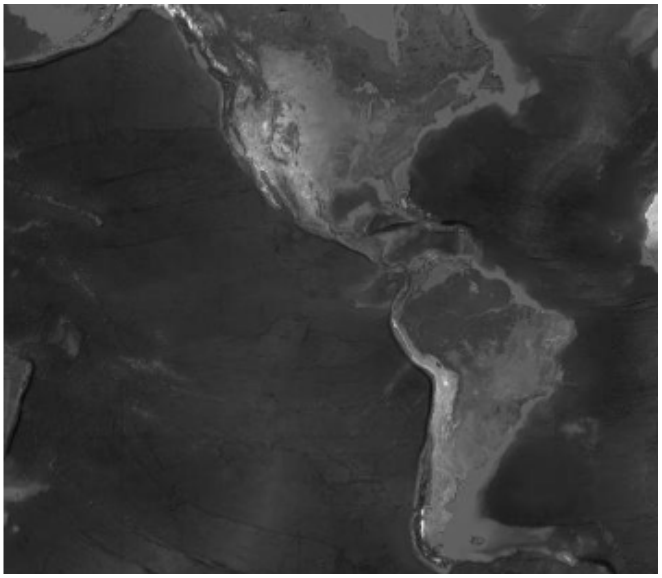
1.4.1 In the “XYZ Tiles” option of the browser, you should see the connection you just created called “Google Satellite”.

1.4.2 Double-click on “Google Satellite”.

1.4.3 Double-clicking will load a layer with the same name in the Layers panel and display the world satellite map in the Map Area.

1.4.4 You can zoom in or out on the map using the mouse wheel or the zoom tools in the toolbar.





You can create connections to other Google maps (and other sources) following the same procedure. Here are the URLs to add other types of Google maps:

- Google Maps: https://mt1.google.com/vt/lyrs=r&x={x}&y={y}&z={z}
- Google Satellite: http://www.google.cn/maps/vt?lyrs=s@189&gl=cn&x={x}&y={y}&z={z}
- Google Hybrid: https://mt1.google.com/vt/lyrs=y&x={x}&y={y}&z={z}
- Google Terrain: https://mt1.google.com/vt/lyrs=t&x={x}&y={y}&z={z}
- Google Traffic: https://mt1.google.com/vt/lyrs=h@159000000,traffic|seconds_into_week:-1&style=3&x={x}&y={y}&z={z}
- Google Roads: https://mt1.google.com/vt/lyrs=h&x={x}&y={y}&z={z}

Uruguay's Spatial Data Infrastructure Base Map (IDEuy)

The maps provided by IDE Uruguay offer significantly higher resolution for the Uruguayan territory compared to Google Maps, making them an ideal tool for more detailed and precise local analyses. These cartographic layers are often specifically designed to reflect the country's geographical, administrative, and environmental features, ensuring greater relevance and accuracy. Additionally, as they are generated by official institutions, they guarantee data quality and consistency, allowing journalists to work with a reliable foundation to investigate complex issues or convey stories that require a higher level of geographical detail.

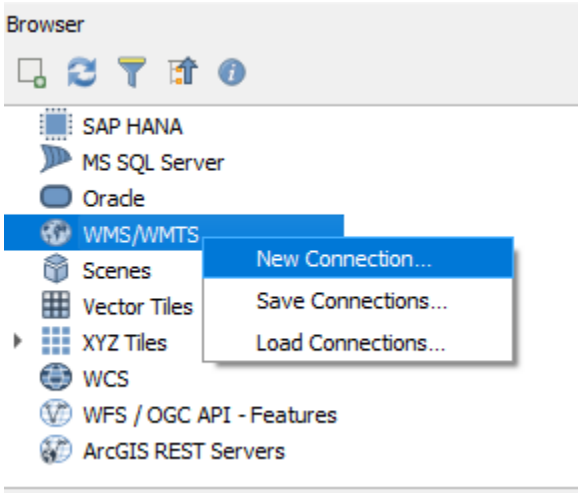
1.1 In the Browser panel:

In QGIS, look for the "WMS/WMTS" option in the Browser panel on the left side of the screen.

1.2 Create a New Connection:

1.2.1 Right-click on "WMS/WMTS".

1.2.2 Select "New Connection".



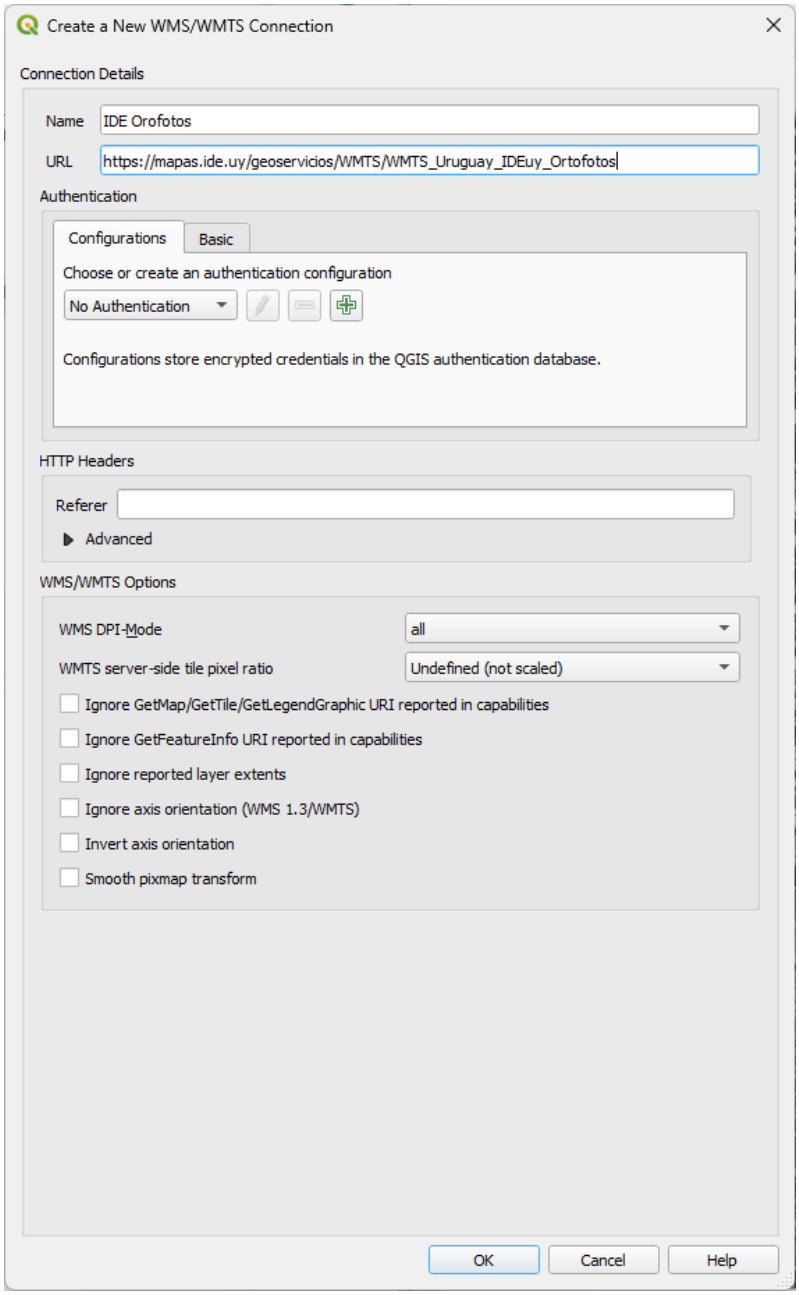
1.3 Configure the WMS/WMTS Connection:

1.3.1 In the "WMS/WMTS Connection" window that appears, fill in the fields as follows:

- Name: IDE Orthoimages

- URL: https://mapas.ide.uy/geoservicios/WMTS/WMTS_Uruguay_IDEuy_Ortofotos

1.3.2 Leave the other fields with their default values and click OK.



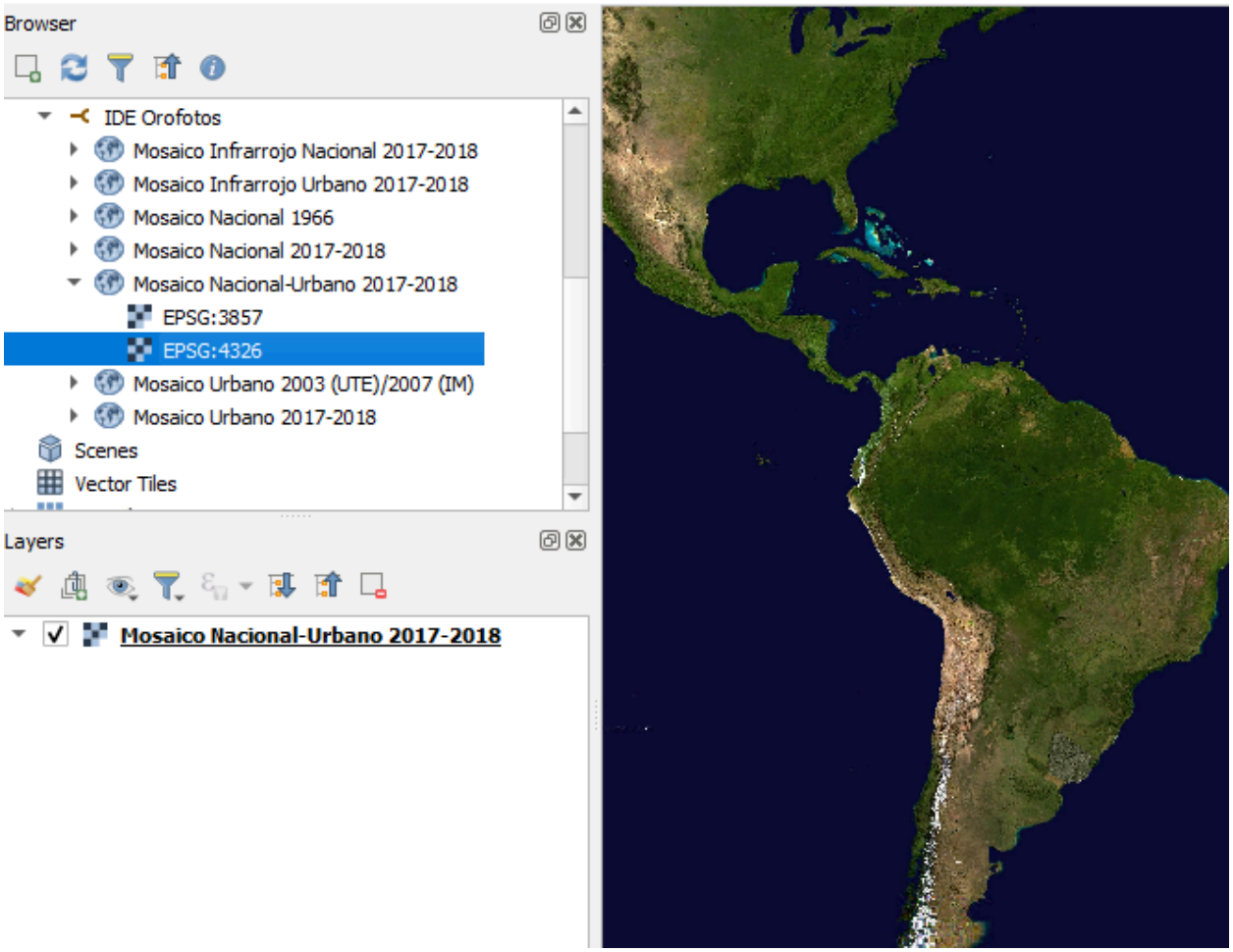
1.4 Add the IDEuy Layer:

1.4.1 In the “WMS/WMTS” option of the Browser panel, you should see the connection you just created called “IDE Orthoimages”. It will contain different national and urban maps over various time periods.

1.4.2 Add the map “Mosaico Nacional-Urbano 2017-2018” (National-Urban Mosaic 2017-2018). Two projections will be available. Choose the appropriate one for your project and double-click on the projection to add it to the Layers Panel.

1.4.3 Double-clicking will load a layer with the same name in the Layers Panel and display the world satellite map in the Map Area.

1.4.4 You can zoom in or out on the map using the mouse wheel or the zoom tools in the toolbar.



Step 2: Open a Flood Projection Layer for Ciudad del Plata

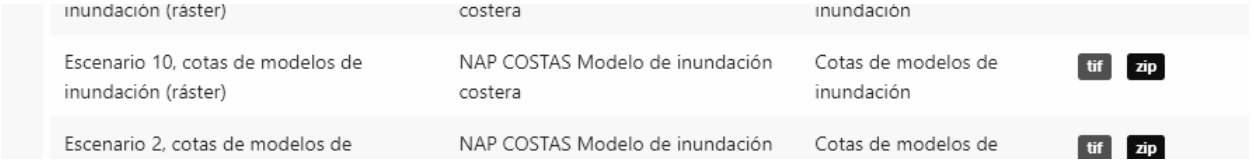
Once the base map is loaded, the next step is to add the first analysis layer, which introduces specific information to the previously established geographic context. In this case, we will use a layer representing the flood projection surface for Ciudad del Plata. This layer allows us to identify areas susceptible to flooding, which is essential for understanding associated risks and visualizing how they overlap with the surrounding environment. This step-by-step approach, moving from a general context to detailed analysis, makes spatial data easier to interpret and helps journalists tell visually rich, evidence-based stories.

