QGIS Practical 8: Landslide Susceptibility Map

In this practical exercise, you will create a **Landslide Susceptibility Map** (refers to the likelihood or probability of an area experiencing a landslide based on environmental and human factors), and work with raster data and analytical tools to understand how many settlements are located in areas of high susceptibility to landslides, and may therefore need evacuating, and how many people live in those areas as well.

This is the first time within this course that we will not only visualise and symbolise data but also use it to perform some geospatial analysis.

1.0 Planning your map project

As you start working on your product, it is a good idea to take a step back and reflect on what you want the final product to look like. Also remember, that map projects are often iterative in nature. You may start with a simple product, that you can then use as a base for the next versions, or other products altogether.

Here are some points to take into consideration as you start your work:

- Who is this product for?
- What data do I need?
- What is the status of those datasets? Are they fit for purpose? Is any cleaning necessary?
    - Always open the datasets and inspect them to make sure they are indeed fit for purpose. You can start by opening them to do a visual check, but it is also always a good idea to open the attribute table and have a sense of how the information they contain is organised.
- Is there anything I should warn my final user about? Anything about how to read the map, any caveats regarding the data, its use, and its shareability?

2.0 Getting Started

1. Start a new project and add the following datasets:
    a. The Admin 1 layer for the country: brb_admn_ad1_py_s1_gadm_pp_parish in GIS\2_Active_Data\201_admn
    b. The Settlements layer: brb_stle_stl_pt_s3_osm_pp_settlements in GIS\2_Active_Data\213_stle

c. The Population raster layer: brb_popu_pop_ras_s2_worldpop_pp_100m_2020 in GIS\2_Active_Data\212_popu

d. The Landslide Susceptibility raster layer: brb_hazd_sli_ras_s1_mapaction_pp_landslidesusceptibility in GIS\2_Active_Data\208_hazd

2. Right-click on Admin 1 layer and select the first option, **Zoom to Layers.**
3. At this point, you would normally spend some time choosing the appropriate symbology for each dataset. In this case, however, we are going to do some analysis first, so the only symbology we need right now is the one that will help us visually in our analytical work.
4. Landslide Susceptibility layer: Right-click to open its **Layer properties** and access its **Symbology**. This layer has 3 values, from1 to 3, 1 being not very susceptible to 3 being very susceptible to landslides. We want to clearly visualise these areas.

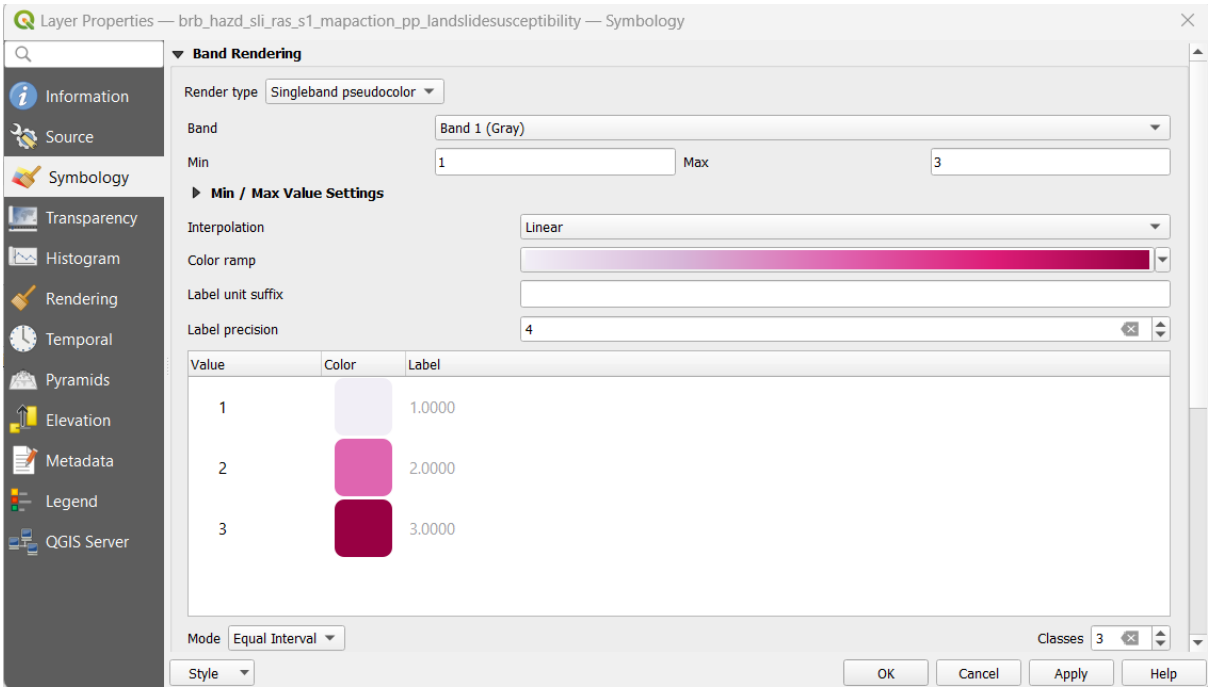
   a. Click on **Render type** and choose **Singleband pseudocolor**

   b. At the bottom right corner, choose **Equal Interval** as **Mode** and reduce the number of classes in the bottom right corner to 3

