Exercise 06L: Landslide risk assesment

Calculate the number of buildings in high, moderate and low landslide susceptibility classes

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Q: Open the new table and check the content; you should see 4 columns, what does the column "**Area**" represent? In the column **Building_map_1998** we can observe that some buildings have more than one column; why?

A: The cross table represents the intersection of the information of two maps, in this case the building_map_1998 and the landslide Susceptibility map. The cross table we created shows for each building the susceptibility class present at the building location. If the building is located at the boundary between two susceptibility classes the table has two records for that particular building, and each one is related to a particular susceptibility class. Check the example below, the building B_02989 is simultaneously in the High, Moderate, and Low susceptibility class; hence the cross table has three record representing the tree part of the building in the corresponding susceptibility classes. The column area represents the area of the building in that particular susceptibility class.

B_02987 * Mo	B_02987	Moderate	42	42
B_02988 * Lo	B_02988	Low	10	10
B_02989 * Lo	B_02989	Low	36	36
B_02989 * Mo	B_02989	Moderate	9	9
B_02989 * Hi	B_02989	High	9	9
B_02990 * Lo	B_02990	Low	309	309
B_02991 * Lo	B_02991	Low	28	28

Q: Identify which is the predominant susceptibility class for each building; go to *columns / aggregation* and chose *column*: **Susceptibility**; *function*: predominant; *group by*: **Building_map_1998**; *weight*: **Area**. Call the new column: **Susceptibility_per_building**. What does this operation calculate?

A: The operation calculates for each building the predominant susceptibility class on the basis of the area: in the building B_02989 the highest are belongs to the Low class; therefore such class will be selected for the entire building.

Q: **combine = code(building_type)+ "_" +code(susceptibility)** Check the column **Combine**. What do the acronyms stand for?

A: The acronyms refer to the codes of the domain "Building_Type" and "Susceptibility". The expression creates a string (ex. BC_L or RCC_M …) where the first acronym represents the building type for that particular building and the second one identifies the predominant susceptibility class for that building.

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Q: Within the "brick with cement" type, how are the buildings distributed among the susceptibility classes? Give the percentages.

Within the "wood and other scrap materials" type, how are the buildings distributed among the susceptibility classes? Give the percentages.

Comment the two different patterns and try to give your own explanation to justify the differences.

A: Brick with cement = Low: 42% Moderate: 44% High: 14%

Wood and other scrap materials = Low: 81% Moderate: 16% High: 3%

The buildings in bricks with cement are more concentrated in the low susceptibility class (81%); few of them are located in the moderate (16%) and high classes (3%). On the other hand, the category wood and other scrap materials is mainly located in the moderate class (which is the class with the highest landslides density regarding return periods of 100, 200, 300, and 400 years; see: "Quantitative calculation of annual risk and generation of a risk curve for landslides" in this exercise). The 14% of the buildings are located in the High class and only 42% in the low class. This fact can be explained by analyzing the two building types according to their socio-economic aspects. The "brick with cement" mainly belongs to landuses like: residential small / moderate single, residential large, residential multiple, commercial shop / business; the "wood and others" buildings are only squatters. The richest residential wards are located in the areas far from hazardous slopes, while the squatters grew up without a proper urban planning program in the free areas but more prone to hazards, without any planning.

Q: For each of the susceptibility classes, extract the building type with the highest percentage; try to find out what is the most common landuse for the chosen building types (go to building_map_1998 and sort it by building_type).

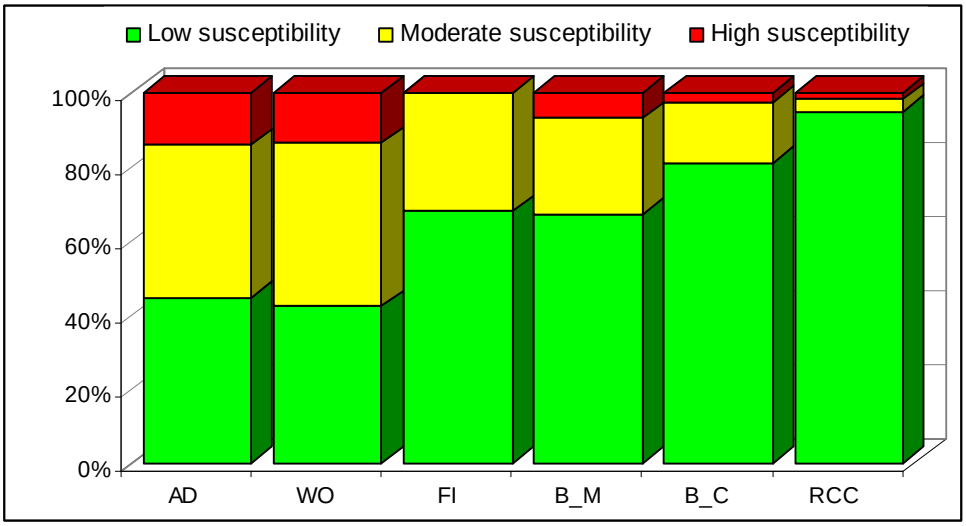
A: Low: Reinforced Concrete Landuse: industries, public offices, warehouses etc.

