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Climate change and landslides: introducing a thermo-hydro-mechanical approach

Gianvito Scaringi
Institute of Hydrogeology, Engineering Geology and Applied Geophysics, Faculty of Science, Charles University, Prague, Czech Republic (scaringg@natur.cuni.cz)

Global warming will alter the frequency and patterns of landslides, increasing the risk to populations, infrastructures, and ecosystems in many regions of the world. Scientists draw this prediction mainly from expected changes in precipitation, ice covers, sea level, and land uses. The direct role of soil temperature is usually neglected, even though changes in patterns of temperature – propagating from the surface to depths of several metres – can alter the strength, permeability, water retention capacity, and other properties of various soils. This has been demonstrated, for instance, for active clays subjected to heating while addressing specific engineering problems, such as the long-term storage of radioactive waste in deep geological repositories.

In an ongoing project, we attempt to apply an advanced thermo-hydro-mechanical soil model – based on the theory of hypoplasticity and accounting for various coupled behaviours – to perform slope stability analyses in clayey soils. By this model, we can reproduce complex hydro-mechanical responses caused by changes of temperature, including effects on water pressures, water retention, and swelling or shrinkage. We plan to carry out short- and long-term parametric analyses under climate scenarios, to compare the direct role of temperature with that of other types of forcing (such as changes in precipitation). This way, we expect to quantify how local warming or cooling and altered patterns of temperature can control some types of landslides, and consequently affect current landslide hazard and risk assessments. Ultimately, we plan to conceptualise an upscaled model, so as to work towards physically-based regional assessments through a thermo-hydro-mechanical coupled approach.