MATASCI Battista (2015): Rockfall susceptibility assessment and remote geological mapping with LiDAR point clouds

Abstract

Characterizing the geological features and structures in three dimensions over inaccessible rock cliffs is needed to assess natural hazards such as rockfalls and rockslides and also to perform investigations aimed at mapping geological contacts and building stratigraphy and fold models. Indeed, the detailed 3D data, such as LiDAR point clouds, allow to study accurately the hazard processes and the structure of geologic features, in particular in vertical and overhanging rock slopes. Thus, 3D geological models have a great potential of being applied to a wide range of geological investigations both in research and applied geology projects, such as mines, tunnels and reservoirs. Recent development of ground-based remote sensing techniques (LiDAR, photogrammetry and multispectral / hyperspectral images) are revolutionizing the acquisition of morphological and geological information. As a consequence, there is a great potential for improving the modeling of geological bodies as well as failure mechanisms and stability conditions by integrating detailed remote data.

During the past ten years several large rockfall events occurred along important transportation corridors where millions of people travel every year (Switzerland: Gotthard motorway and railway; Canada: Sea to sky highway between Vancouver and Whistler). These events show that there is still a lack of knowledge concerning the detection of potential rockfalls, making mountain residential settlements and roads highly risky. It is necessary to understand the main factors that destabilize rocky outcrops even if inventories are lacking and if no clear morphological evidences of rockfall activity are observed. In order to increase the possibilities of forecasting potential future landslides, it is crucial to understand the evolution of rock slope stability. Defining the areas theoretically most prone to rockfalls can be particularly useful to simulate trajectory profiles and to generate hazard maps, which are the basis for land use planning in mountainous regions.

The most important questions to address in order to assess rockfall hazard are:

- Where are the most probable sources for future rockfalls located?
- What are the frequencies of occurrence of these rockfalls?

I characterized the fracturing patterns in the field and with LiDAR point clouds. Afterwards, I developed **a model to compute the failure mechanisms on terrestrial point clouds** in order to assess the susceptibility to rockfalls at the cliff scale. Similar procedures were already available to evaluate the susceptibility to rockfalls based on aerial digital elevation models. This new model gives the possibility to detect the most susceptible rockfall sources with unprecedented detail in the vertical and overhanging areas. The results of the computation of the most probable rockfall source areas in granitic cliffs of Yosemite Valley and Mont-Blanc massif were then compared to the inventoried rockfall events to validate the calculation methods. Yosemite Valley was chosen as a test area because it has a particularly strong rockfall activity (about one rockfall every week)

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