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Forecasting landslide occurrence from radar rainfall at the municipality scale : a case study in a Mediterranean climate context in France

Séverine Bernardie[1], Stefania Viaggio[2], Nathalie Marcot[3], Yoann Drouillas, Rosalie Vandromme[1], and Thomas Lebourg[4]

[1]BRGM, Orléans, France (s.bernardie@brgm.fr)
[2]Università degli Studi di Genova, Italy
[3]BRGM, Marseille, France
[4]Université de Nice-Sophia Antipolis, Geoazur, France

Improving the resilience of territories to landslides is a rising need for security managers in a context of climate change, with the increase in frequency and intensity of extreme events. The French department of the Alpes-Maritimes has experienced numerous heavy rainfall occurences over the last two decades, among which the particularly intense events of November 2019 and October 2020 (known as Storm Alex) should be mentioned. During these intense events, the Menton municipality has experienced several damaging landslides. In this context, it is necessary to develop innovative operational systems, based on rainfall data, which is a fundamental physical parameter for triggering landslides. In this study, we propose to develop a tool for landslide prevention at a municipality scale. For that, a fine-tuned approach is proposed : we uses a physical based model to estimate the landslide susceptibility induced by meteorological events, with considering the influence of groundwater level evolution on slope stability. This distributed model is based on a limit equilibrium method that computes Safety Factor along 2D profiles over the entire area. Then a hydrogeological model has been applied for estimating the daily local piezometric level, based on meteorological parameters (rainfall, snowmelt, evapotranspiration...) that might evolve in response to rainfall. Spatialized radar rainfall data has also been introduced and has made it possible to improve the temporal and spatial accuracy of susceptibility maps, by making them "dynamic" and thus facilitating real-time forecasting. This analysis is now possible by setting up a processing chain that, starting with the radar measurement of rainfall (grid resolution 1km²) and through the computation of the corresponding groundwater level, allows a landslide susceptibility map to be produced in response to groundwater level fluctuations. The methodology has been tested on a significant rainfall episode in 2019, and the results are presented. This system is intended for local managers, which are facing with the management of landslide risk. The accuracy of the approach and the different uncertainty sources are presented, leading to some discussions about some necessary improvements of the system for a reliable Early Warning System.