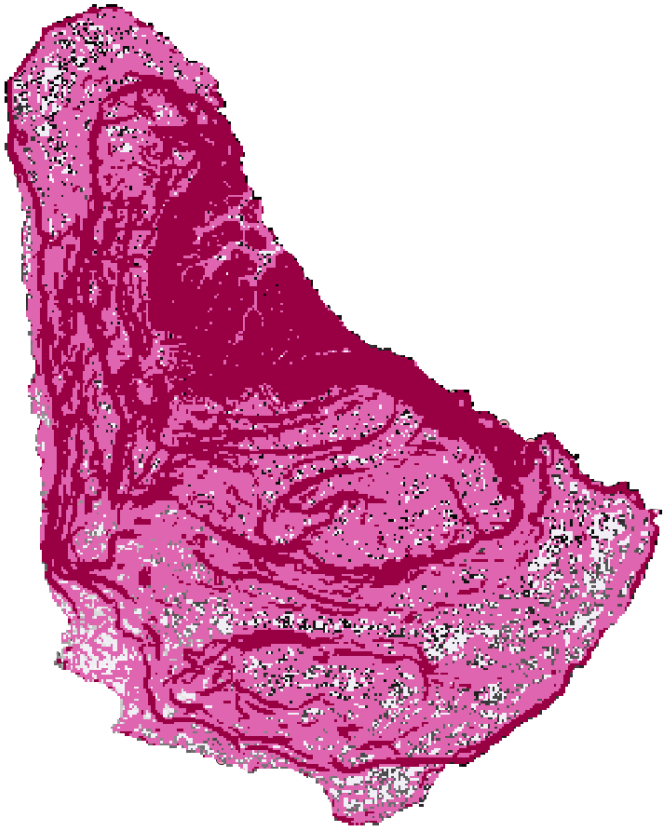
   c. Choose a color palette of your choice. Make sure, higher susceptibility (num. 3) are darker than lower susceptibility.

   d. If you are seeing a 0 as well, change the **Min** option at the top to 1.

   e. **Apply** and **OK**!



The map should look something like this:



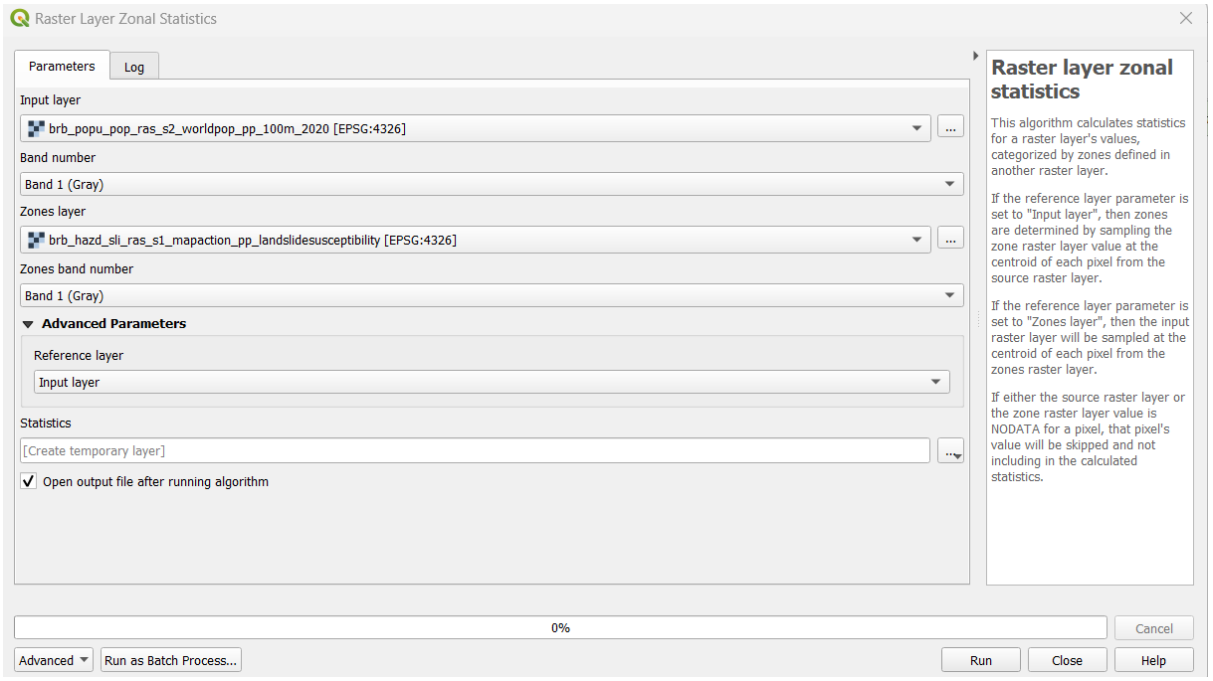
We now want to:

- Calculate the amount of people living in each landslide susceptibility area.
- Extract areas with landslide susceptibility level 3
- Create a vector file out of those areas, which we can use more easily to interact with the rest of our data
- Apply a small buffer around this new vector file of areas with landslide susceptibility level 3. This is because we don't lose any information based on the fact a settlement may fall just outside a line.
- Select all settlements that are located within that area
- Before you move on to the next step, take a moment to save your project as "Landslide_Susceptibility_Map" in GIS\3_Mapping\33_Map_Projects.

3.0 Calculating how many people live in each landslide susceptibility zone

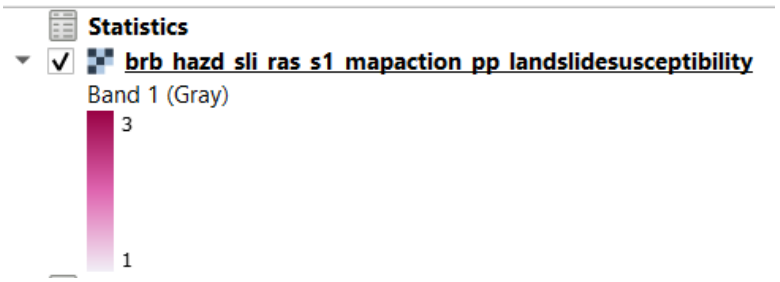
1. Open the **Processing Toolbox** by clicking on the cog icon  in the upper menu. The Toolbox will normally open on the right side.
2. In the search bar, look for **Raster Layer Zonal Statistics**

