REVERENCE TO NATURE:
An Avalanche Risk Assessment in Valais, Switzerland

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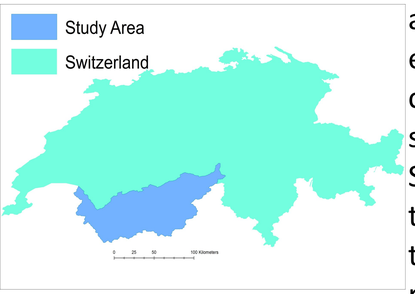
Projection: ETRS_1989_LAEA
Data Sources: Copernicus Land Monitoring Service, European Environment Agency.

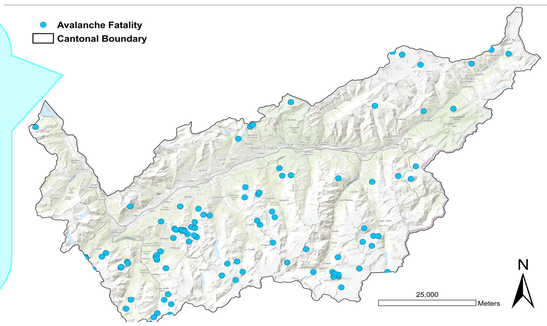
SNOW ADVENTURE AND RISK

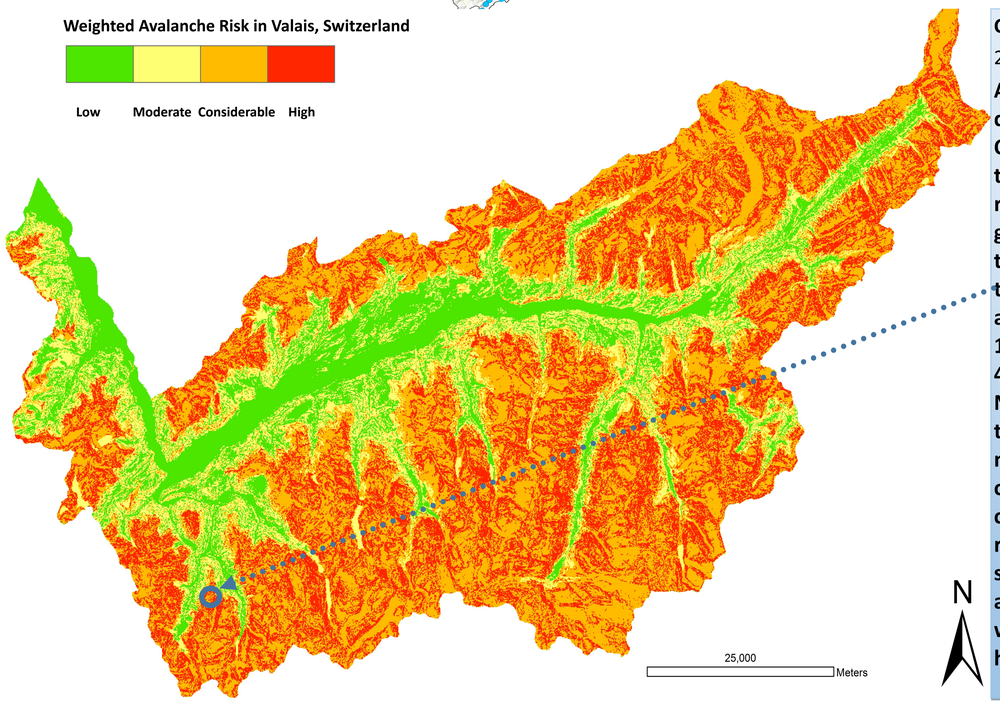
Switzerland has been well known as Alps that crosses its landscape. It is the best place for ski lovers because of its geographical characteristics. The perpetual snow, the slope, and vegetation make some regions to be an ideal place for skiing, and hiking adventures. However, they can also be perfect causes for avalanches. Global statistics, as well as those for Switzerland, always shock us by the massive damage from extreme natural events occurred repeatedly in places where avalanche has for centuries been the part of the landscape. It is essential to take natural catastrophes into seriously consideration for safety of countries because it causes not only the financial damage costs but also huge number of human fatalities. The goal of risk maps is to protect people and buildings by emphasizing dangerous areas. Switzerland, as a beautiful country with lots of mountainous regions, had experienced avalanches for years and the imperative measures, therefore, have to be taken such as analyzing the historical data collected from existed disasters, mapping avalanche risk model and executing effective protection for people and their belongings.



