

# QGIS Practical 8: Landslide Susceptibility Map

In this practical exercise, you will create a Landslide Susceptibility Map, 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 organized.
- 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**

- Start a new project and add the following datasets:
  - The Admin 1 layer for the country: kna\_admn\_ad0\_py\_s1\_gadm\_pp\_parish in GIS\2\_Active\_Data\201\_admn
  - The Settlements layer: kna\_stle\_stl\_pt\_s3\_osm\_pp\_settlements in GIS\2\_Active\_Data\213\_stle





- The Population raster layer: kna\_popu\_pop\_ras\_s2\_worldpop\_pp\_100m\_2020 in GIS\2\_Active\_Data\212\_popu
- Right-click on Admin 1 layer and select the first option, Zoom to Layers.
- 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.
  - Landslide Susceptibility: Right-click to open its Layer properties and access its Symbology. This layer has 4 values, from 0 to 3, 0 being not very susceptible to 3 being very susceptible to landslides. We want to clearly visualize these areas.
    - Click on Render type and choose Singleband pseudocolor
    - At the bottom right corner, choose Equal Interval as Mode and reduce the number of classes in the bottom right corner to 4

🔇 Layer Properties	— kna_hazd_sli_ra	s_s1_mapaction	_pp_landslides	susceptibility — Symbolog	JY				
λ	Band Rendering	ng							
information	Render type Sin	gleband pseudoco	olor 🔻						
💸 Source	Band		Band 1 (G	Gray)					•
🖌 Symbology	Min		0		Max		3		
Z Transparency	▶ Min / Max \	/alue Settings							
	Interpolation			Linear					•
△ Histogram	Color ramp								
Rendering	Label unit suffix								
Temporal	Label precision			4					<
Nyramids	Value	Color	Label						<b>_</b>
Metadata	0		0.0000						
- Legend	1		1.0000						
QGIS Server	2		2.0000						
	3		3.0000						•
	Mode Equal Int	erval 🔻					c	Classes 4	<ul><li></li></ul>
	Style 🔻					ОК	Cancel	Apply	Hel

■ Apply and OK!

Depending on the color palette you chose, the areas that are most susceptible to landslides might be the darker ones.

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 used a raster with pixels of about 90 meters. We want to smooth out the edges a little bit so that we don't lose any information based on the fact it falls just outside a pixel.
- 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 <sup>38</sup> in the upper menu. The Toolbox will open on the right.
- 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**

🔇 Raster Layer Zonal Statistics					$\times$
Parameters Log			ister laye nal statis		•
Band number			algorithm calcu		
Band 1 (Gray)			stics for a raste es, categorized		
Zones layer		defir	ned in another r	aster layer.	
kna_hazd_sli_ras_s1_mapaction_pp_landslidesusceptibil 💌			e reference laye meter is set to		
Zones band number		laye	r", then zones a	re	
Band 1 (Gray)		zone	rmined by samp raster layer va	lue at the	
Advanced Parameters			roid of each pix ce raster layer.	el from the	
Reference layer		If th	e reference laye	er	
Input layer 💌			meter is set to r", then the inpu		
Statistics			r will be sample roid of each pix		
[Create temporary layer]			es raster layer.		
✓ Open output file after running algorithm	-		ther the source ne zone raster la	· · ·	Ŧ
0%				Cancel	
Run as Batch Process		Run	Close	Help	

The output is a table that is now shown in the Layers list. Open it up to look at the result.









Layers
💉 🏨 🔍 🍸 🖏 👻 🗊 🗔
Statistics
🔻 🗸 🚏 kna_hazd_sli_ras_s1_mapaction_pp_landslidesusceptibility
0.0000
1.0000
2.0000
3.0000
kna_stle_stl_pt_s3_osm_pp_settlements
🔻 🗸 🚏 kna popu pop ras s2 worldpop pp 100m 2020
0.106653
11 6076

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** and create a new field called Pop, in which we are going to round the total population numbers

Statistics — Fie	ield Calculator	×
✓ Create a new	field Update existing field	
Create virtual fi	field	
Output field name	Pop	
Output field type	Whole number (integer)	· · ·
Output field length	10 Precision 3	
Expression Fi	Function Editor	
Preview: 9428	<ul> <li>Date and Time</li> <li>Fields and Values</li> <li>NULL</li> <li>1.2 zone</li> <li>1.2 deg<sup>2</sup></li> <li>1.2 sum</li> <li>123 count</li> <li>12 min</li> </ul>	Show Values
	are editing information on this layer but the layer is currently not in edit mode. I mode will automatically be turned on. OK Cancel	ff you click OK, Help

2. Let's also create a new field to make the susceptibility levels human readable. 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









🔇 Add Fie	ld	×
N <u>a</u> me	L_Susceptibility	
Comment		
Туре	Text (string)	•
Provider type	string	
Length	10	-
	OK Cancel	

• And modify the values so that you have Very Low where it says 0, Low for 1, Medium for 2 and High for 3.