2.1 Download the flood projection layer from Uruguay's National Environmental Observatory of the Ministry of Environment (National Environmental Observatory URL).

2.1.1 In the website menu, click on "Datos" (Data) and then on "Datos Abiertos" (Open Data) in the dropdown menu.

2.1.2 Search for datasets containing the word "inundación" (flood).

2.1.3 In the results, identify the dataset “Escenario 10, cotas de modelos de inundación (ráster)” (Scenario 10, flood model elevations (raster)).



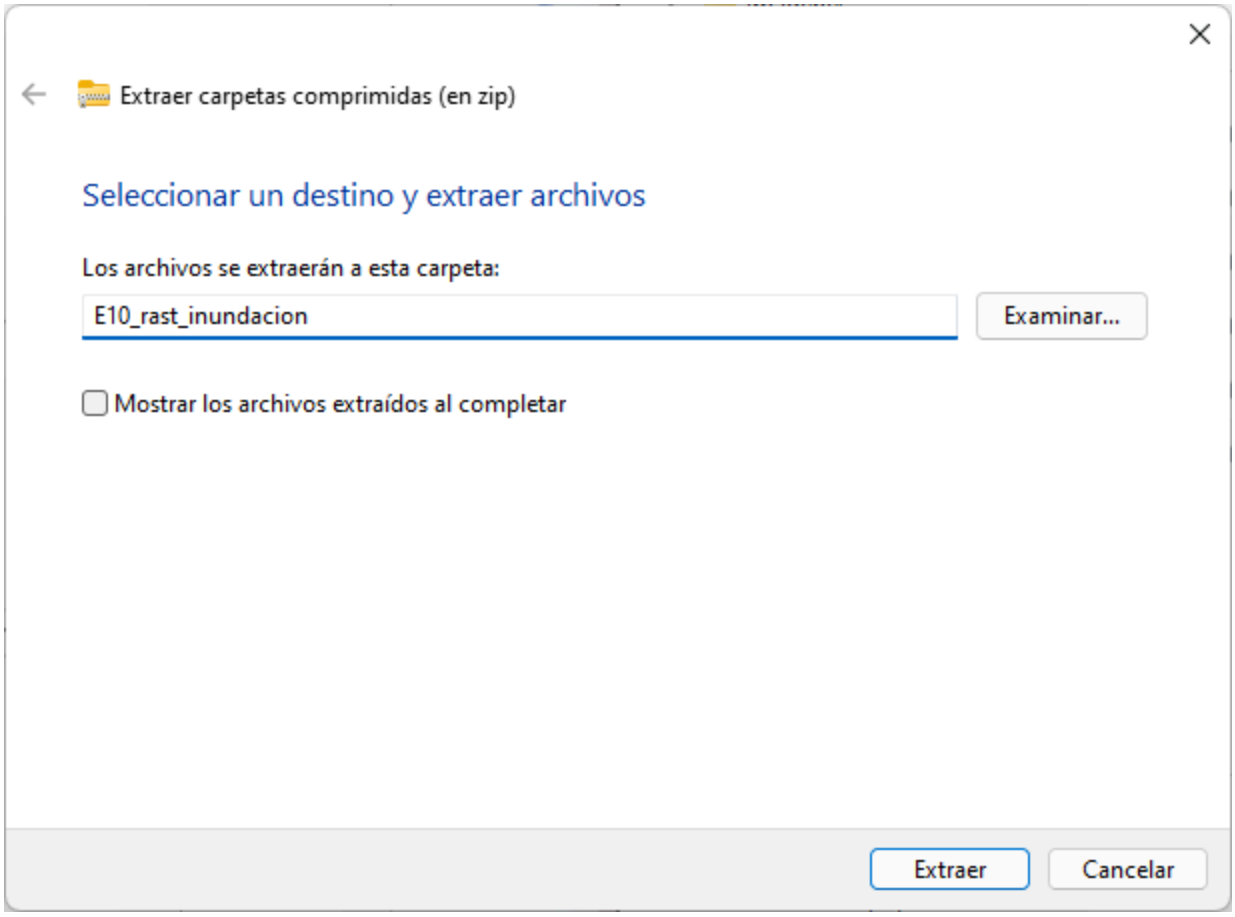
- Download the zip file corresponding to Scenario 10.

2.2 Unzip the downloaded file:

2.2.1 Locate the downloaded file in Windows Explorer.

2.2.2 Right-click on the file and select “Extract All”.

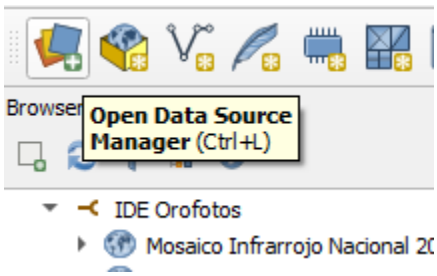
2.2.3 In the window that opens, select the location where you will store the extracted files and click Extract.



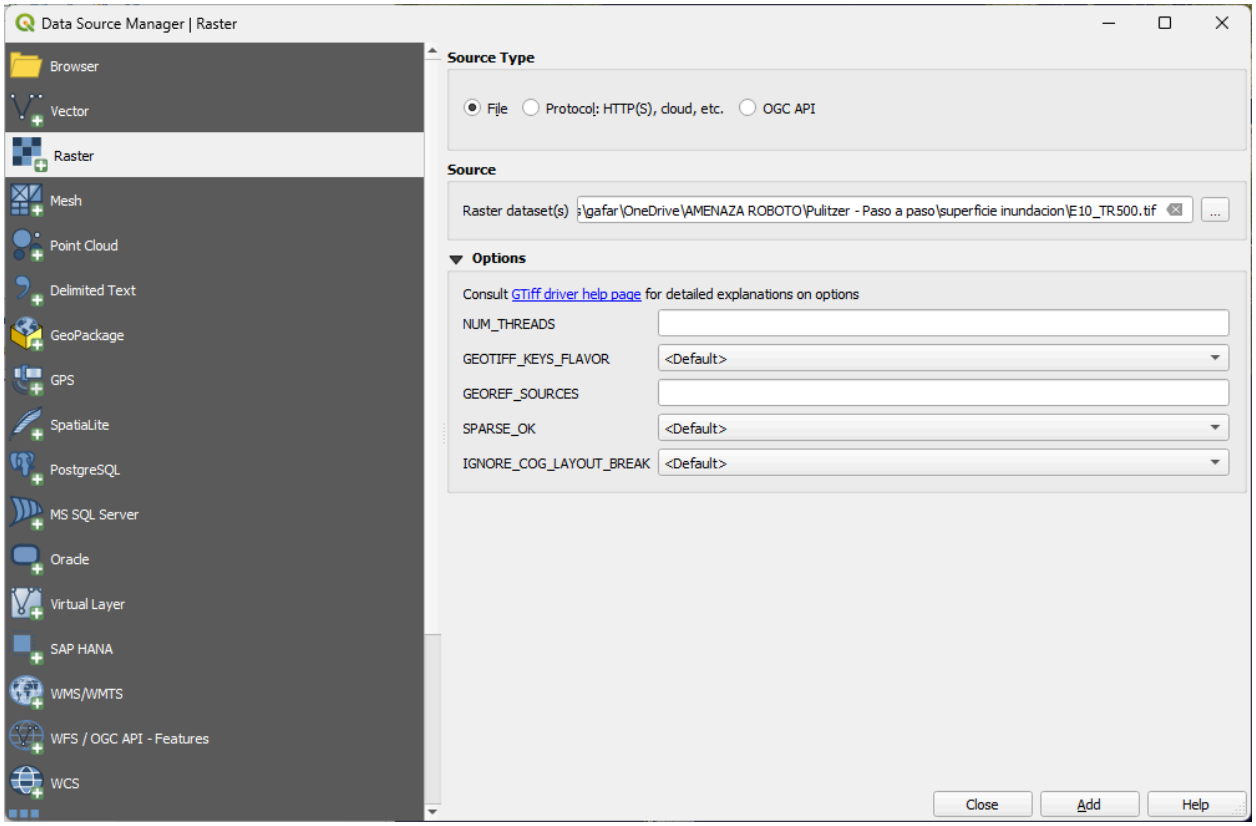
2.2.4 Remember the location of the unzipped folder named E10_rast_inundacion.

2.3 Add the layer in QGIS:

2.3.1 Return to QGIS and open the Open Data Source Manager.



2.3.2 In the left menu of the Open Data Source Manager, select the Raster option.



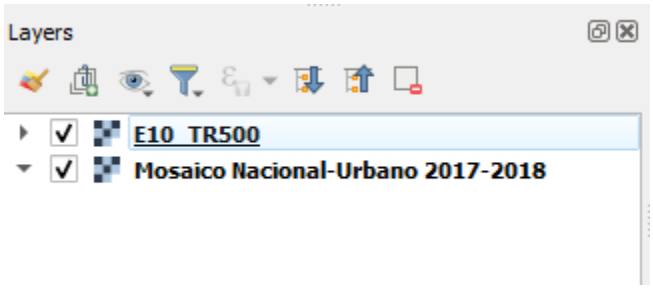
2.3.3 In Source Type, choose File.

2.3.4 In Source, click the button with three ellipses and select the E10_TR500.tif file located inside the folder you unzipped.

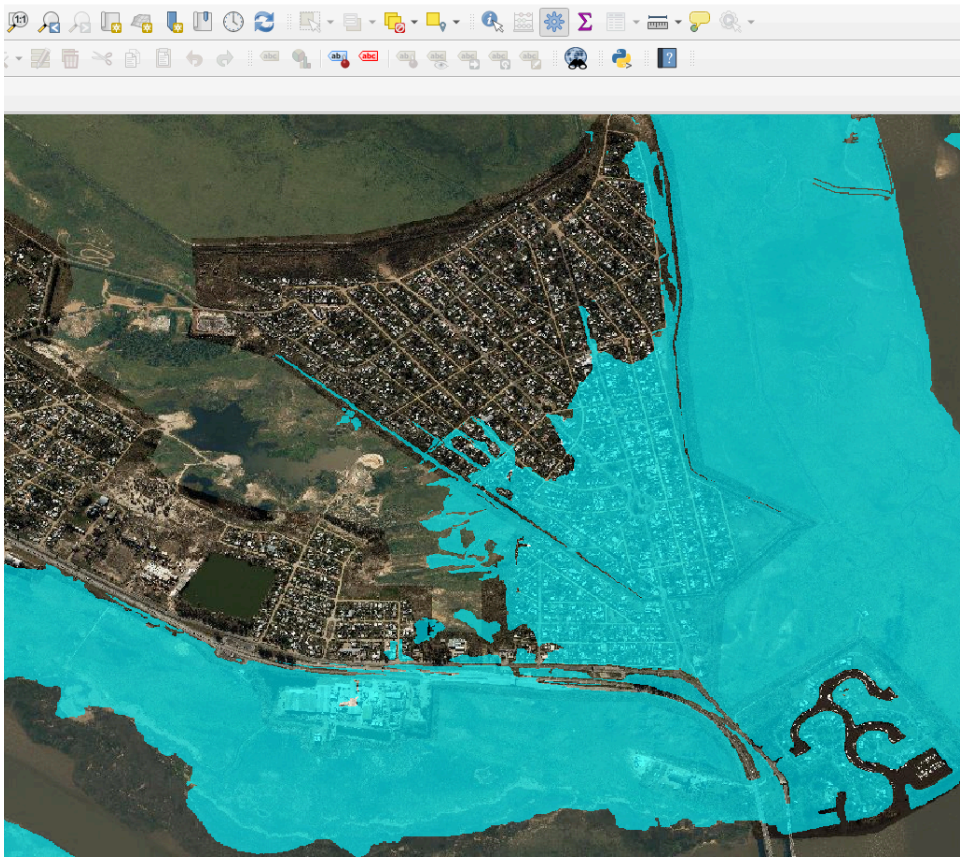
2.3.5 Click Add and then Close.

2.4 View the flood projection layer:

2.4.1 You will see a new layer added in the Layers Panel.



2.4.2 On the map, over the Uruguayan coast, you will see the projected flood area overlaid on the IDE satellite map.



2.5 Layer Display Order

2.5.1 The order of layers in the Layers Panel determines how they are displayed on the map. The first layer in the list (the topmost) is the one displayed on top of the map. The last layer in the list (the bottommost) is the one displayed at the bottom.

2.5.2 If the Flood Surface Layer is below the IDE Layer in the Layers Panel, the satellite image will cover the flood layer.

