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Landslide hazard evolution due to land–use and climate change : a case study in a Pyrenean valley

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Global changes would have impacts worldwide, but their effects should be even more exacerbated in areas particularly vulnerable. Mountainous areas are among these vulnerable territories. In order to estimate the capacity of such mountainous valleys to face global changes (climate, but also climate- and human- induced land-use changes), it is necessary to be able to evaluate the evolution of the different threats. The present work shows a methodology to evaluate the influences of both vegetation cover and climate on landslide hazard over a whole valley until 2100, to propose adequate solutions for current and future forestry management.
Firstly, the assessment of future land use is addressed through the construction of four prospective socio-economic scenarios up to 2040 and 2100, which are then spatially validated and modeled with LUCC models. Secondly, the climate change inputs of the project correspond to 2 scenarios of emission of greenhouse gases. The used simulations were performed with the GHG emissions scenarios RCP 4.5 and RCP 8.5. The impact of land use and climate change is then addressed through the use of these scenarios into hazards computations. For that we use a large-scale slope stability assessment tool ALICE which combines a mechanical stability model, a vegetation module which interfere with the first model, to take into account the effects of vegetation on the mechanical soil properties, and a hydrogeological model.
The results demonstrate the influence of the forest on slope stability; the absence of the forest implies an increase of the probability of landslide occurrence, and at the contrary, the presence of forest has a local stability effect on the slope. The results also indicate some future evolution of the land use, leading to significant modifications of the stability of the slopes in local areas. Finally, the climate change may have noteworthy impact on the occurrence of landslide with the increase of the water content of the soil when regarding future long periods; the results point out a reduction of the Safety Factor in a large part of the studied area. These changes are not uniform over the area, and are particularly significant for the worse scenario RCP 8.5.