Moderate: Wood and others / Adobe Landuse: squatters (small residential units)

High: Wood and others / Adobe Landuse: squatters (small residential units)

Reinforced concrete buildings belong to categories like schools, hospitals, hazardous industries, hotels and other private activities. They are expensive constructions and the store in some cases hazardous materials (chemical industries); moreover some of them have a very high social vulnerability (especially hospitals and schools); therefore they are built in safe areas (or they should be!).

Q: Try to show the results stored in the above table through a cumulative histogram in Excel and comment it. Check the example below.



The graph reflects exactly what we said before: Adobe and Wood and others buildings have the higher percentage in the high susceptibility class; while the reinforced concrete buildings are almost entirely located in the low class (buildings in fieldstone are very few compared the total number of buildings). The X ax reflects the economic scale of building types: from the cheapest: adobe and wood, to the most expansive: brick with cement and reinforced concrete. According to what we previously stated the percentage of buildings in the high and moderate classes decreases from adobe to reinforced concrete.

Quantitative calculation of annual risk and generation of a risk curve for landslides.

From susceptibility to hazard

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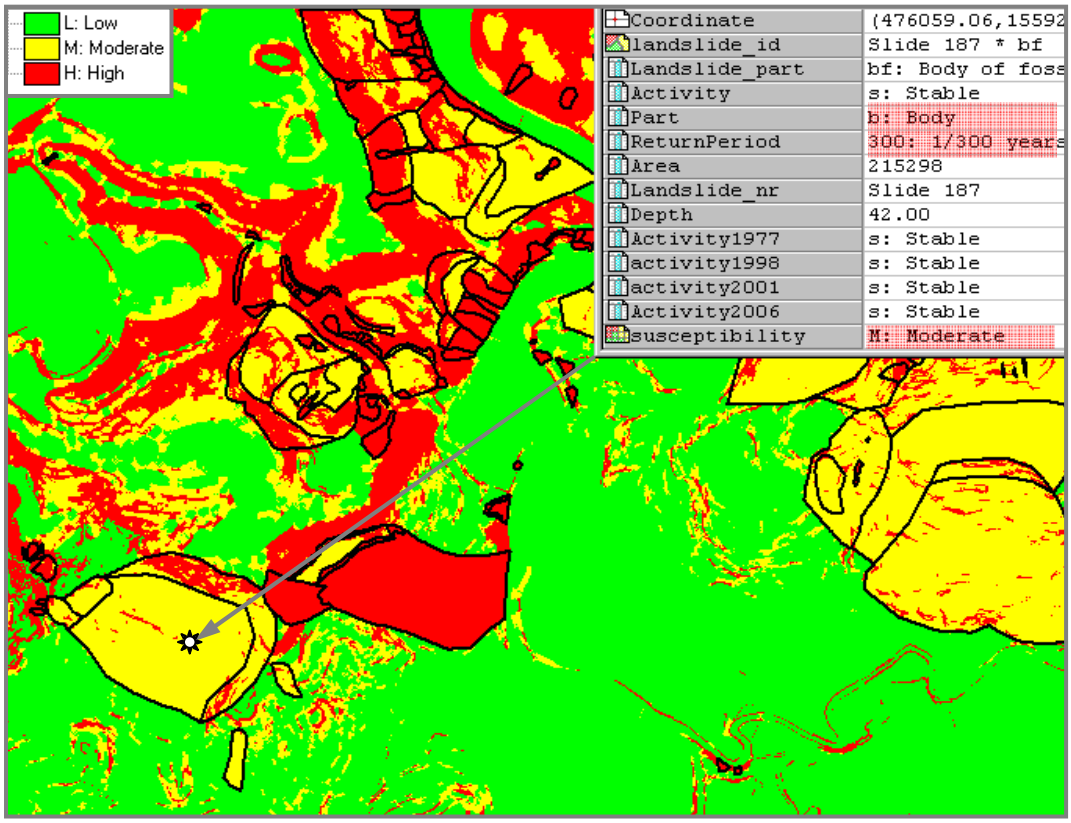
Q: Which hazard class has the highest spatial probability values? Is it the expected result? Try to explain why this class has the highest spatial probability of occurrence

		Spatial probability				
Hazard Classes		Spat_prob_50y	Spat_prob_100y	Spat_prob_200y	Spat_prob_300y	Spat_prob_400y
	HIGH	**0.01815**	**0.16549**	**0.25490**	**0.32932**	0.3713
	MOD	0.000001312	0.005740	0.1345	0.2931	**0.5523**
	LOW	0.000000596	0.000005367	0.000008587	0.000009542	0.00001014