2.5.3 To fix this and view the flood line overlaid on the satellite map, drag the Flood Surface Layer to the top position in the Layers Panel.

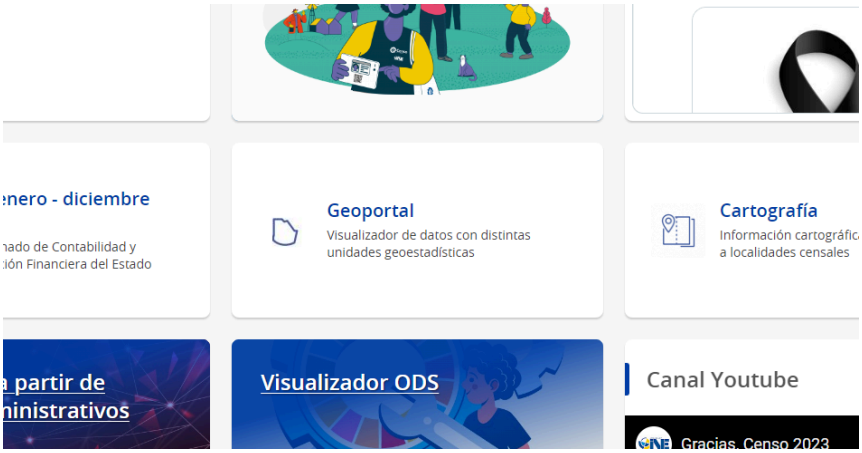
Step 3: Add a Geospatial Census Data Layer

The next step involves loading a layer with sociodemographic information from the census, a standard practice among national statistical institutes in every country. These institutions typically publish census data in geospatial formats, enabling analysis in relation to the territory. In this case, we will learn to load layers containing data such as population distribution, gender, socioeconomic characteristics, and other key indicators. These layers are essential for understanding the impact of phenomena like floods on affected communities, facilitating analyses that combine geographic information with demographic data for a more comprehensive and meaningful interpretation.

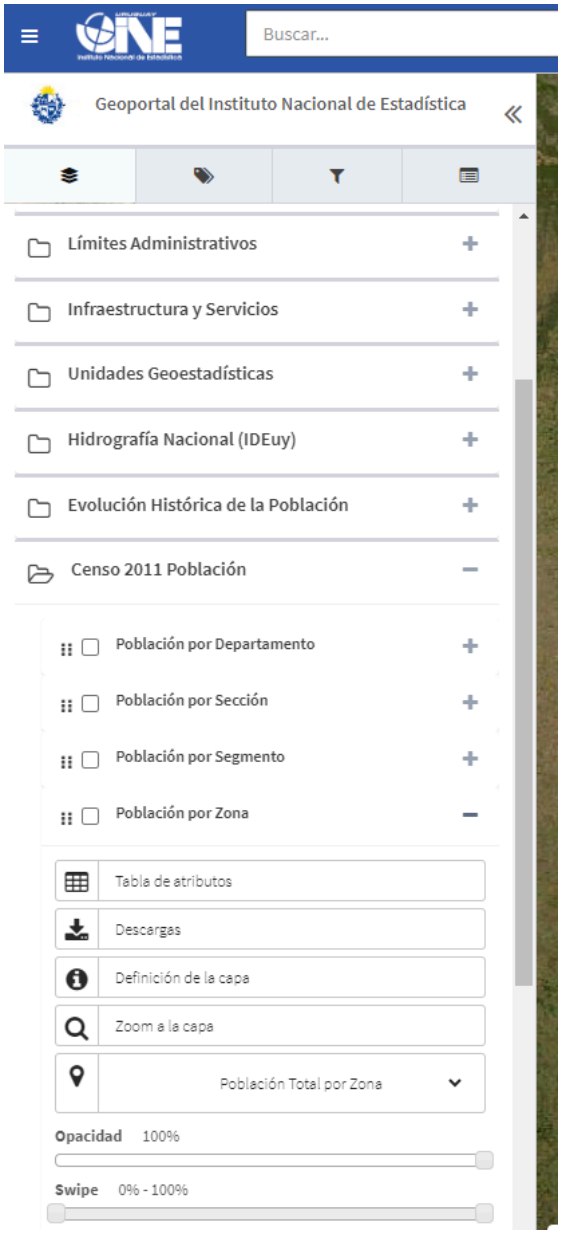
3.1 Download the census data:

3.1.1 Go to the INE website: www.ine.gub.uy.

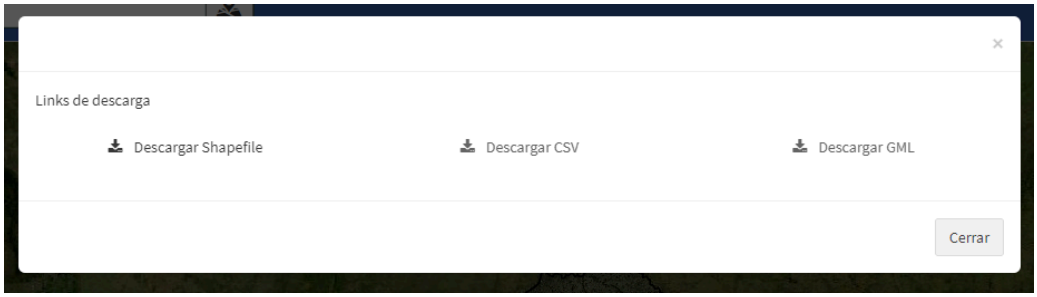
3.1.2 Scroll down to find the Geoportal link and click it.



3.1.3 In the left menu of the Geoportal, click on Census 2011 Population, then on the + sign next to Population by zone, and click Downloads.



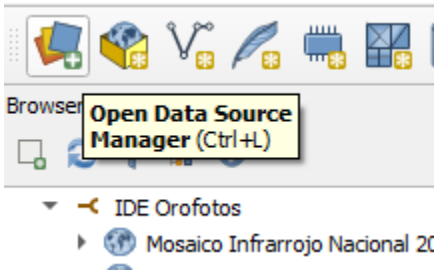
3.1.4 In the Downloads window, choose the Shapefile Download option.



3.1.5 Save the file in a location you remember and unzip it once downloaded.

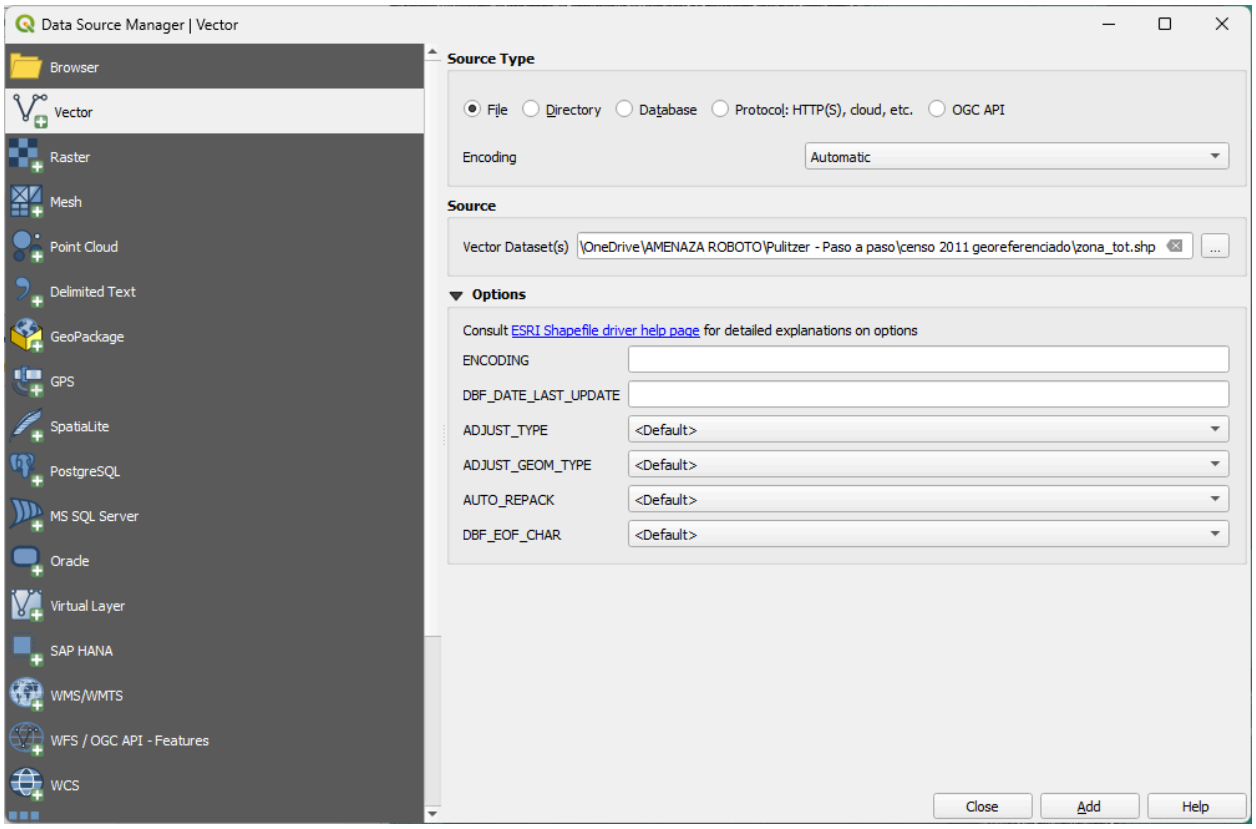
3.2 Open the population layer in QGIS:

3.2.1 Return to QGIS and open the Open Data Source Manager.



3.2.2 In the left menu of the Open Data Source Manager, select the Vector option.

3.2.3 In Source Type, choose File; in Encoding, select Automatic; and in Source, click the three ellipses to locate the “zona_tot.shp” file in the folder of the 2011 census you unzipped.