3. Choose the Population raster layer as **Input**, the Landslides as **Zones Layer,** and click on **Run**



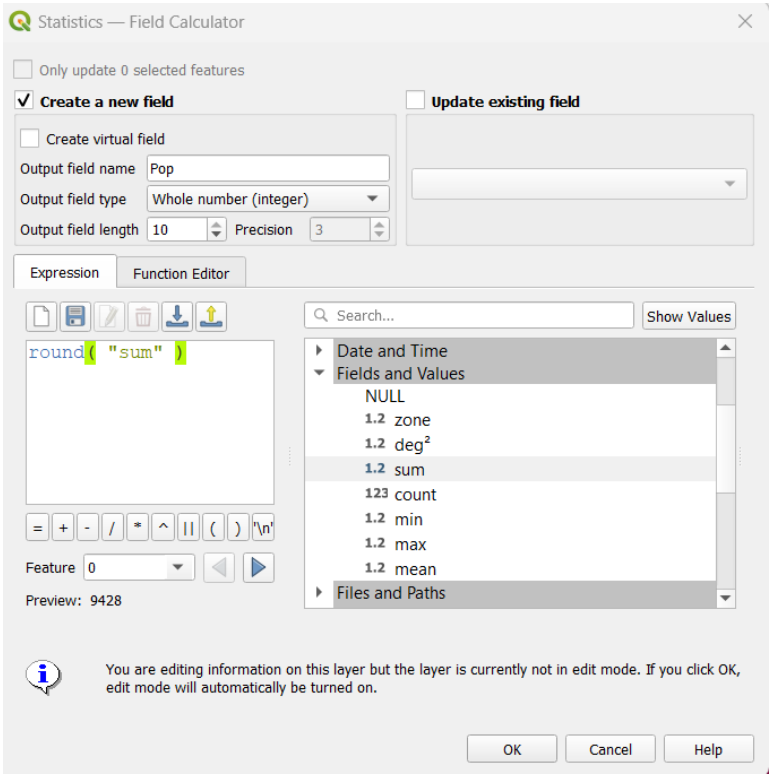
The output is a table that is now shown in the **Layers list.**

4. Open it up to look at the result.



As we are going to add it to our final map, we need to clean up how the numbers look.

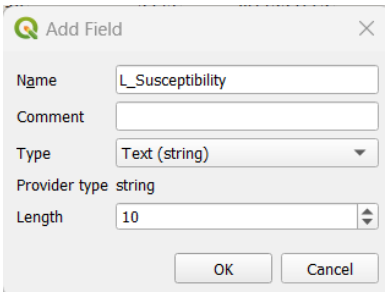
1. Click on **Field Calculator** in the Statistics layer and create a new field called Pop, in which we are going to round the total population numbers.
2. Output field type: **Whole number (Integer)**
3. In the expression box enter: **round ("sum")**. The round function, rounds a number to a number of decimal places, in this case not specifying means 0 decimals.



4. Let's also create a new field to make the susceptibility levels easier to understand.

   This time we will use the **Add Field** button  and work directly on the table.

   - Pick a descriptive name and change the **Type** to Text

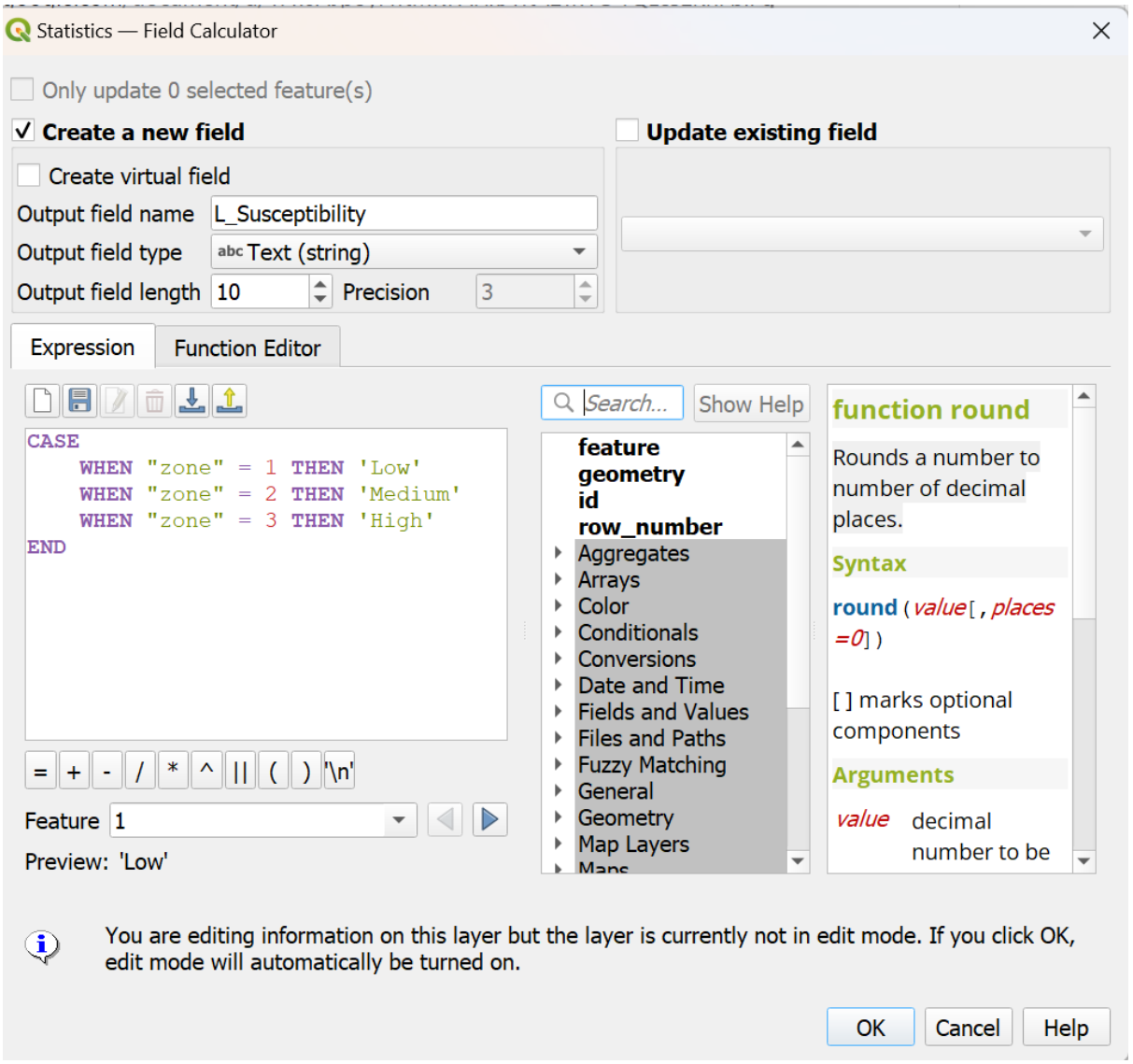


   - And modify the values directly in the table so that you have: Low for 1, Medium for 2 and High for 3.

