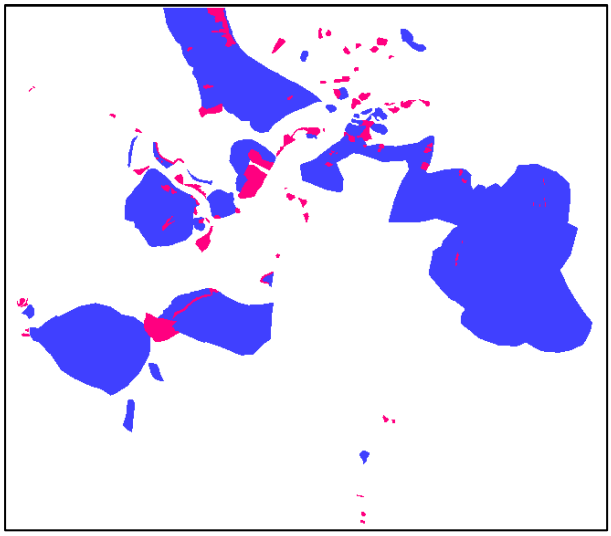
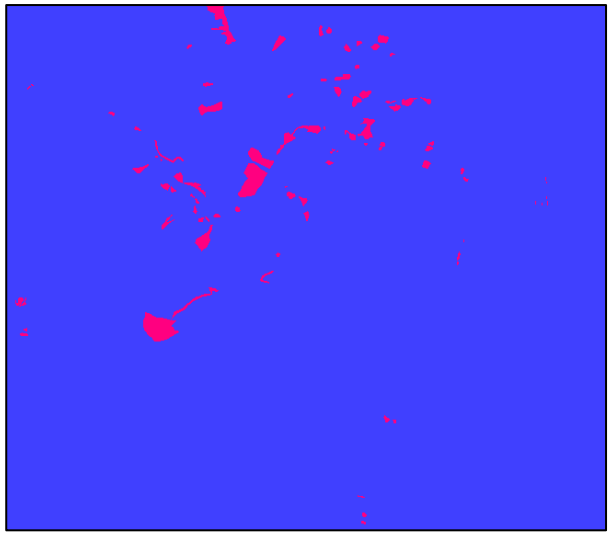
Exercise. Landslide susceptibility assessment using statistical method

Input data

Active1:=iff(((Activity=”a”)or(Activity=”r”))and(Part=”s”),1,0) ⟶ 109 landslides fulfill this criteria



Raster map Active1 (with value 1,0,?) .



Raster map “Active (with value 1,0).

Step 3: Calculating weight values

In the table below you are able to see that the class with more relations with landslides is “60-90”.

Table "Slope_cl" - ILWIS

File Edit Columns Records View Help

	Areaslopetot	Areaslopeact	Areaslopeact_aggregate	Densclass	Dclas	Weight
0 - 5	4173424	3986	3986	0.0010	0.0010	-2.7213
5 - 10	2723958	5521	5521	0.0020	0.0020	-2.0281
10 - 15	1952714	10854	10854	0.0056	0.0056	-0.9985
15 - 20	1502075	13786	13786	0.0092	0.0092	-0.5021
20 - 25	1086549	24235	24235	0.0223	0.0223	0.3833
25 - 30	854335	28284	28284	0.0331	0.0331	0.7782
30 - 40	1073296	55408	55408	0.0516	0.0516	1.2222
40 - 50	450340	43088	43088	0.0957	0.0957	1.8399
50 - 60	147443	22346	22346	0.1516	0.1516	2.3000
60 - 90	35866	5938	5938	0.1656	0.1656	2.3883

Step 4: Creating the weight maps

Here is described how evaluate the weight of the lithology. The procedure is the same used for the slope.