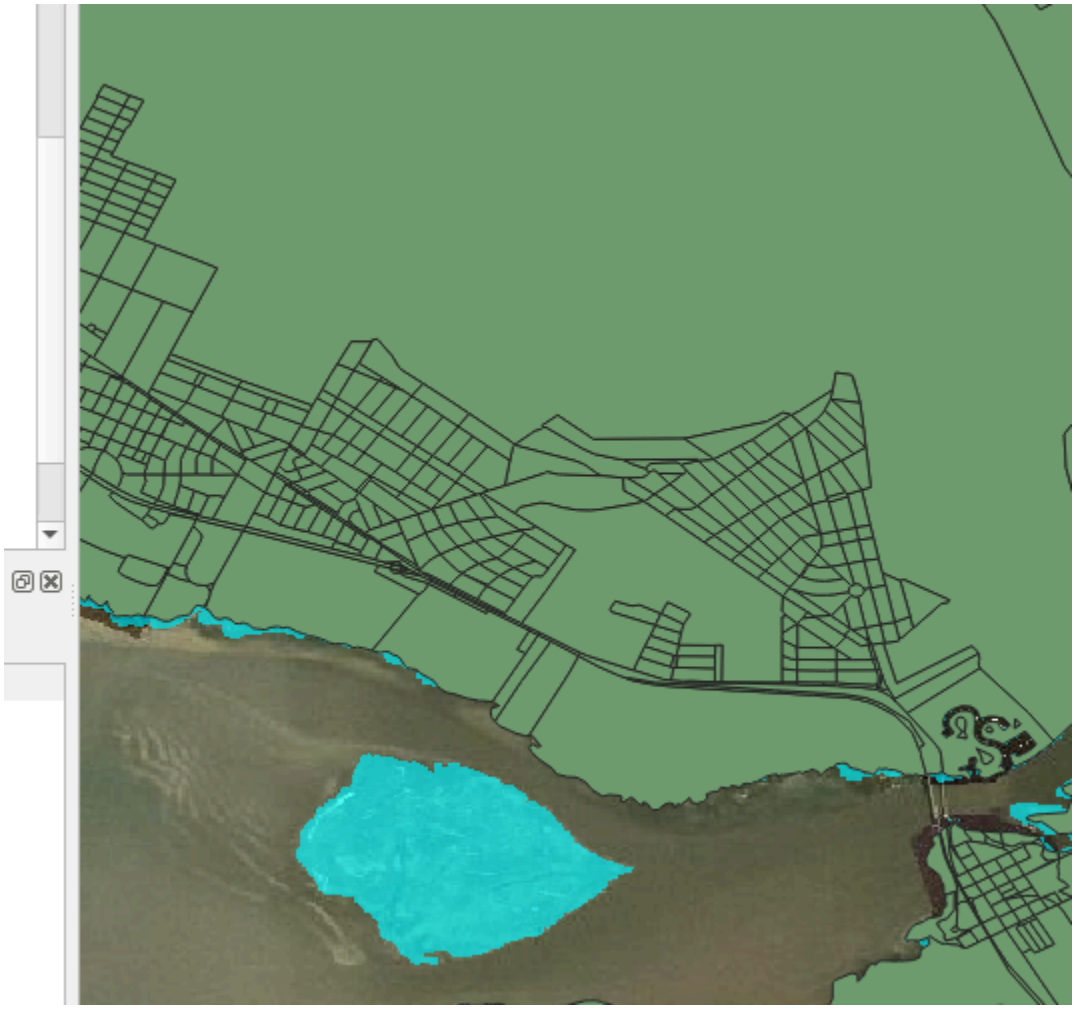


3.2.4 Once the file is selected, new options will appear. Leave everything as is.

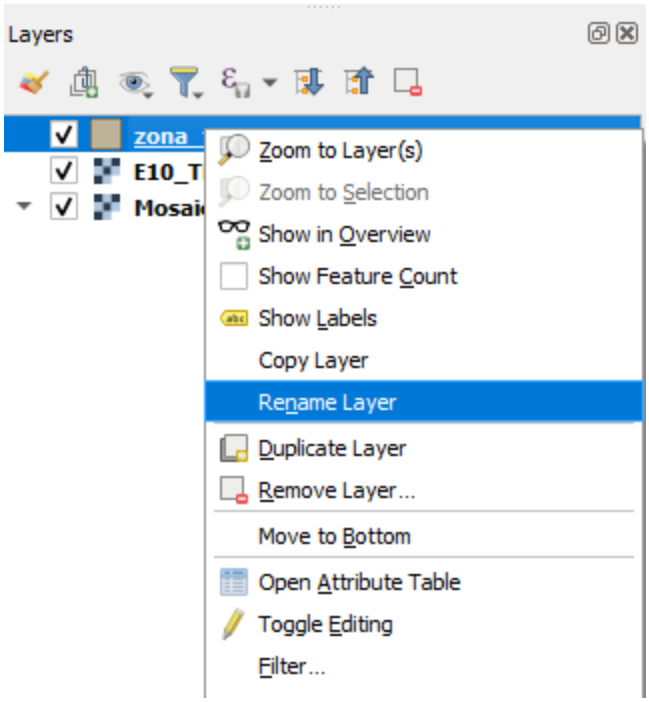
3.2.5 Click Add and then Close.

3.3 Manage the population layer:

You will see a new layer added that will overlap and cover the previous ones.



3.3.1 Rename the layer. Right-click on the new layer and then on Rename Layer in the context menu.



3.3.2 Delete the current name and write “Population by Zone. Census 2011”.

3.3.3 Click Apply and then OK. The layer will be renamed.

3.3.4 You can do the same with other layers and any you create in the future to facilitate management and understanding of the project.

3.4 Modify the layer color. Right-click on the Flood Surface Layer and then on Style in the context menu.

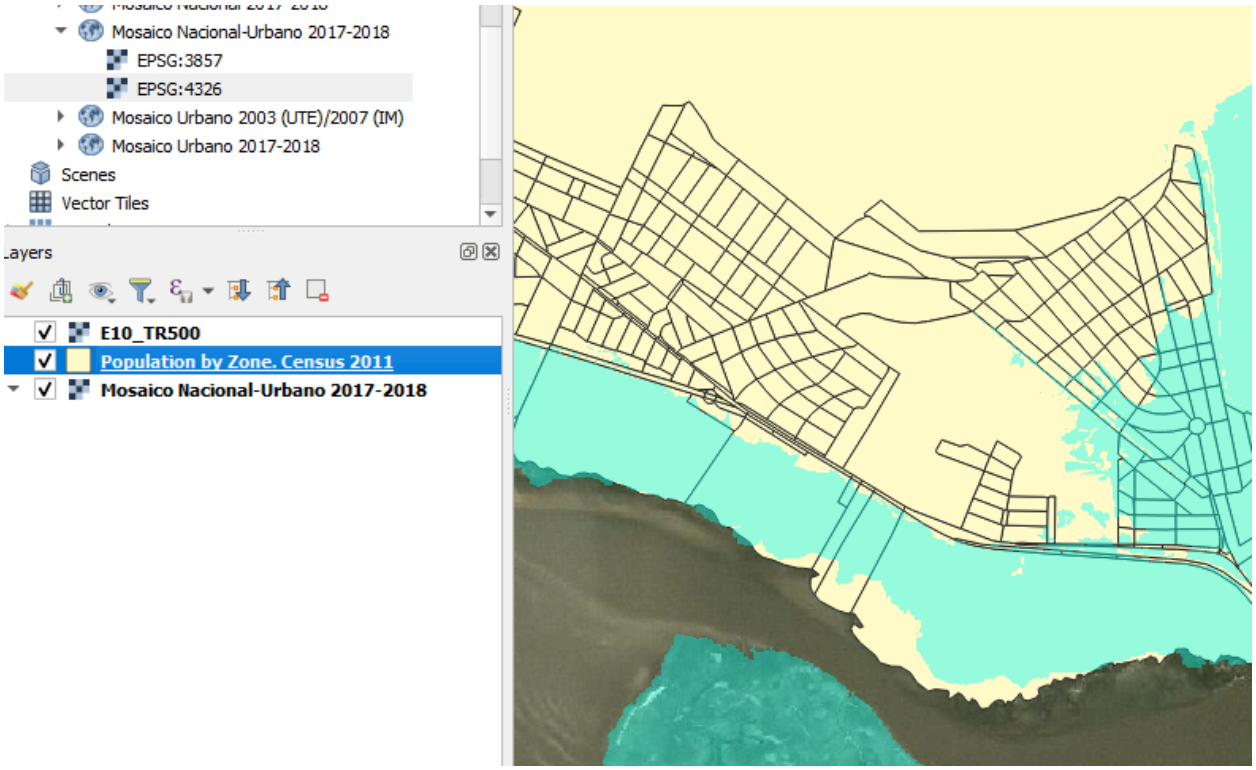
3.4.1 A window with a color selector will open.

3.4.2 Choose a cream color.

3.4.3 The layer color will change to the one you selected

3.5 Adjust Layer Order:

Drag the layer "Population by Zone. Census 2011" to the second position in the Layers Panel. This ensures that the population layer does not obscure the flood projection layer.



3.6 Display Labels with the Total Population of Each Zone:

3.6.1 Right-click on the "Population by Zone. Census 2011" layer and select Properties.

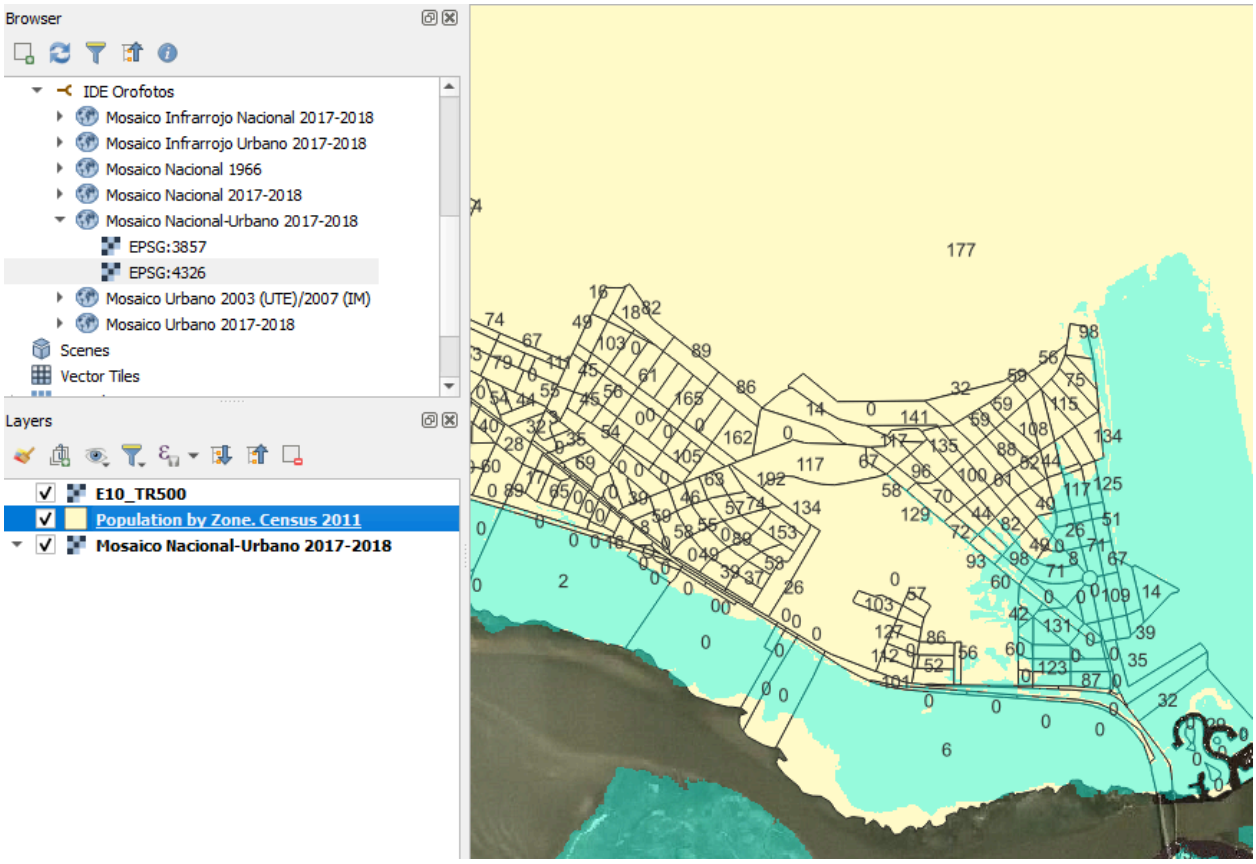
3.6.2 In the left menu, choose the Labels option.

3.6.3 In the window that opens, select "Single Labels."

3.6.4 In the Value field, find the attribute "tot_pob" corresponding to the total population by census zone. You will also see the attributes "tot_muj" and "tot_hom" for the total population of women and men in the census zone.

3.6.5 Click Apply, then OK. This will display the total population for each census zone.

3.6.6 To comfortably read the numbers, turn off the Google Satellite layer.



If you have followed the steps correctly, you will see a map displaying the total population by census zone overlaid with the flood projection.

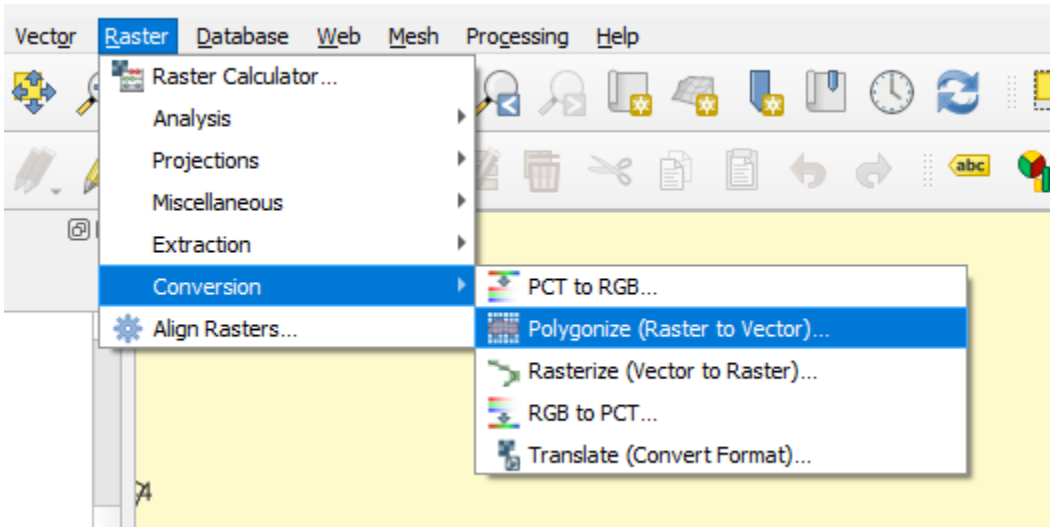
In this third step, you have successfully incorporated the layer with census information geographically distributed at the highest level of resolution allowed by public information in Uruguay, which is the census zone. You have loaded the satellite map, the flood surface, and the georeferenced census data. In the next step, you will learn how to estimate the potentially affected population.

Step 4: Calculate the Affected Population

The final step is to calculate the affected population, where we will learn to manage layers in different formats, such as raster and vector, to perform integrated analysis. This process includes intersecting the previously loaded layers, such as the flood projection surface and the sociodemographic census data, to calculate how many people are located in high-risk areas. This type of analysis is crucial for quantifying the potential impact of events like floods and generating valuable information for decision-making and effectively communicating the results through clear and accurate maps.