HISTORICAL EVENTS

Number of fatalities due to avalanches within 20 years (1995—2015) has increased to 100 in Valais, Switzerland.

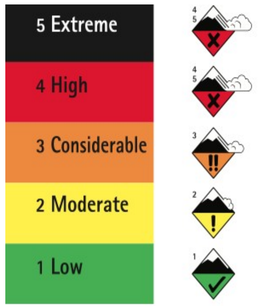




Case Study:
2/5/2003
An avalanche caused death of 4 people in Orsires, Valais, when they were skiing. The risk level on that region was determined to be 4. Terrain features for that region are that elevation is 1950 m, slope is 45.63°, aspect is Northeast. Even though no information about profile curvature and land cover, the known terrain features are sufficient to cause an avalanche, especially with the triggered by human activities.

Note: Since avalanches that were on very high risk only accounted for 0.01% of all the avalanches happened within 20 years, this project only considered four levels of risk, which is from low to high.

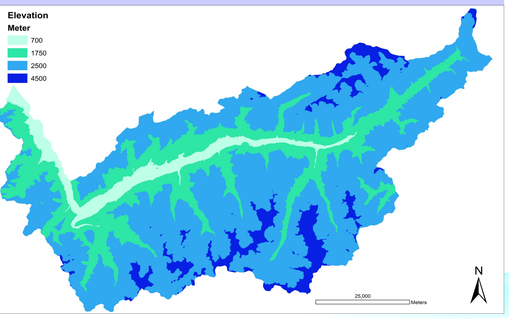
RESULT



Spatial distribution of the avalanche risk values shows different risk level in Valais, Switzerland. It can be declared that the most dangerous regions have relatively dense distribution even though most of them are in very tiny areas. Considering the process that avalanche happens, it is always triggered in a small area. However, it can bring huge influence along its snow path even with mud slide and rock fall so that a larger area would be buried. Analyzing the result of avalanche risk in Valais, it is easy to identify that avalanche has close relation to elevation. Almost all the low risk areas are in the valley of Alps. High elevation provides more possibilities for avalanche events. Thus, it is reasonable to determine that the number of fatalities due to avalanches happened in Valais always keeps in the first place within 20 years.