	▼ Update A	Update Selected
	Рор	L_Susceptibility
i	12519	Low
	9428	Very Low
i	11150	High
1	18448	Medium

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

## 4.0 Obtaining a vector of areas with landslide

#### susceptibility level 3

- 1. Open the **Processing Toolbox** by clicking on the cog icon <sup>20</sup> in the upper menu. The Toolbox will open on the right.
- 2. In the search bar, look for Raster Calculator
- 3. Compose the following expression, by double-clicking on the landslide layer, and the various operators.

```
(
"kna_hazd_sli_ras_sl_mapaction_pp_landslidesusceptibility@1"=
3) / ((
"kna_hazd_sli_ras_sl_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:

- $\circ$   $\,$  1 for when the expression is TRUE, so all pixels that have value 3  $\,$
- $\circ~$  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.





yers	Operators				
Output@1	+	*	cos	sin	log10
Output_1@1 Output_2@1	-	1	acos	asin	In
kna_hazd_sli_ras_s1_mapaction_pp_landslidesusceptibility@	^	sqrt	tan	atan	(
kna_popu_pop_ras_s2_worldpop_pp_100m_2020@1	<	>	=	!=	<=
	abs	min	max		
pression					
( "kna_hazd_sli_ras_s1_mapaction_pp_landslidesusceptibility@1"=3) / (	[ "kna_hazd_sli_	_ras_s1_mapac	tion_pp_landslic	desusceptibility@	<b>⊡1"=3)&gt;0)</b>

4. Scrolling down, as **Reference Layer,** use the landslide dataset, and click on **Run** 



Let's now turn this into a vector file!

- 5. In the Processing Toolbox, search for Polygonize Raster to Vector
- 6. Choose the temporary Output from Raster Calculator as **Input**, and leave the other parameters unchanged

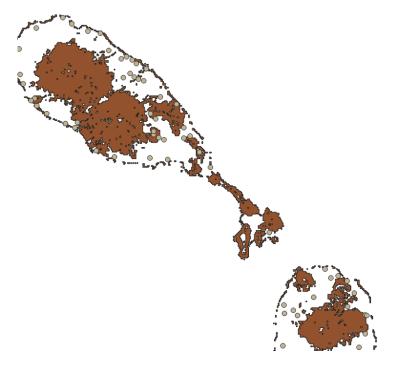






<b>Q</b> Polygonize (Raster to Vector)	
Parameters Log	
Input layer	
Vutput [EPSG:32620]	
Band number	
Band 1 (Gray)	
Name of the field to create	
DN	
Use 8-connectedness	
Advanced Parameters	
Additional command-line parameters [optional]	
Vectorized	
[Save to temporary file]	
✓ Open output file after running algorithm	
	0
Run as Batch Process	

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



We can now apply a buffer.

If you have not done so already, change the Coordinate System of your project by going into Project, Properties, and CRS, and pick WGS84 / UTM one 20 N. 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.

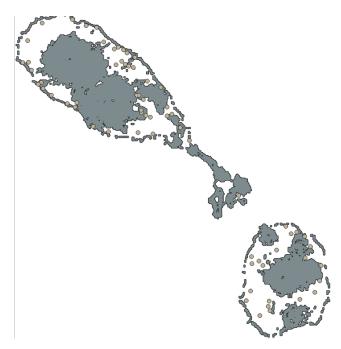








- 7. Back in the Processing Toolbox, search for Buffer
- 8. Make sure the Vectorized is the **Input**, change the distance to 50 meters, and check the **Dissolve result** checkbox (this will ensure we create one smooth polygon rather than many overlapping)



- 9. 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), by right-clicking and choosing **Export** on the **Layer properties.**
- 10. 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 the top menu, select Vector, Research Tools, and Select by Location
- 2. With the settlements as Input and the High Susceptibility Areas as Comparison layer, check on the parameters that make sense to you, for example, intersect and touch



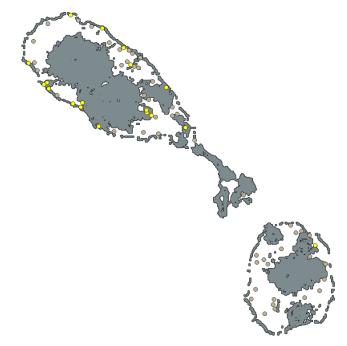






Select by Location				×
Parameters Log Select features from	•	This a	lgorithm cre	location eates a selection The criteria for
<ul> <li>kna_stle_stl_pt_s3_osm_pp_settlements [EPSG:4326]</li> <li>Where the features (geometric predicate)</li> <li>✓ intersect ✓ touch</li> <li>contain overlap</li> <li>disjoint are within</li> <li>equal cross</li> <li>By comparing to the features from</li> <li>✓ Buffered [EPSG:32620]</li> </ul>	•••	selecti spatia featur	ing features I relationshi	is based on the p between each atures in an
Selected features only Modify current selection by				
creating new selection	•			
0%				Cancel
Run as Batch Process	Ru	In	Close	Help