Pop	L_Susceptibility
23865	Low
79775	High
159663	Medium

*ALTERNATIVE APPROACH:

Let's assume that you have many rows to edit manually and you want to do it automatically in the field calculator. You could use an expression for that, as follows in the image below.



Done! We will use this later in the final map product.

5. Click the Toggle Editing Mode button to stop editing and save your changes 

4.0 Obtaining a vector of areas with landslide susceptibility level 3

1. Click on the menu that says **Raster** between Vector and Database in the top of your screen.
2. Click **Raster Calculator.** We are going to create a raster from the landslide layer with only the values of high risk of landslide.

3. Compose the following expression, by double-clicking on the landslide layer, and the various operators as follows.

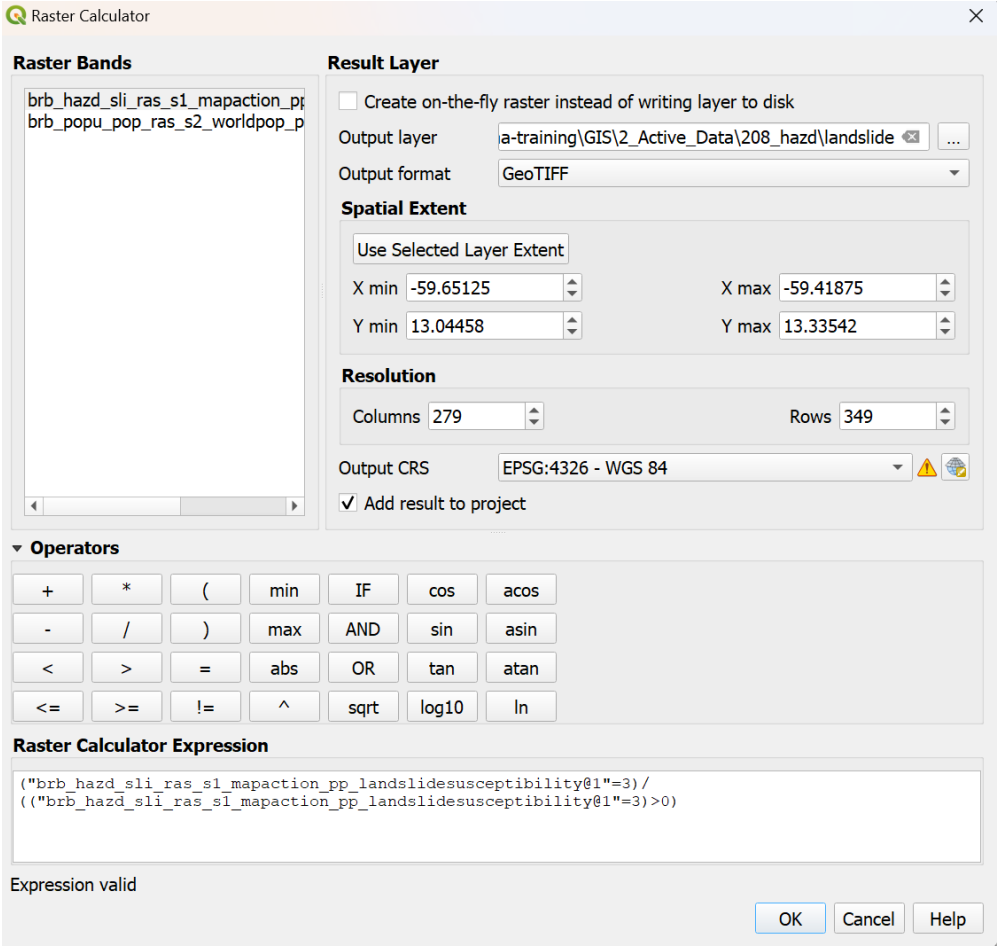
```
(
"brb_hazd_sli_ras_s1_mapaction_pp_landslidesusceptibility@1"=
3)                                /                                ((
"brb_hazd_sli_ras_s1_mapaction_pp_landslidesusceptibility@1"=
3)>0)
```

   If we wrote simply landslide layer = 3, that would also have worked, but it would have created a layer that had 2 values:

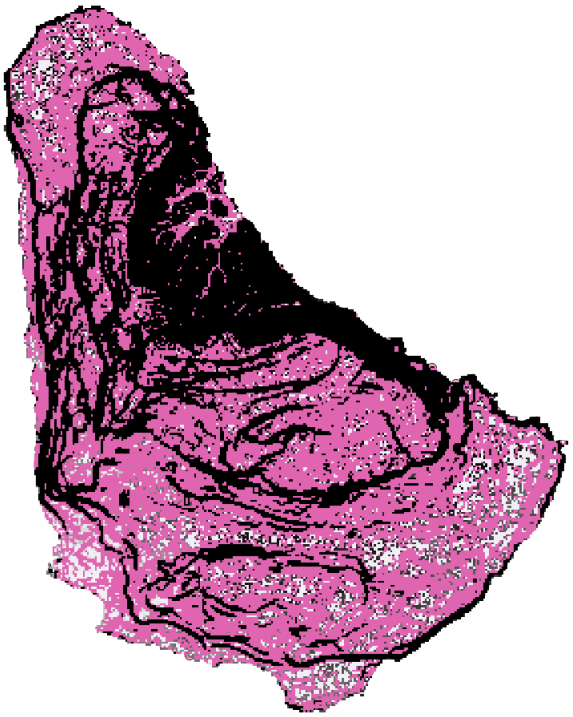
   - 1 for when the expression is TRUE, so all pixels that have value 3
   - 0 for all other pixels, where the expression is FALSE

   Writing it this way ensures that only the pixels with value 3 are retained in the final layer.