☞

- Select from the main ILWIS menu the options: *Operations, Raster operations, Cross*.
- Select the map **lithology** as the first map, the map **Active** as the second map, and call the output table **Actlithology**. (Ignore the undefined values has no effects, as both maps don't have undefined values). Now the crossing of the two maps takes place.
- Type the following formulas:

AreaAct=iff(Active=1,area,0)

- Select from the table menu: *Columns, Aggregation.*
  Select the column: **Area**. Select the function **Sum**. Select group by column **lithology**. Deselect the box Output Table, and enter the output column **Arealithtot**. Press OK. Select a precision of 1.0.
- Again select from the table menu: *Column, Aggregation*.
  Select the column: **AreaAct**, Select the function **Sum**, select Group by column **lithology**. Deselect the box Output Table, and enter the output column: **Arealithact**. Press OK. Select a precision of 1.0.
- Again select from the table menu: *Columns, Aggregation*.
  Select the column: **Area**. Select the function **Sum**. Deselect the box group by. Deselect the box Output table, and enter the output column: **Areamaptot**. Press OK. Select a precision of 1.0.
- Now the same for the total active area in the map. Go *to Columns, aggregations*, and select the column **AreaAct**. Use the **sum** function and deselect the box "group by". Call the new column **Areamapact**.

Now we have to evaluate the weight for each class.

- Create a table **litho_cl** for the domain **lithology**. (In the main window of ILWIS go to *File, create, table.* See the image on the left).
- Select Columns, Join. Select table **Actlithology**. Select column: **Area**. Select function **Sum**. Select group by column: **lithology**. Select output column **Arealithtot**. Press OK.
- **Step 2:** Calculate the area with active landslides in each slope class. Select *Columns, Join*. Select table: **Actlithology**. Select column **AreaAct**. Select function **Sum**. Select output column **Arealithoact**. Press OK.
- **Step 3:** With both columns, you can calculate the landslide density in each class with the formula:

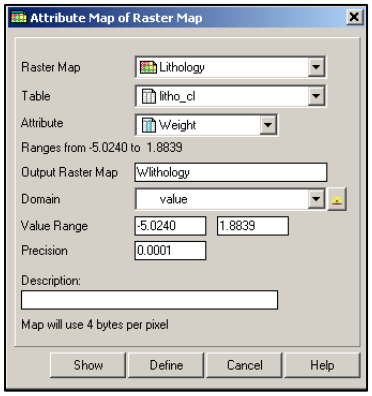
  Densclas:=Arealithoact/Arealithotot

  Select a precision of 0.0001.
- There are some classes with a density of 0. To adjust type the following formula:

  Dclas:=iff(Densclas=0,0.0001,Densclas)
- The final weight can now be calculated with the formula:

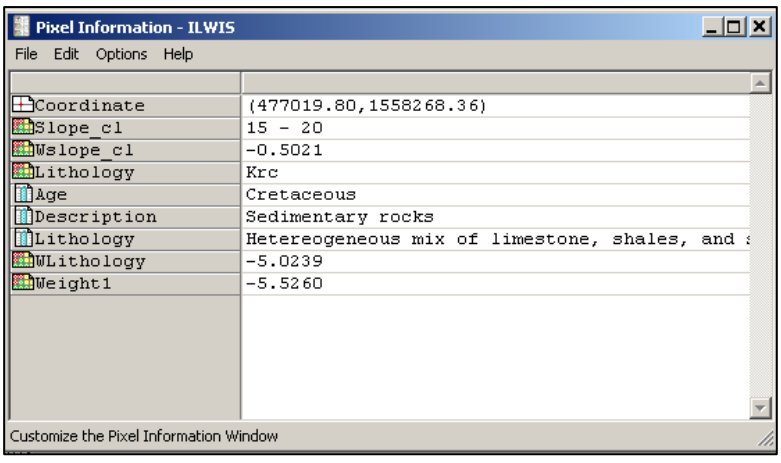
  Weight:=ln(Dclas/0.0152)
- Check the resulting weights in the table. Which lithology classes have the most important relation with landslides?

Now you can create the attribute map from the weight of the lithology and then combined with the Weight map of the slope.