You will now see those settlements highlighted in yellow on the map, and in blue in the settlements layer's attribute table



- Right-click on the Settlements layer to open its Attribute Table and click on Field
   Calculator
- 4. We are going to add a column that says these 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 write 3 as a value

Create a new field Create virtual field	Update existing field
Output field name Land_Susc	
Output field type Whole number (integer	
Output field length 10 Precision	
Expression Function Editor	
3 = + - / * ^    ( ) "\n" Feature arnes Ghaut • • • •	<ul> <li>Show Help</li> <li>Aggregates</li> <li>Arrays</li> <li>Color</li> <li>Conditionals</li> <li>Conversions</li> <li>Date and Ti</li> <li>Fields and V.</li> <li>Files and Pat.</li> <li>Fuzzy Match.</li> <li>General</li> <li>Image: Array and a statement of the statement</li></ul>
You are editing information on edit mode will automatically be	this layer but the layer is currently not in edit mode. If you click OK,

5. Once you have OKed this, make sure you save and close the editing session on the

Attribute Table by clicking on the 3rd and 1st icons at the top left 📝 😻 📑

6. Now, even if we press on Deselect <sup>4</sup> 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

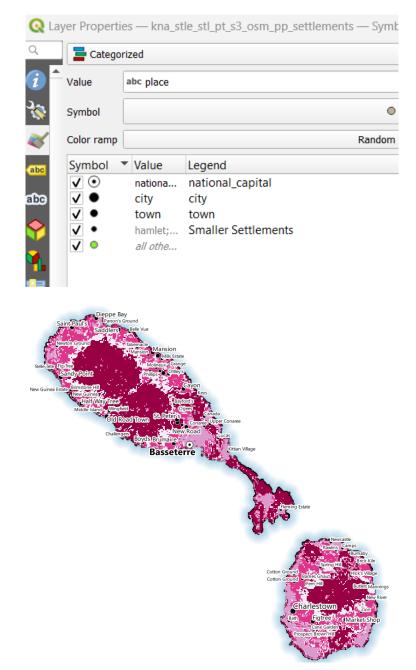
It is time to look at the symbology and aesthetics of the final product.

- Add the feather:
- Right-click on the kna\_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. 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** 



#### 7.0 Landslide Susceptibility Map Layout

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

 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 <u>Portrait templates</u>!









2. If not, from the **Project** menu select **New Print Layout**. You will be prompted to enter a title. Click **OK**.

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 and 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, so select all the others and click on the red minus.

Layout	Item Properties	Guides	Atlas	
Item Prop	erties			ð×
Attribute	table			
▼ Main	Properties			<b></b>
Source	Layer Features			-
Layer	Statistics		-	
	Refresh	Table Data		
	Attri	butes		









	Heading	Alignment	Width
Рор	Рор	Middle left	Automatic
L_Susceptibility	L_Susceptibility	Middle left	Automatic
	Reset	Clear	
rting			
-			
	ribute	Sort	Order
Att	ribute	Sort Ascending	Order
Att	ribute		Order
_	ribute		Order
Att	ribute		Order
Att	ribute		Order
Att	ribute		Order

- 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.
- 9. 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 🗔

- 10. Add another attribute table, this time selecting the Settlements dataset as Layer.
- 11. Once again, let's get rid of all attributes, but the name and the place by clicking on **Attributes**, selecting all other attributes, and removing them with the red minus
- 12. Scroll down and click on **Filter with**, to write an expression such as: **"Land\_Susc"=3** and filter out all elements that are not in areas of high susceptibility.

<ul> <li>Feature Filtering</li> </ul>	
Maximum rows 30	\$
Remove duplicate rows from table	
Show only features visible within a map	
Linked map	-
Show only features intersecting atlas feature	
✓ Filter with "Land_Susc" =3	3

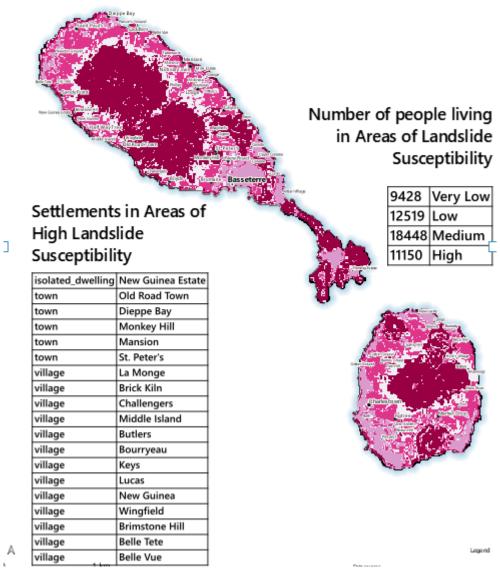








13. Once again, format the table, change the font, its size, remove the headers, and add a text element to explain what is in the table.



- 14. Now spend some time adding all the final elements, such as a descriptive title, description, data sources, legend, and scalebar.
- 15. 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!