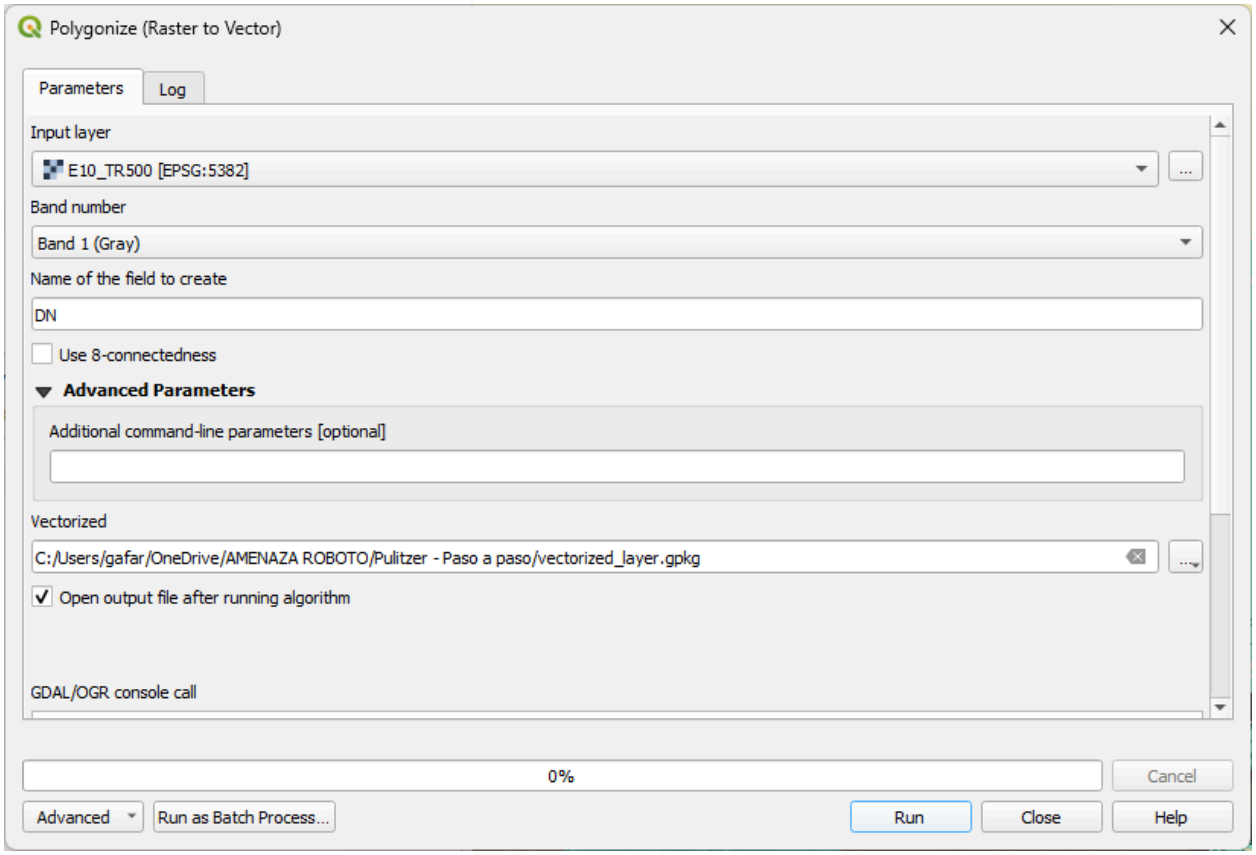
4.1 Convert Raster to Polygon (Vector):

4.1.1 Click on the Raster menu, then on Conversion, and finally on Polygonize (Raster to Vector).

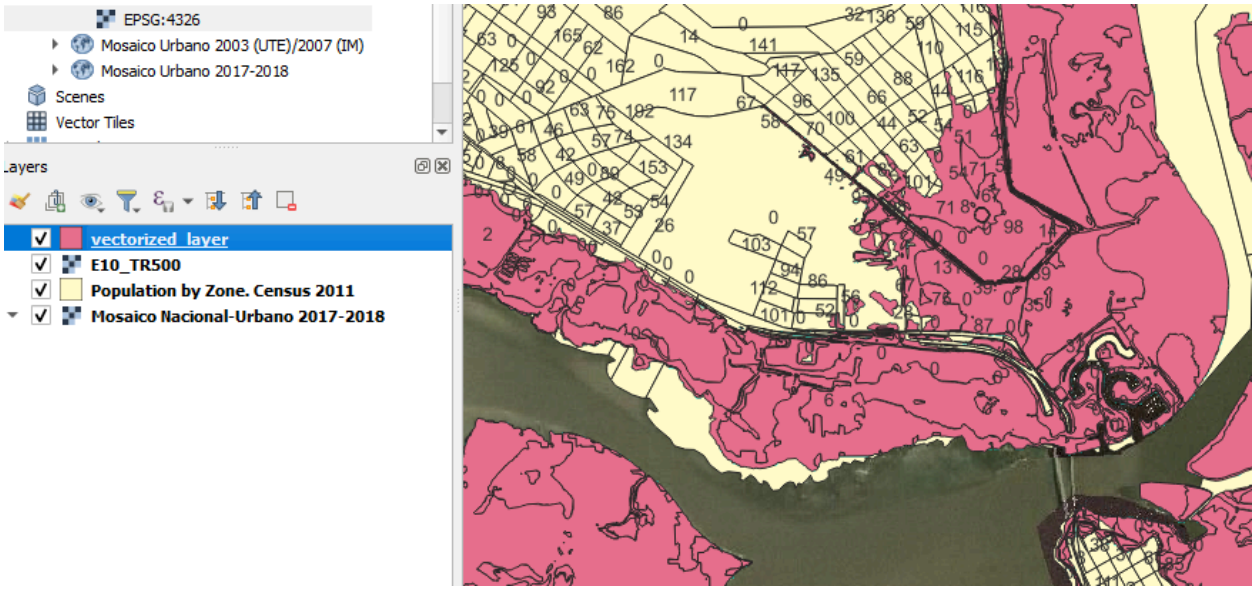


4.1.2 In the Polygonize (Raster to Vector) window, select the flood surface layer, which in this case is named E10_TR500, as the Input Layer.

4.1.3 In the Vectorized field, choose a path and name to save the new layer by clicking on the three ellipses button and then on Save to file. Choose the path and a name to save your new layer. Leave the default file type (GPKG).



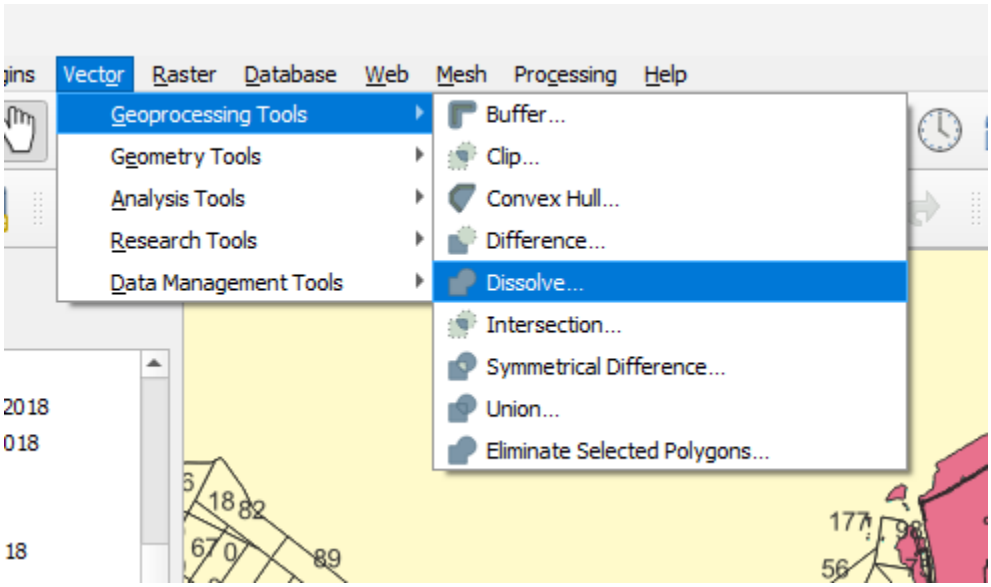
4.1.4 Press Run. The conversion process will take a few minutes. Once completed, click Close. If the process is successful, a new vector layer with the name you specified will appear.



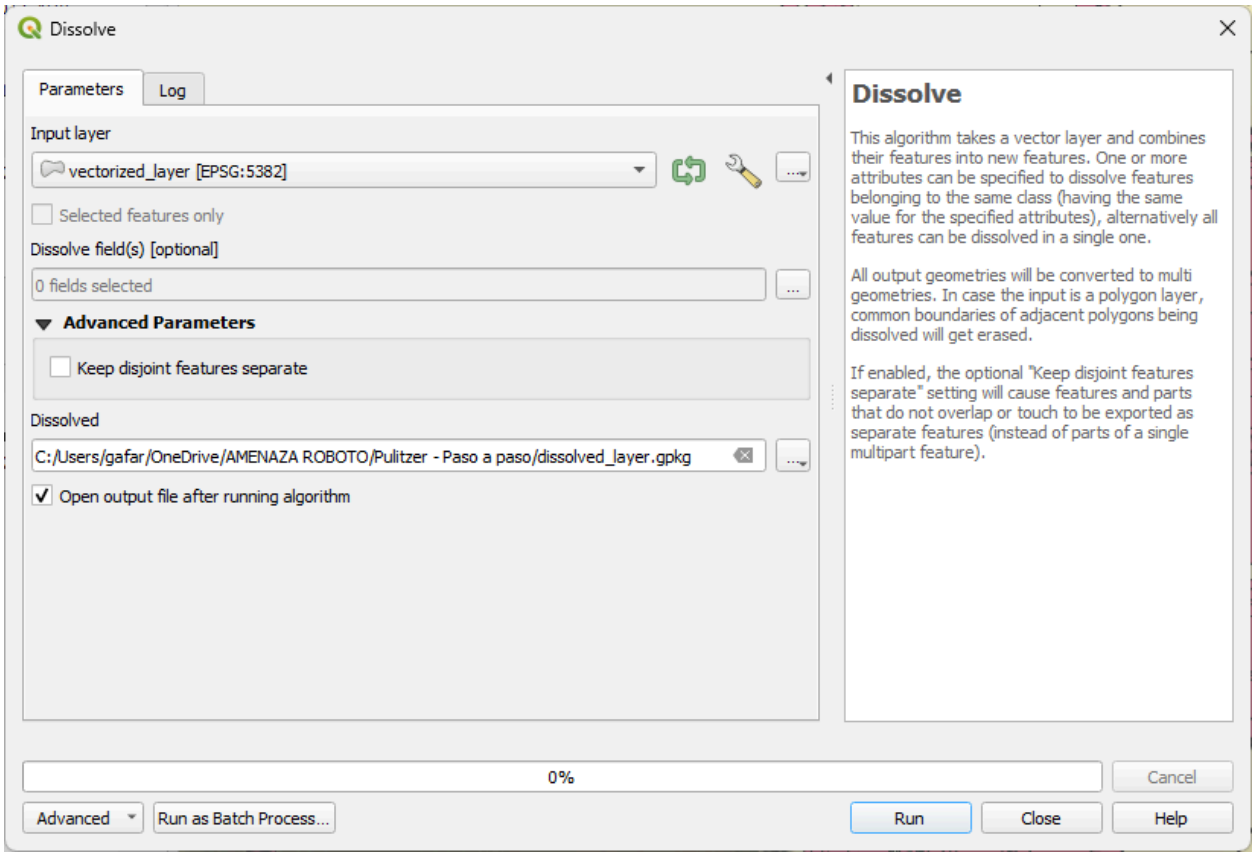
4.2 Remove Unnecessary Information:

4.2.1 This flood surface layer contains elevation data. To simplify the analysis of the potentially affected population, remove this information.

4.2.2 Select the Dissolve tool within the Geoprocessing Tools found in the Vector menu.



4.2.3 In the Dissolve window, choose the Vectorized layer as the Input Layer and select a file name and path where to save the file by clicking on the three ellipses and selecting the Save to file option.

