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The effect of bedrock originated groundwater on the triggering mechanism of different landslides in Switzerland

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It is well known that the most important triggering mechanism for rapid landslides is the infiltration of precipitation water at the surface of slopes which decreases the soils shear strength. However, the present study put focus on the exfiltration of groundwater from the substratum and its effect on the triggering of overlying landslides. Which is the origin of this groundwater? Which role does the hydrogeology play on the triggering mechanism of landslides? Is the bedrock locally feeding (springs) or draining (fractures) the overlying soil material in slopes?

Due to the invisibility of the underground, these questions are difficult to answer. The aims of this research are 1) combining suitable field methods in order to create geological and hydrogeological conceptual models for different landslides located in representative geological settings in Switzerland, 2) to compare the different models and 3) to complement them with numerical flow modelling.

For this purpose, three different case studies were chosen:
• Landslide triggerd by artificial rainfall on a natural slope: This experiment was carried out in the Northern Swiss Molasse Basin where horizontally layered porous and fractured sandstone intersects with marlstone and is overlied by silty colluvium and sandy eluvium. The role of the joints and the groundwater in the porous sandstone is studied.
• Reactivated fast moving landslide: This landslide affects moraine material and weathered bedrock which overlies black schist, flysch and rauhwacke in a tectonically affected zone in the Western Swiss Prealps. The origin of the groundwater in the landslide area and the influence of a spring at the base of the landslide are of special interest.
• Slope prone to landslides: This slope is located in the Swiss Subalpine Molasse where inclined and heavily fractured conglomerate is interbedded with sandstone and marlstone and covered with silty and clayey eluvium. The destabilizing effect of springs on the slope, their origin from the fractured conglomerate and their response to rainfall is investigated.

In a first project step, the geology and geometry of the landslides are investigated by the combination of geophysical methods (active seismic and electric resistivity), LIDAR, borehole drilling and geological mapping. In a second step, the hydrological/hydrogeological regime is investigated by measuring the hydraulic conductivity with the use of infiltration tests, measuring of precipitation and spring flux, monitoring the groundwater level in boreholes and analyzing hydrogeochemical parameters. Based on these investigations, hydrogeological conceptual models are created. In a next step, different water flow scenarios will be simulated using finite element hydrological flow models.

The first results give evidence that for the understanding of the triggering mechanism of the different landslide types it is important to take into account the groundwater regime of the substratum: either it acts as a drain or it is feeding the overlying unstable mass and therefore either disadvantages the triggering or brings it forward. In a further step, the described conceptual models will be compared and verified with related landslides in similar geological settings.