A: The class with the highest spatial probability values on average is the high, but for the 400 years return period the moderate class has a higher spatial probability than the high class; it is not the expected result because the highest values are supposed to be all in the high class. In order to understand why the results show this inconsistency we should check the susceptibility map together with the landslides return period map. The figure below shows the landslide map (only boundaries) overlapped on the susceptibility map. The pixel information window shows the values of the point in the figure (see arrow) for the two maps. The body of the large landslide with a return period of 1 into 300 years is classified in the susceptibility map as "moderate" class. The same thing happens for the large landslides on the right part of the map with a return period of 400 years. This is the reason why, when the landslide density is calculated for the 200, 300 years return period the spatial probabilities of the high and moderate classes are similar and for the 400 years return periods they are higher in the moderate class.



Estimating Vulnerability

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Q: Open the histogram and study it. What is the meaning of the columns Value, Npixpct and Npixcum?

A: The column Value represents the Floor space value in the map; the column Npixpct represents the percentage of pixels related to that value; the column Npixcum regards the cumulative number of pixels.

Q: **perc_cum = npixcum/3154801*100.** What does the large number refer to?

A: the number is the total number of pixels. The formula calculates the cumulative percentage of pixels from the column Npixcum.

Class name	Cum. percentage	Floor space value (upper boundary)
Very small	20%	104
Small	40%	200
Medium	60%	376
Large	80%	876
Very large	100%	150000

Q: **Floorspace_class = clfy(Floorspace, Floorspace_class)** What does the function **clfy** calculate? What does the new column contain?

A: The function classifies the column "Floorspace" according to the group domain "Floorspace_class". The new column contains the given class names: "Very small", "Small", etc.

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Q: **Vulnerability_building = vulnerability_building[Building_type, Floorspace_class]** Check the content of the new column and explain the performed operation.

A: The operation assigned for each building the correct vulnerability rate according to the values of building type and the floorspace class stored in the 2D table Vulnerability_building

Estimating losses and generating the Risk Curve

Q: In the calculations above we apparently don't take into account the **Amount** any more. Can you explain why there is no need here to use the amount of buildings calculated in the first part of the exercise? In which units are the losses indicated here?

A: Simply because we are calculating the losses for each single building; therefore in the general formula

R=H*V*A

the amount (A) for each row (building) is equal to 1. When we extract from the table the sum of the columns **Losses_XXy**, we actually considerate all the buildings (28038); each building contributes with its lossess to the general amount of losses which is expressed in number of building lost.

Return Period	Temporal probability	Losses
50	0.02	31
100	0.01	314
200	0.005	1286
300	0.00333	2420
400	0.0025	4140

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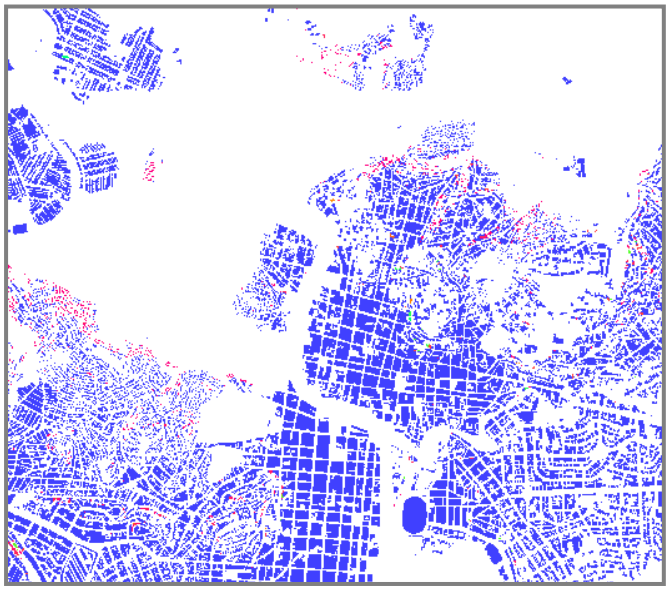
Q: How to evaluate this risk? Is it high? How would it compare with other hazard types?

A: Since you will not evaluate the risk for other hazards, you will be able to answer this question after having completed the multi-hazard risk assessment exercise. But you can already try to guess which hazard will have the highest losses among the 4 hazard types.

Q: Display the results also in the map by showing the attribute **Losses_50y** with the map Building_map_1998. Where are the zones with the highest individual risk levels?

A: The highest losses are expected to occur where the largest landslides (300 and 400 years return period) are located. This is reasonably correct because we learned in the Hazard Assessment section that the chance of reactivation of previous landslides is one of the crucial aspects in landslide risk assessment.

50 years Return Period Losses



400 years Return Period Losses