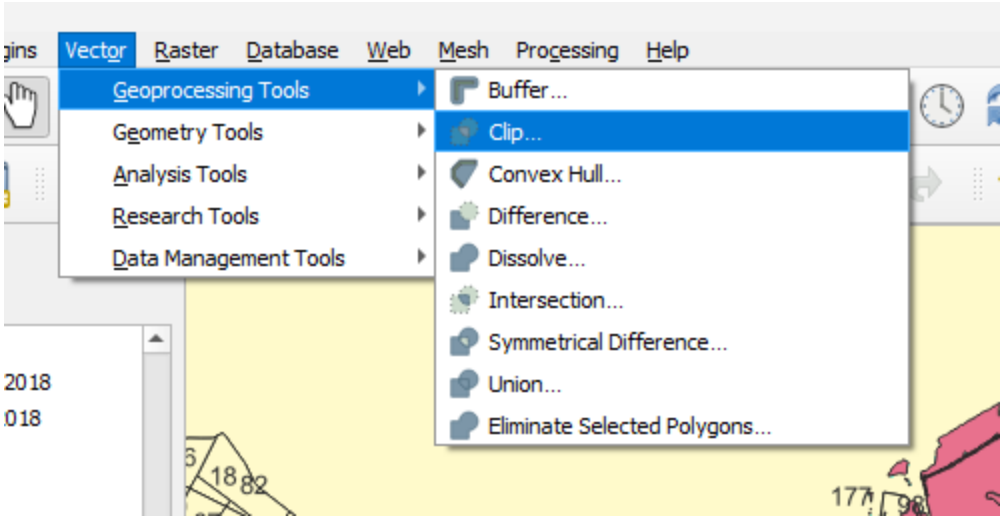


4.2.4 Click Run. The process will take a few minutes. As a result, you will have a new layer in the Layers Panel.

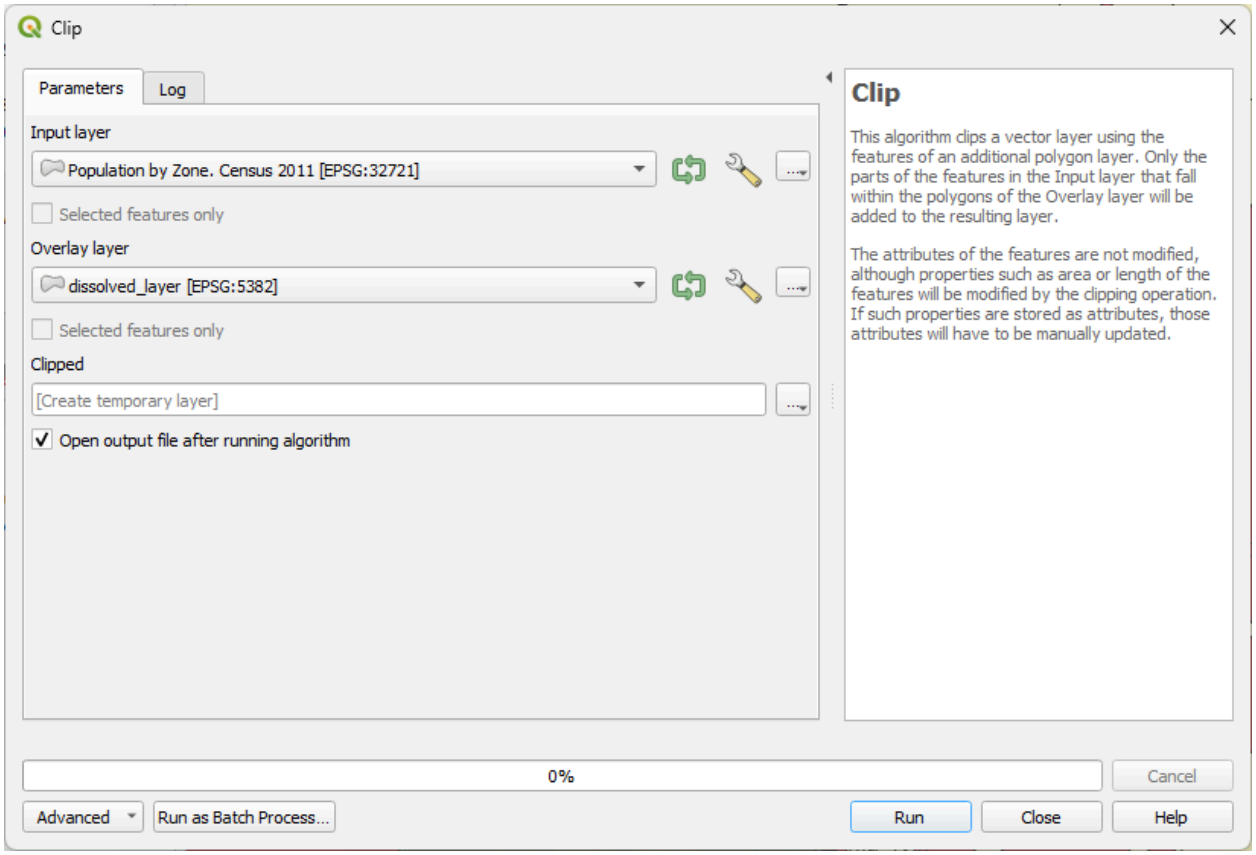
4.3 Clip the Census Layer with the Flood Layer:

4.3.1 Use the new Dissolved layer to clip the vector containing the census information.

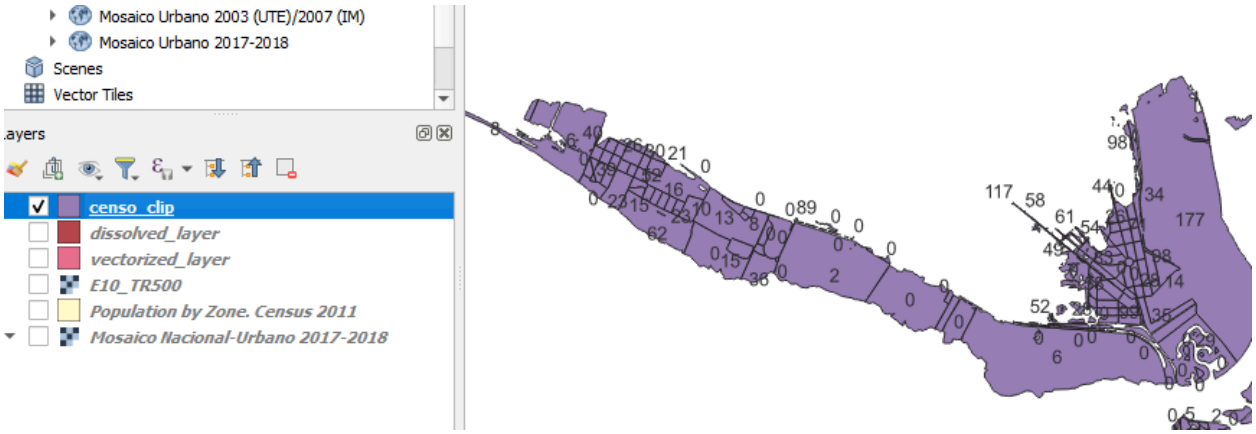
4.3.2 Use the Clip tool within the Geoprocessing Tools in the Vector menu.



4.3.3 In the Clip window, choose the layer containing the census information as the Input Layer and the “dissolved_layer” as the Overlay Layer. Select a file name and path to save.



4.3.4 Click Run. The process will take a few minutes. As a result, you will obtain a layer containing the census information only for the areas affected by the projected flood.

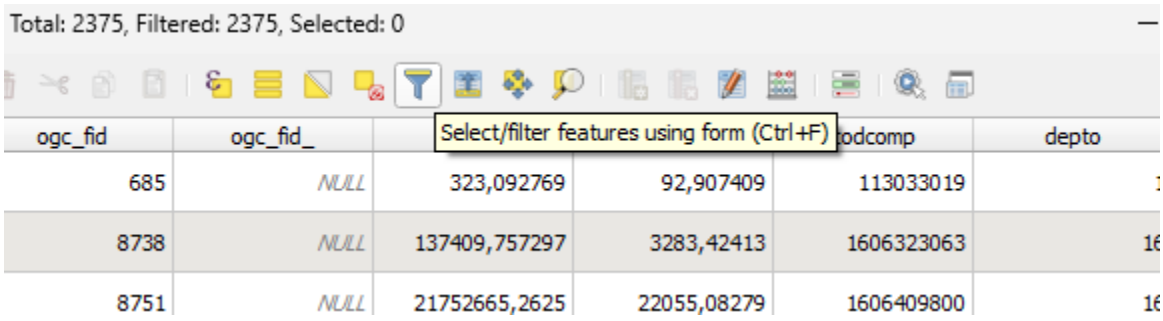


4.4 Count the Affected Population:

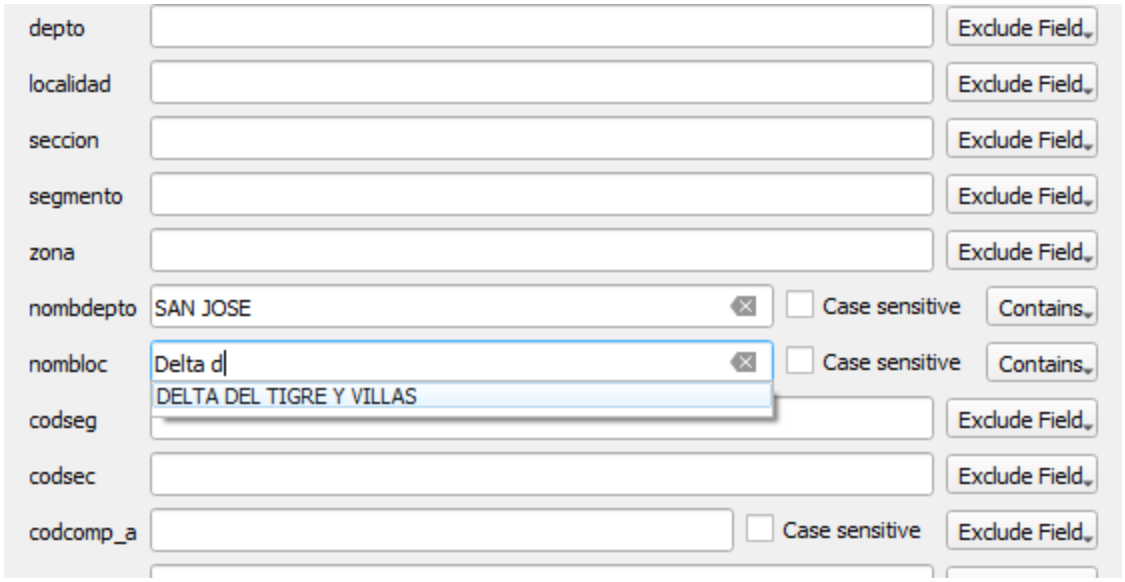
4.4.1 To count the population of Delta del Tigre y Villas, you need to filter this department (In Uruguay, the term **"department"** (Spanish: **"Departamento"**) refers to one of the country's administrative and political divisions.)

4.4.2 Open the attribute table of the affected_population layer. Right-click on the layer and then click on Open Attribute Table.

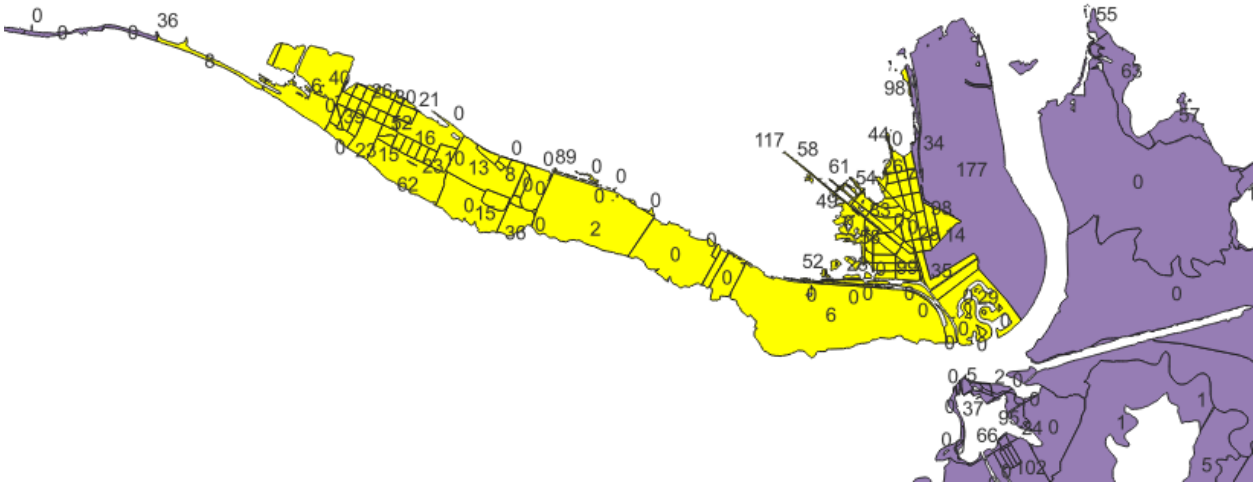
4.4.3 Click on the Filter icon within the Attribute Table.



4.4.4 In the Filter window, type Delta del Tigre y Villas in the "nombloc" field.

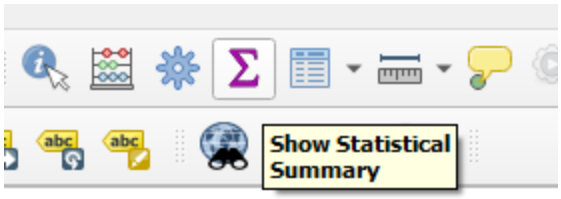


4.4.5 Click Select Objects. Then close the Filter window and then the Attribute Table. You will see the corresponding zones of Montevideo highlighted in yellow, indicating that the selection was successful.