4. You can either save the output or click Create on-the-fly raster instead of writing layer to the disk so it creates a temporary raster. Let's save it in our folder (GIS\2_Active_Data\208_hazd) as a **brb_hazd_ras_landslide_high**

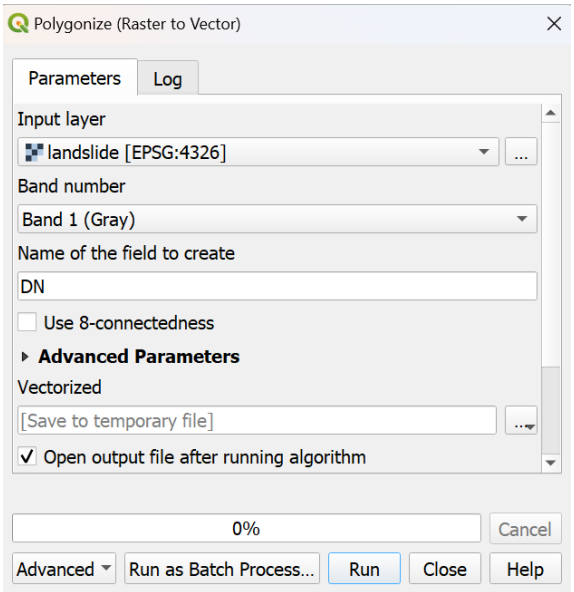


5. The results should be a new raster layer in your screen. Here the black areas are the ones that match our raster calculation condition. Thus, the areas in high risk of susceptibility.

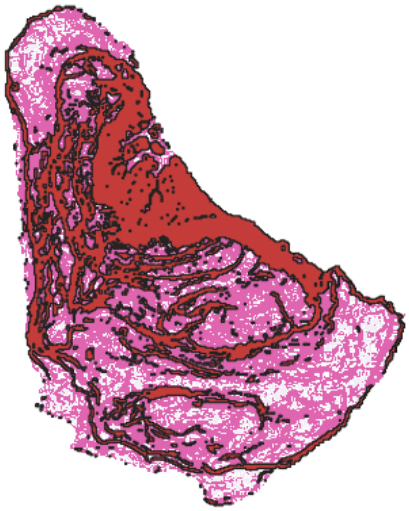


Next step is to turn this raster file into a vector file as it is easy to work with.

6. In the Processing Toolbox, search for **Polygonize (raster to vector)**
7. Choose the brb_hazd_ras_landslide_high layer as **Input Layer**, and leave the other parameters unchanged, click Run

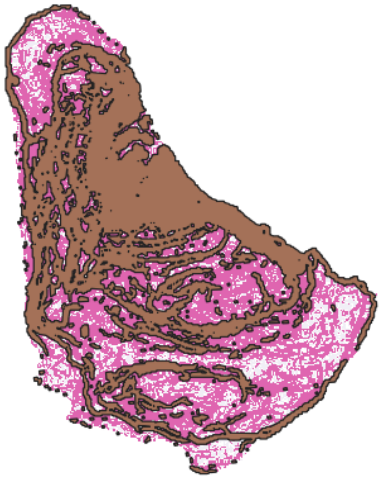


You should now have another temporary file, called **Vectorized**.



We can now apply a buffer to the high susceptibility vector landslide layer, but first we need to reproject the vectorized layer. This is because when working with buffers and distances in general, it is easier to work with a **projected coordinate system** that allows you to set distances in the metric system, rather than in degrees.

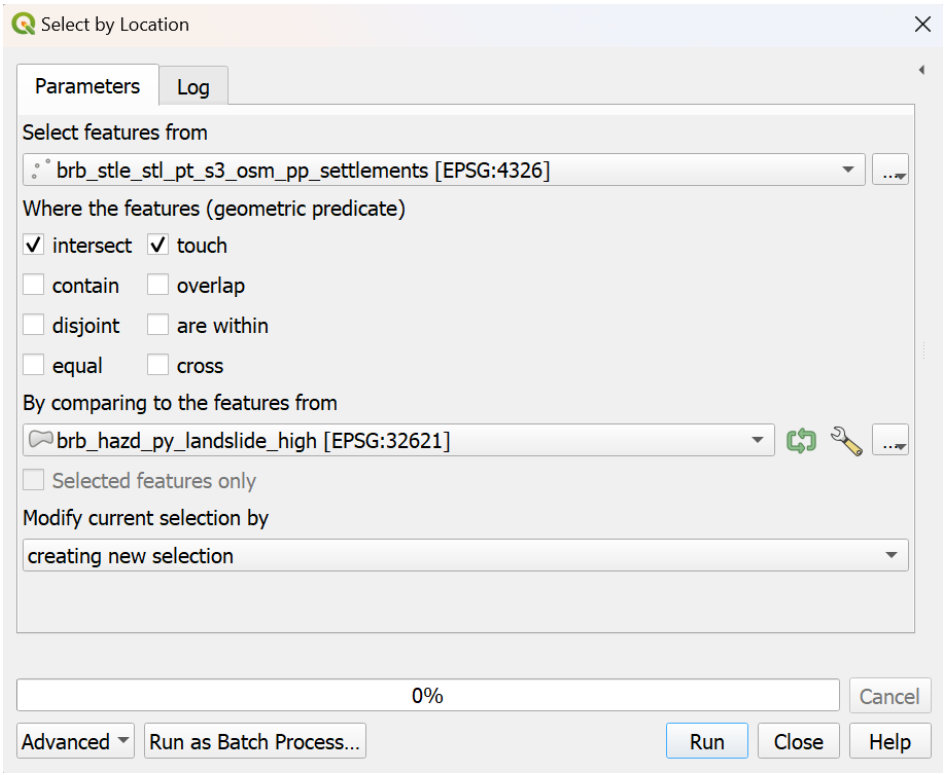
8. Search in the **Processing Toolbox** for **Reproject Layer** (under Vector general), choosing **WGS84 / UTM zone 21 N** as a Target CRS, and our temporary Vectorized as input. Click Run and we will get a temporary layer called Reprojected.
9. Back in the **Processing Toolbox**, search for **Buffer**
10. Make sure the Reprojected is the **Input**, change the distance to 50 meters, and check the **Dissolve result** checkbox (this will ensure we create one smooth polygon rather than many overlapping)
11. You can save this output in GIS\2_Active_Data\208_hazd, choosing a name that respects the naming convention (it must say these are high landslide susceptibility areas)



