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Future trends in landslide risk in the Central Pyrénées (France)

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Better understanding the pathways through which future socio-economic changes might influence land use and land cover changes is a crucial step to accurately assess the vulnerability and resilience of societies to mountain risks in a global change context. In the context of the French-funded ANR Project SAMCO which aims at enhancing the overall resilience of societies on the impacts of mountain risks, a procedure to quantify changes in landslide risk at catchment scales has been developed. The methodology is applied to a case study in the French Pyrenees on the municipality of Cauterets which is affected by several types of mass movements, is a highly populated touristic place in Winter and Summer.

Over the last 60 years, socioeconomic development was based on tourism activities with historical hydrothermal spas and a newly developed ski resort in the late 1970s. It is part of the National Park of the Pyrenees since its creation in the late 1960s. These socioeconomic drivers favored the urban development in the bottom part of the valley (+ 156% since 1950s). The analysis of gains and losses of land covers exhibits clear encroachment and reforestation trajectories. Natural grasslands of the uplands have significantly decreased and been converted into shrublands, meanwhile shrublands have been converted into open forests. Pastoral activity is still important in summer welcoming herds from outer valleys in the administratively defined uplands called 'estives'.

Land use practices (e.g. the use of permanent shepherds) have changed inducing a decrease in pastoral pressure. Some of the south facing grasslands are nowadays nearly abandoned. Finally, Cauterets is of particular interest regarding the diversity and intensity of natural hazards (a major landslide in 2006 as well as two centennial floods in Oct. 2012 and June 2013).

In this research, we investigate first landslide susceptibility, the spatial component of the hazard, through the hydro-geomechanical model ALICE. This latter is based on the calculation of the safety factor of the slope in order to simulate the spatial locations of possible unstable areas in relation to environmental controlling factors. Second, we studied potential consequences using a semi-quantitative region-scale indicator-based method, called method of the Potential Damage Index (PDI). It allows estimating the possible damages related to landslides by combining weighted indicators reflecting the exposure of the element at risk for structural, functional and socio-economic stakes. Finally, we provide landslide risk maps by combining both susceptibility and potential consequence maps resulting from the two previous steps.

The risk maps are produced for the present time and for the future (e.g. period 2040) taking into account four spatially-explicit of future landcover and landuse development co-constructed with stakeholders (Houet et al., 2017). Results allow identifying the geographical areas that are likely to be exposed to landslide risk in the future. The results are integrated on a web-based demonstrator, enabling the comparison between various scenarios, and could thus be used as decision-support tools for local stakeholders. The method and the demonstrator will be presented through the analysis of landslide risk in this Cauterets catchment.