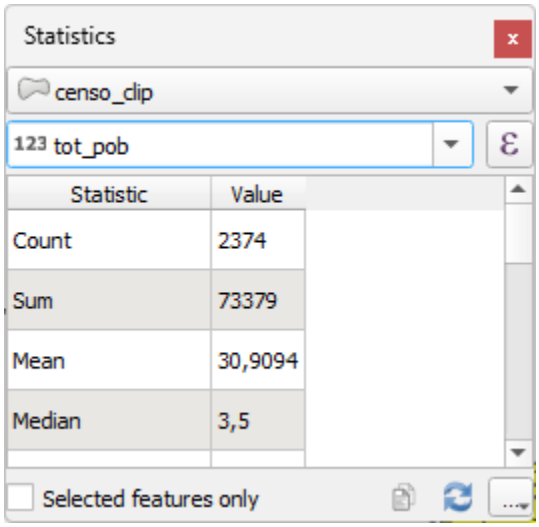


4.5 Show Statistical Summary:

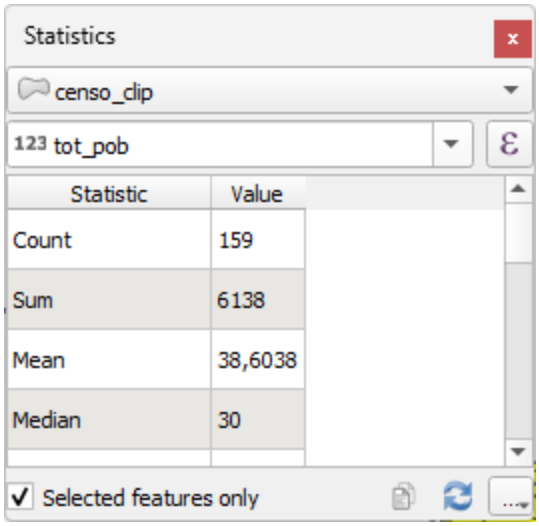
4.5.1 Click Show Statistical Summary.



4.5.2 Choose the affected_population layer and the "tot_pop" attribute. This will return the sum of the total population. For this project, the total population in the entire coastal strip of Uruguay is 73,379 people.



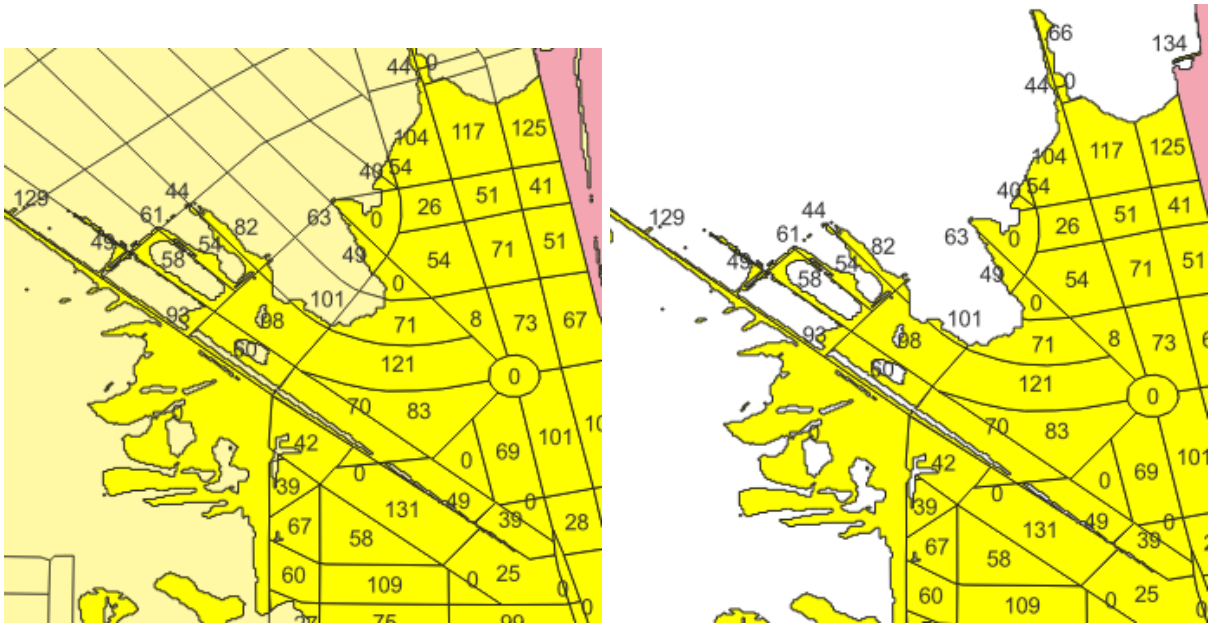
4.5.3 To find out the population of Delta del Tigre y Villas, click on Selected Objects Only. The number for Delta del Tigre y Villas is 6,138.



In this stage, you have successfully combined the two maps to identify only the population residing in areas overlapped by the flood surface. In the next section, you will delve into the methodology used by the program to count the population and learn a way to improve data accuracy.

Step 5: Refining the Sum

The calculation you just performed has some limitations that make the calculated number less accurate. If you analyze the map, you will notice that some zones are completely within the flood area, while others are cut in half. The current calculation sums the total population of the census area simply because part of the flood surface touches that zone, which is not accurate.

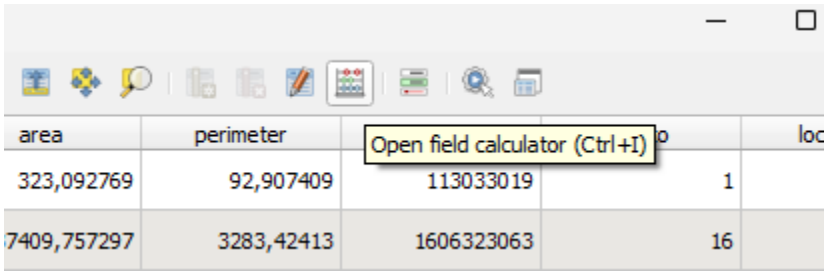


The Uruguayan Census database publishes data at the census zone level of detail. In other countries, this level of detail can reach down to the individual household. To obtain a more accurate estimate, we will assume that the affected population is proportional to the area that falls under the projected flood surface. To perform this calculation, follow these steps:

5.1 Open the Field Calculator within the Attribute Table of the "affected_population" layer:

5.1.1 Open the attribute table by right-clicking on the layer and selecting Open Attribute Table.

5.1.2 In the attribute table, click on the Field Calculator icon (it looks like a calculator) or go to Field -> Field Calculator in the Attribute Table menu.



5.2 Create the Flooded Area Field:

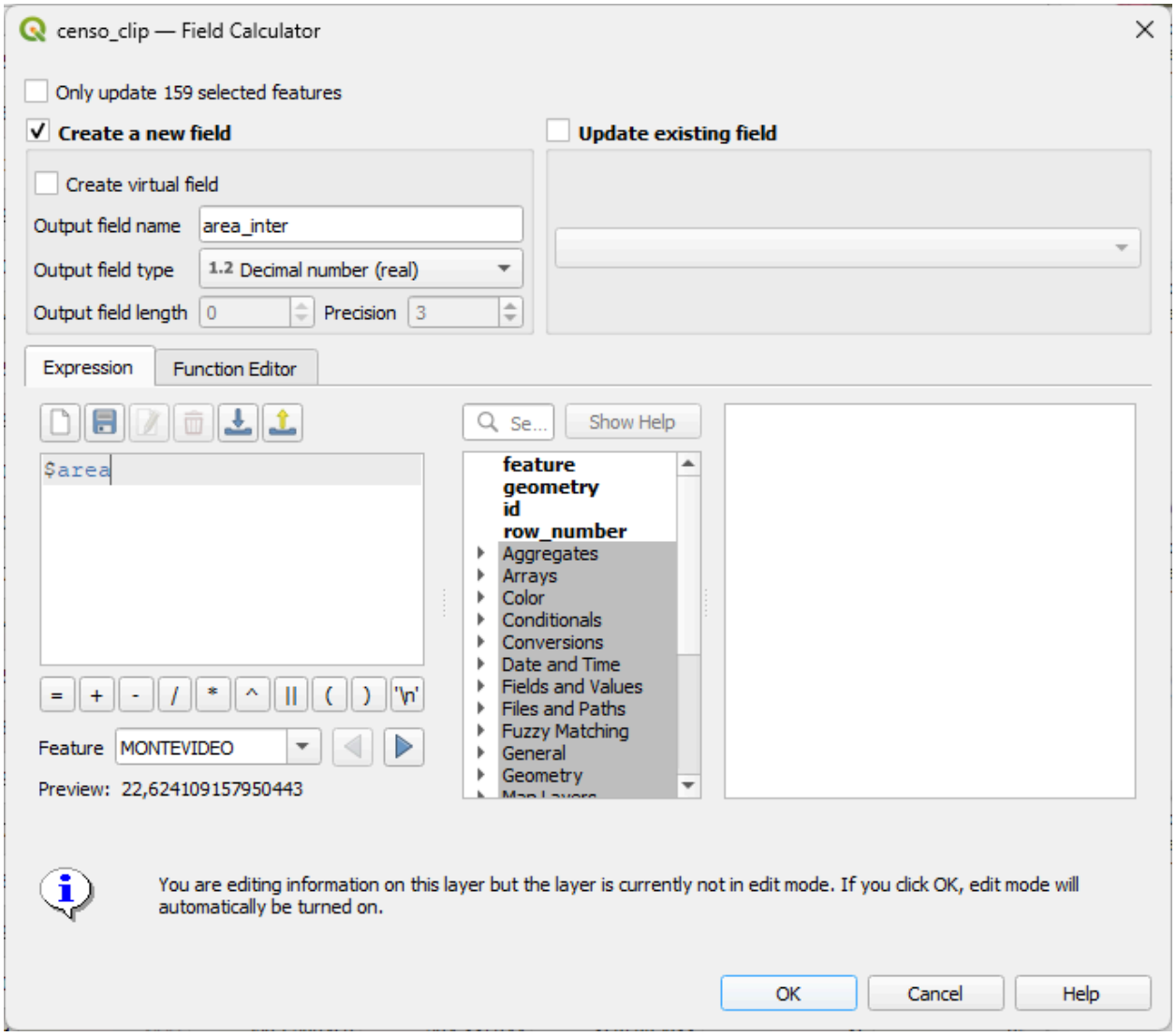
5.2.1 In the Field Calculator window, check the option to Create a new field.

5.2.2 Ensure that the option Only update... selected feature(s) is not selected.

5.2.3 Name the new output field, for example, flooded_area.

5.2.4 Set the field type to Decimal number (real).

5.2.5 In the expression box, type $area. This will calculate the area of each geometry in the intersection layer.



5.2.6 Click OK to create the new field.

5.3 Calculate the Percentage of Flooded Area in the Zone:

5.3.1 Reopen the Field Calculator.

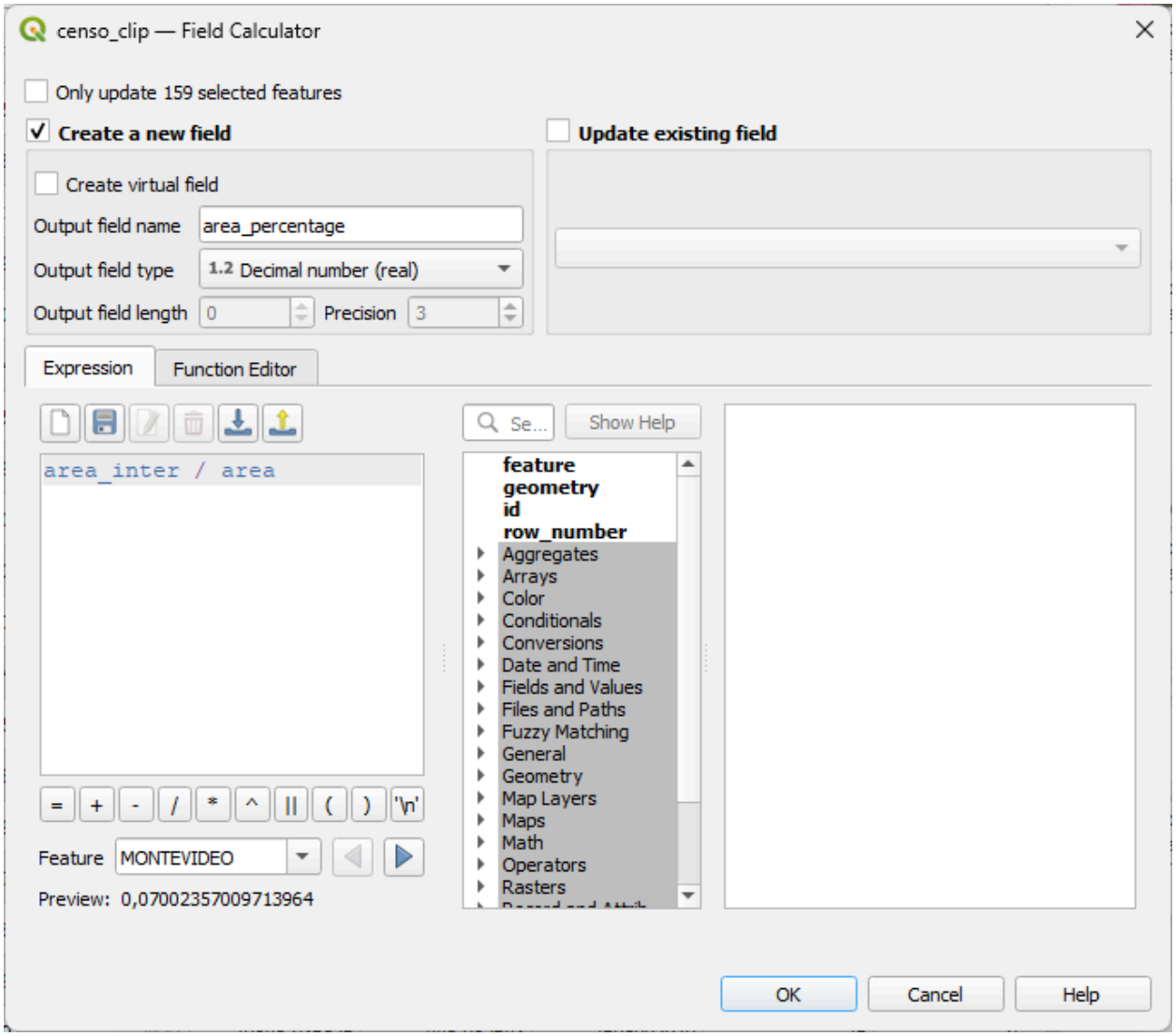
5.3.2 Again, check the option to Create a new field.