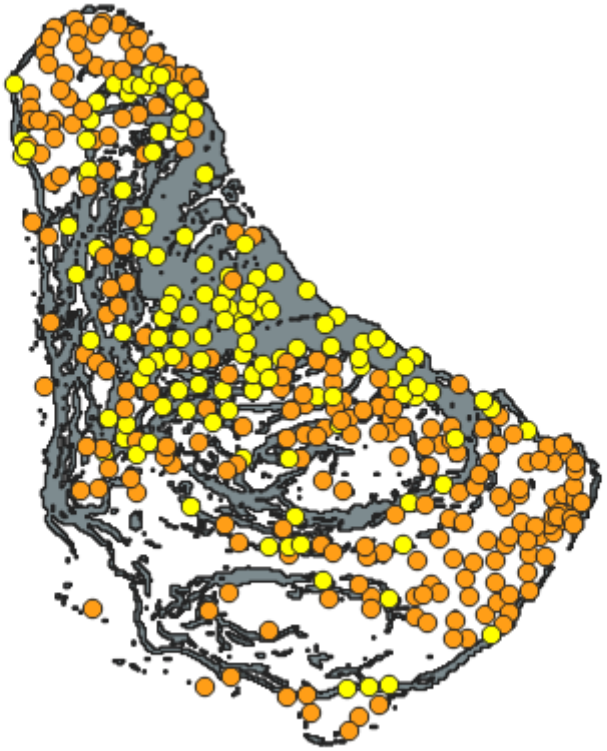
12. We can clean up our layer list from all the intermediate outputs. Remove them with the **Remove Layer** button.

5.0 Obtaining a list of settlements that fall within areas of high landslide susceptibility

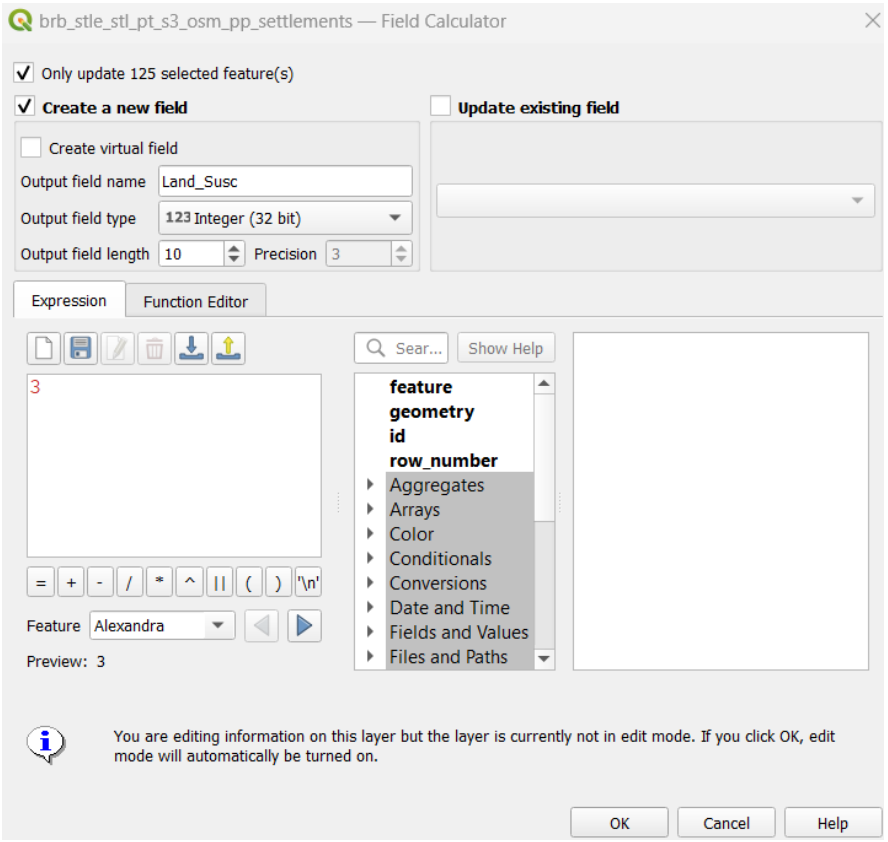
1. In your layers panel, make sure the settlement layer is above the high susceptibility landslide. You can uncheck all the others for now.
2. In the top menu, select **Vector**, **Research Tools**, and **Select by Location**
3. In the *Select features from field* choose the settlements layer
   For the *By comparing to the features from* field choose the Reprojected High Susceptibility Areas, check on the parameters that make sense to you, for example, intersect and touch, then click Run



You will now see settlements highlighted in yellow on the map if they intersect or touch the high susceptibility layer, and in blue in the settlements layer's attribute table (you may need to reorder the layers to see these). You should have around 168 settlements selected.



4. Right-click on the Settlements layer to open its **Attribute Table** and click on **Field Calculator**
5. We are going to add a column that says these settlements are in areas that are highly susceptible to landslides.
    a. Make sure you have checked the option to update only selected features.
    b. Add a new column called Land_Susc, and field type integer
    c. Write 3 as a value in the expression panel. This will add a 3 to all the rows selected. The rest will be considered null.



6. Once you have OKed this, make sure you save and close the editing session on the Attribute Table by clicking on the 3rd first, and then 1st icons at the top left 
7. Now, even if we press on Deselect  on the upper left menu, we will still have a record of which settlements are most at risk, thanks to that new field.

6.0 Reviewing and final aesthetics

It is time to look at the symbology and aesthetics of the final product.

