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

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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 Alpes-Maritimes department has experienced numerous episodes of intense rainfall over the last twenty years, with some particularly notable in terms of intensity, in November 2019 and in October 2020 (storm Alex). 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 key physical parameter for triggering the instabilities. 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 use a physical based model to estimate the landslide susceptibility induced by meteorological events, with considering the influence of the evolution of the ground water level 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 due to meteorological events. 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 from the radar measurement of rainfall (1km² grid resolution), the computation of the water table level h , and the production of a susceptibility map corresponding to this water table level. 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.