5.3.3 Ensure that the option Only update... selected feature(s) is not selected.

5.3.4 Name this new output field, for example, percentage_area.

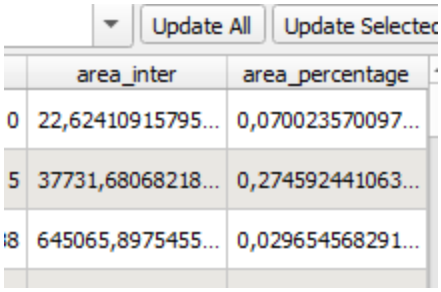
5.3.5 Set the field type to Decimal number (real).

5.3.6 In the expression box, enter the following formula: flooded_area / area. (The area field contains the original area information).



5.3.7 Click OK to create the new field.

If you followed the procedures correctly, you will have two new fields in the attribute table. The fields will be added in the last columns.



5.4 Calculate the Weighted Population:

5.4.1 Reopen the Field Calculator.

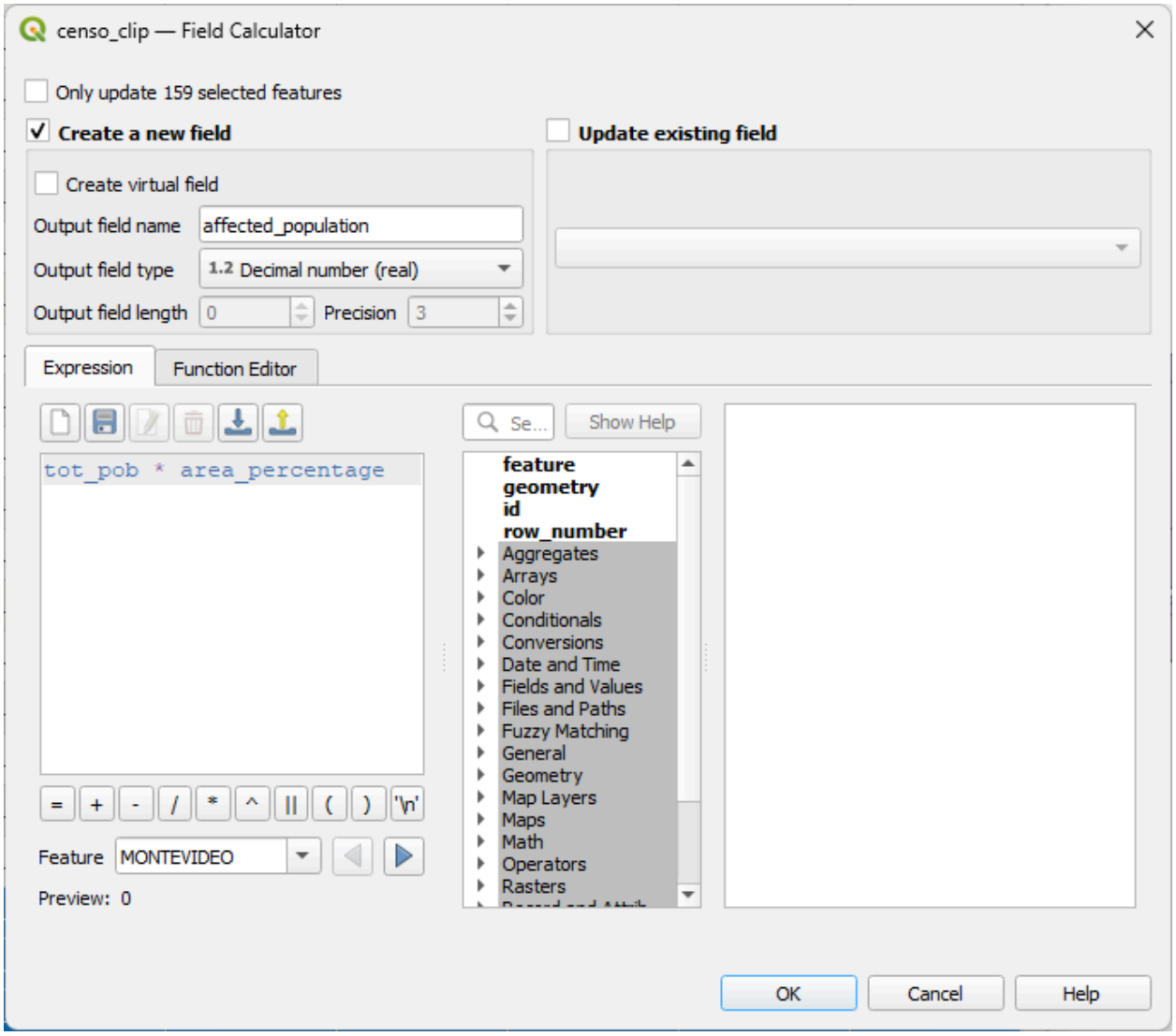
5.4.2 Ensure that the option Only update... selected feature(s) is not selected.

5.4.3 Check the option to Create a new field.

5.4.4 Name this new output field, for example, affected_population.

5.4.5 Set the field type to Decimal number (real).

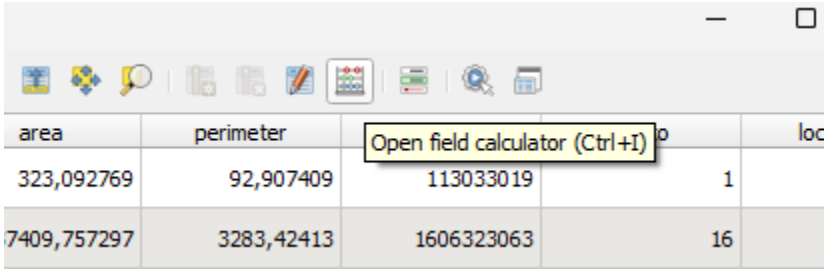
5.4.6 In the expression box, enter the following formula: tot_pob * area_percentage. (The tot_pob field contains the total population information of the zone).



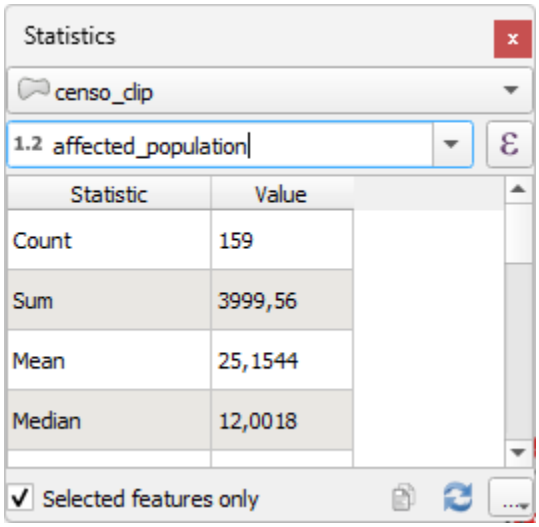
5.4.7 Click OK to create the new field.

5.4.8 Close the attribute table.

5.4.9 Open the Show Statistical Summary tool.



5.4.10 Choose the affected_population layer and the affected_population field.



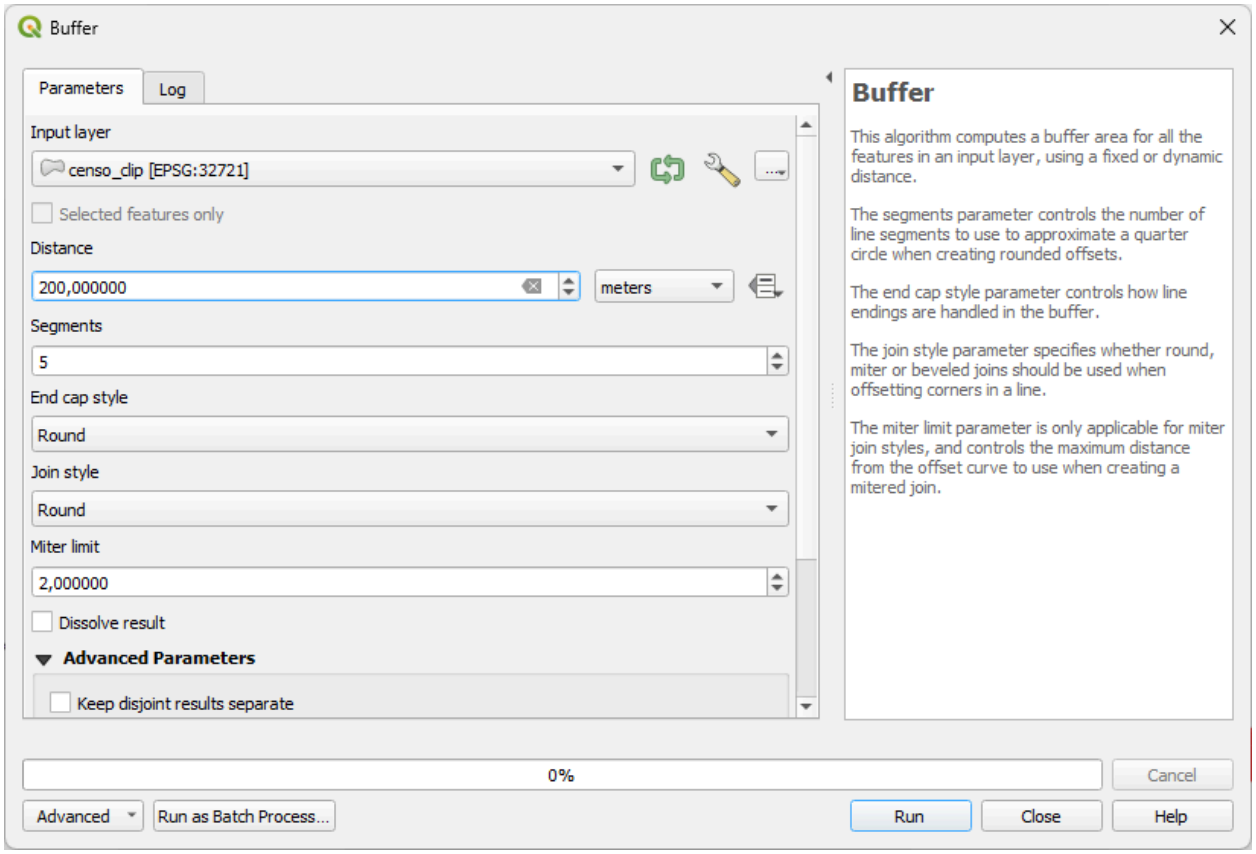
5.4.11 You will have a more accurate estimate of the population potentially affected by the projected flood surface. For Delta del Tigre y Villas, the number will be 954 people.

5.5 Establish a Buffer Zone

You can consider a zone of influence (known as a "buffer zone") for people who, although not directly in a projected flood zone, will be affected by living in the vicinity. To do this, set up a buffer area of one block (100 meters).

5.5.1 Select the Buffer tool within the Geoprocessing Tools in the Vector menu.

5.5.2 Choose the Vectorized layer and set a distance of 100 meters.



5.5.3 Choose a path and a name for the new layer.

5.5.4 Click Run.

After a few minutes, you will obtain a new layer. Then, continue the tutorial starting from the step to dissolve the layer.