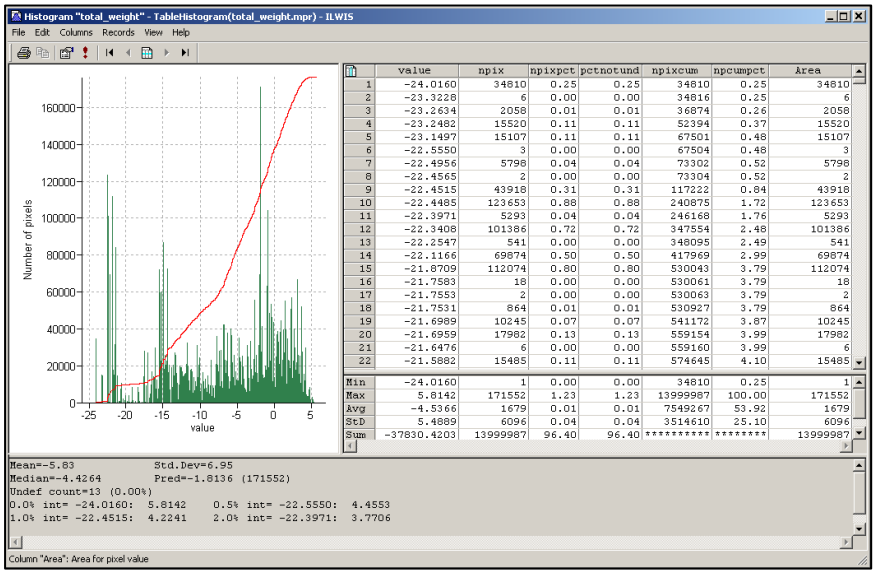


- Select from the main ILWIS menu: *Operations, Raster operations, Attribute map*. Select raster map **lithology,** table **litho_cl**. Select attribute **Weight**. Select output raster map **Wlithology.** Press OK. (See the image on the left).
- The weights for the two maps can be added with the formula:

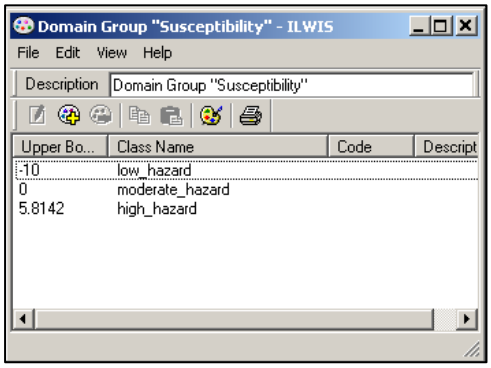
  Weight1=Wslope_cl+WLithology
- Display the map **Weight1** and use the pixel information window in order to read the information from the maps **Slope_cl, Wslopecl, Lithology, WLithology** and **Weight1**. (See below).



Step 6: Combining the weights in a final susceptibility map



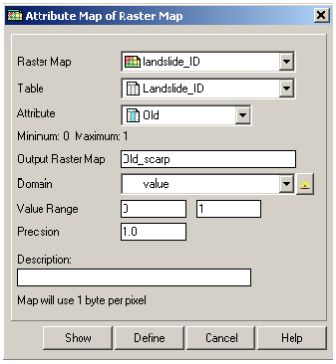
Histogram of the total weight map.



Domain “Susceptibilty”.

You can establish the boundary of the domain looking at the histogram and considering also the distribution of the value into these ranges. This is only an example but you can decide to use others values that you hold as appropriate.

For experienced ILWIS users:



We are going to assume that for the areas classified as "low_hazard", but affected by landslides in the past, the hazard could be moderate.

Try to include the old landslide in the hazard map.

☞

- Create an attribute map of the Old scarp of the landslide. In the table **landslide_id** type the following formula:

Old:=iff((Activity="Stable")and(Part="Scarp"),1,0)

- Now create an attribute map of Old. Go to *operations, raster operations, attribute map*, and select in the raster map **landslide_id**, in the attribute table **landslide_id**, and the column **Old**. See the image on the left.
- Now we want to assign the value "0" for the area undefined.

  In the command line of ILWIS type the following formula:

Old:=iff(isundef(Old_scarp),0,Old_scarp)

- The last step is combining the information of the old scarp with the hazard map. Type the formula:

Final:=iff((Old=1)and(Hazard="low_hazard"),"moderate_hazard", Hazard)

Another method more rigorous is to consider from the beginning also the old landslide (when you evaluate the density of landslide per class and in the total area). You can do that directly in the script.

Step 7: Calculating success rate.

The graph of success rate should have this aspect.

More explanation is needed how the script works

	Percentmap	Percentlandslide
4	99.75	100
5	99.75	100
6	99.74	100
7	99.63	100
8	99.52	100
9	99.52	100
10	99.48	100
11	99.48	100
12	99.16	100
13	98.28	100
14	98.24	100
15	97.52	100
16	97.51	100
17	97.01	100
18	96.21	100
19	96.21	100
20	96.21	100
21	96.21	100
22	96.13	100
23	96.01	100
24	96.01	100
25	95.9	100
26	95.67	100
27	95.66	100