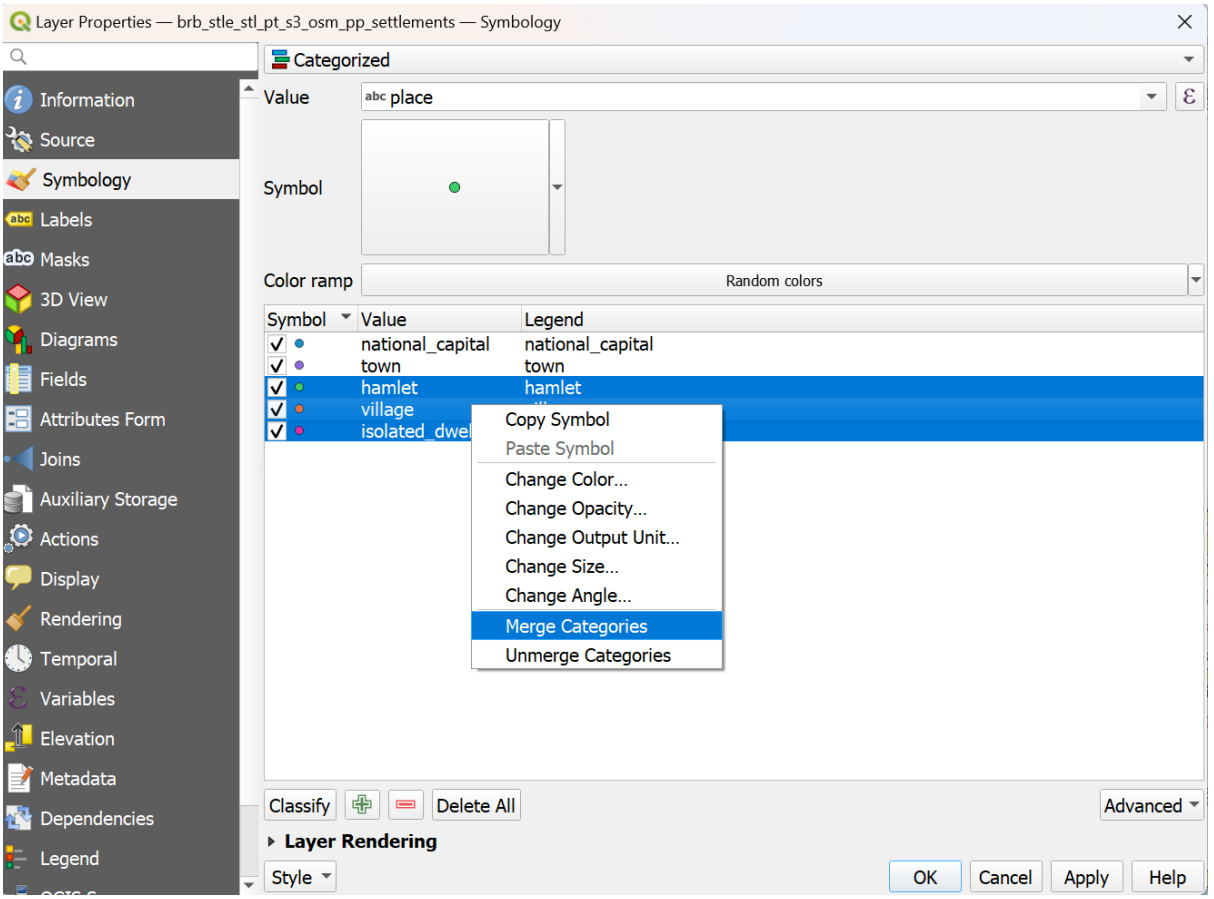
Add the feather:

1. Right-click on the brb_admn_ad1_py_s1_gadm_pp_parish dataset and choose **Duplicate.** Make sure this copy is at the very bottom of the layers list, but above the basemap.
2. Right-click on and find the **Symbology menu** for this duplicate layer in its **Properties** window.
3. At the very top, in the dropdown window, choose **Inverted Polygons**.
4. Click on **Simple Fill** under the **Fill option**, and find in the **Symbol layer type** dropdown the option **Shapeburst Fill**
5. As Gradient colors, choose light blue as the first color, and white as the second, and adjust the distance so that it is about 4 or 5 millimeters.

6. **Apply** and **SAVE**!

Style the Settlements, so that each category has a different symbol and a label of a slightly different size, in order of importance.

1. Right-click on the settlements layer and select the symbology tab
2. Choose the categorized option and place as a value. Classify !
3. Use the symbology applied in other practicals for the national capital (white dot size 4 and black dot 2.5) and cities (black dot).
4. You can group smaller settlements like hamlets, villages, and isolated dwellings in one single category by highlighting them while pressing on your keyboard “ctrl” and right-clicking to find the option **Merge**
5. When you are happy with your results click ok
6. Remember to save the project!



7.0 Landslide Susceptibility Map Layout

You are now ready to move onto the Map Layout workspace to create your map document.

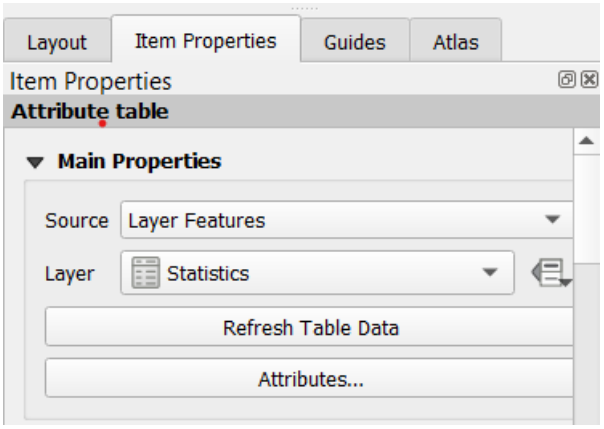
1. If you previously saved a map document as a template - well done you! That saves a lot of time. You can find your template by clicking on **Project**, and then on **Layout Manager**. Under **New from Template,** choose one of your Portrait templates!

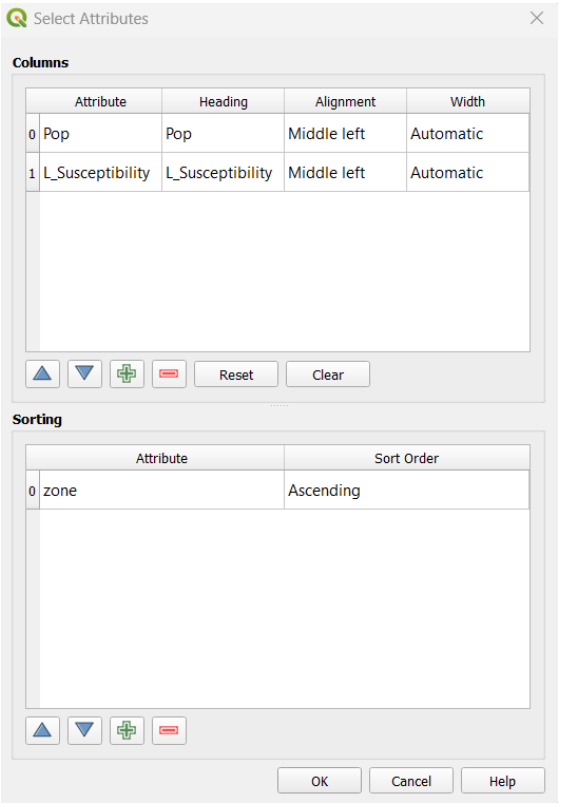
2. If not, from the **Project** menu select **New Print Layout**. You will be prompted to enter a title. Click **OK.**
3. Right-click on the white canvas, page properties and select portrait in page orientation

You can refer back to Practical # 4 to know how the Print Layout Workspace works and how to get to your final product.