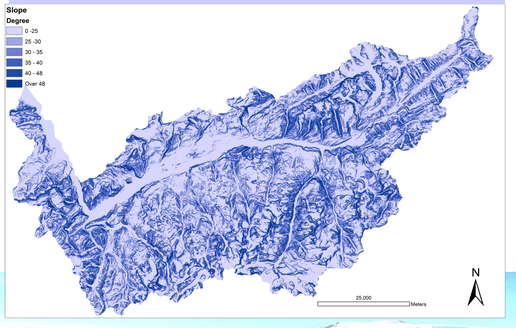
TERRAIN FEATURES ANALYSIS

Elevation



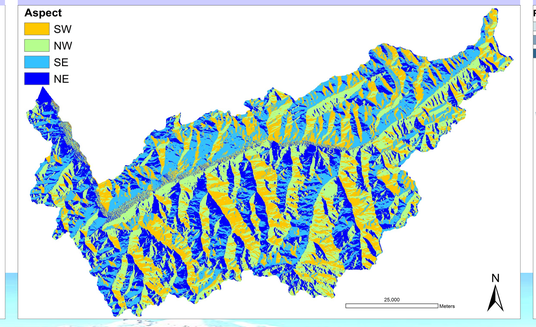
Elevation has a profound influence on snowline as well as diversity of vegetation. Temperature decreases as the elevation increases. This study area was set at 700m, area as below there is not enough snow to form avalanche. From 700m to 1750m, is the below alpine snowpack, which means vegetation could provide anchoring points for snowpack indicating it could reduce avalanche danger. Above 1750m, not only low temperature provides excellent condition for snow accumulation, but also there are not enough vegetation for providing anchoring points for snowpack so that elevation above 1750m is considered to be most dangerous for avalanches.

Slope



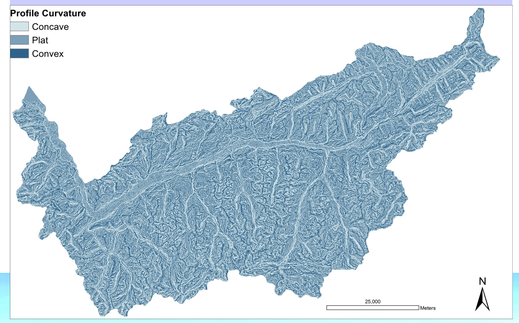
The steeper the slope is, the more gravity is trying to pull snow downhill. For avalanches, any slope that is steeper than 25° is considered steep. The shallow slope is able to allow an accumulation of snow. For this risk model, any slope between 25° and 60° is able to slide. Slope that is less than 25° is less possible to slide because the force component along the slope from gravity has small effect on snowpack compared to the strength of snowpack. While slope that is greater than 60° is less possible to cause avalanches because there is not going to be thick snowpack due to lack of snow accumulation to a significant amount.

Aspect



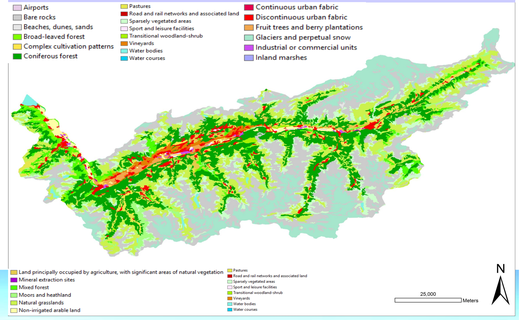
Aspect is defined to be cardinal direction, which are North, East, South, and West, as well as intermediate directions, which are Northeast, Southeast, Southwest, and Northwest. Aspect is considered to be essential for avalanche because it respect to sunlight. In the Northern Hemisphere, northern slopes receive less sunlight than any other aspects, thus it is easier to form a clod snowpack. A cold snowpack tends to develop more persistent weak layers than a warm snowpack. (United States Forest Service, 2015). Eastern slopes will develop colder snowpack than western slopes. Because sunlight in the morning has lower temperature than it in the afternoon.

Profile Curvature



Slope profile is also called curvature. Slope can be concave and convex. Concave means curving in or hollowed inward. A convex surface will apply a tensile stress on the snowpack (National Avalanche Center, 2016) which promotes the formation of a crown and the release of a slab avalanche. A concave slope reduces the tensile stress which will slightly increase the strength of the snowpack. A positive curvature indicates the surface is upwardly concave at the cell. A negative curvature indicates the surface is upwardly convex at the cell. A value of zero indicates the surface is flat (ERSI, 2017).

Land Cover



The type of land cover and surface coverage also influence the strength of snow pack. Areas covered by trees, huge rocks, and large bushes could provide anchoring points for snow to attach the ground so that avalanche risk on these areas will be reduced. Because in order to cause avalanche, it needs more strength of snowpack and larger trigger to initiate it. While areas that are relatively barren, or covered by perpetual snow and glacier, or grassland could not provide anchor points. Because the small friction results in the low capability of holding snowpack and stopping an avalanche.

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