For this map, we will add various elements.

1. With the **Add Map** tool,  add your map to cover the full length of the page
2. Let's now add two tables - the one with population by landslide susceptibility zone and the list of settlements in highly susceptible areas:
    - in the upper menu, click on **Add Item**, and **Add attribute table,** and draw a rectangle in the area in which you want it.
7. In the **Main properties** menu of the attribute table on the right, select the **Statistics** layer
8. Click on **Attributes** to choose which ones to keep in the final table.
    - We can just keep the new text categories, and the **rounded population values and the L_Susceptibility**, so select all the others and click on the red minus.

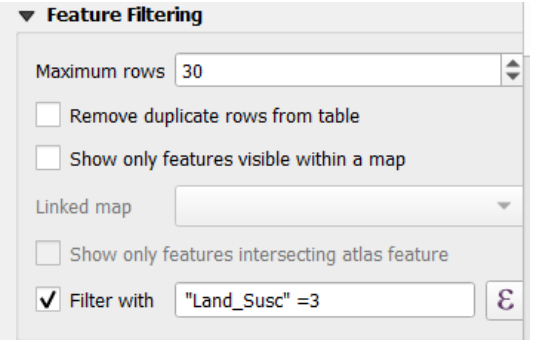




9. You can add with the green plus an attribute in the **Sorting** section, the attribute "zone" to make sure the table is sorted according to the number, in an ascending fashion. Click OK

10. Back in the Item Properties menu you can scroll down to choose a font and a size that you like, and under **Appearance,** you can hide the headers by choosing **No Header** as **Display header** option**.** You can then add some text that explains what the table contains using the **Add label** tool  (*for example: Number of people living in areas with different landslide susceptibility*)

11. Add another attribute table, this time selecting the Settlements dataset as **Layer**.
12. Once again, let's get rid of all attributes, except the name and the place by clicking on **Attributes,** selecting all other attributes, and removing them with the red minus
13. Scroll down in the Feature Filtering menu and click on **Filter with**,
    - Write an expression such as: **"Land_Susc"=3** and filter out all elements that are not in areas of high susceptibility.
    - As you can see, it is challenging to display the 168 elements so you could combine the land_Susc with place for example to have tables only about villages.

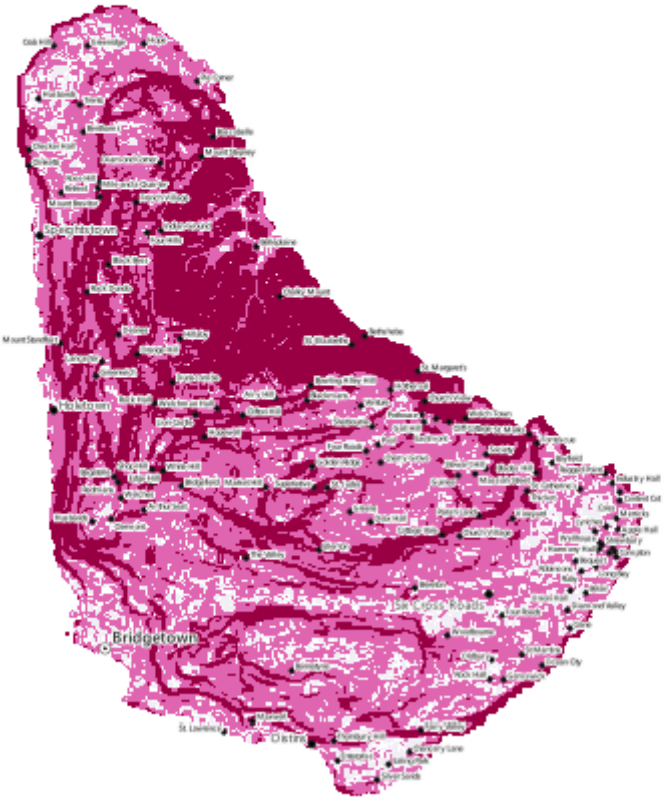


14. Once again, format the table, change the font, its size, remove the headers, and add a text element to explain what is in the table.

Number of people living in areas of different landslide susceptibility

23865	Low
159663	Medium
79775	High

Settlements in areas of high landslide susceptibility



Welchman Hall	village
Mile and a Quarter	village
Bathsheba	village
Orange Hill	village
Redmans	village
Ellerton	village
Cottage Vale	village
Hothersal	village
Clifton Hill	village
Rose Hill	village
Checker Hall	village
Rock Dundo	village
Chalky Mount	village
Market Hill	village
Superlative	village
Clinketts	village
Indian Ground	village
French Village	village
Hillaby	village
Dunscombe	village
Black Bess	village
Four Roads	village
Airy Hill	village
St. Elizabeths	village
Lion Castle	village
Edge Hill	village
White Hill	village
Rock Hall	village
Hopewell	village
St. Marks	village
Parish Land	village
St. Margaret's	village
Church View	village
Cliff Cottage	village
Welch Town	village
Fairy Valley	village
Lancaster	village
Glebe Land	village

15. Now spend some time adding all the final elements, such as a descriptive title, description, data sources, legend, and scalebar.
16. When you are happy, export and Save!

8.0 Saving a project

Saving a project allows you to return to it later and continue working on it.

1. From the project menu select **Save**
2. If it is the first time saving the project, use the menu prompted by QGIS to save the project within the folder ..GIS\3_Mapping\33_Map_Projects and change its name to call it "**Landslide_Susceptibility_Map**."

9.0 Summary

In this session, you started getting familiar with geospatial analysis and working with raster data.

Well done!