Deep Landslides in the Limmat Valley

Project Framework

Most large landslides in Switzerland are known to occur in mountainous regions, like the Alps or the Jura Mountains. This is due to the fact, that large topographic gradients control large gravitational forces and potential energy. However, some large landslides have also been mapped in the Molasse Basin of Northern Switzerland, for example at Bergdietikon in the Limmat Valley, at Mittelleimbach in the Sihl Valley, at Aeugsterberg in the Reppisch Valley, and at Turbenthal and Schlosstal (Winterthur) in the Töss Valley. Morphological features of these landslides, as visible in new high-resolution lidar DTMs (SwissAlti3D Hillshades), are very impressive and are similar to classical rockslide features such as head scarps, grabens, secondary scarps, and rotated slabs (Figure 1). This indicates compound sliding surfaces occurring in the bedrock of the upper freshwater molasse. Some of these landslides also show slow ongoing slope movements as recorded by satellite based radar interferometry or in-situ measurements. The explanation of the origin of these large landslides is not trivial as the bulk slope angles are between 9 degrees (Bergdietikon) and 13 degrees (Turbenthal) only.

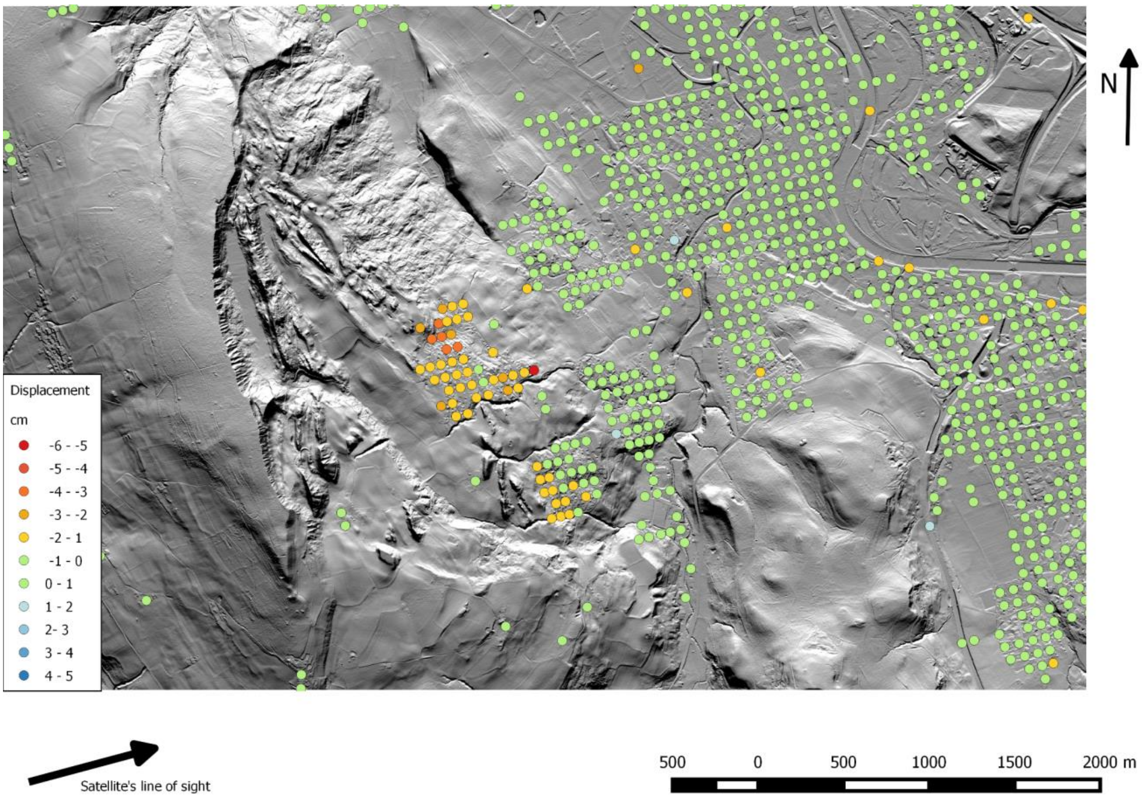

Figure 1: Morphology and active displacements of the Bergdietikon Landslide (Swiss Alti3D Hillshade and 27 Envisat images acquired between 06.07.2003 and 17.10.2010)

Objectives

The objective of this thesis is on the understanding of the origin and movements of these large landslides. The major focus of this first study is on the Bergdietikon landslide, which is the largest and most impressive one. The hypothesis to be tested is, that these landslides formed during the lateglacial period along weak bentonite clay layers in the upper freshwater molasse.

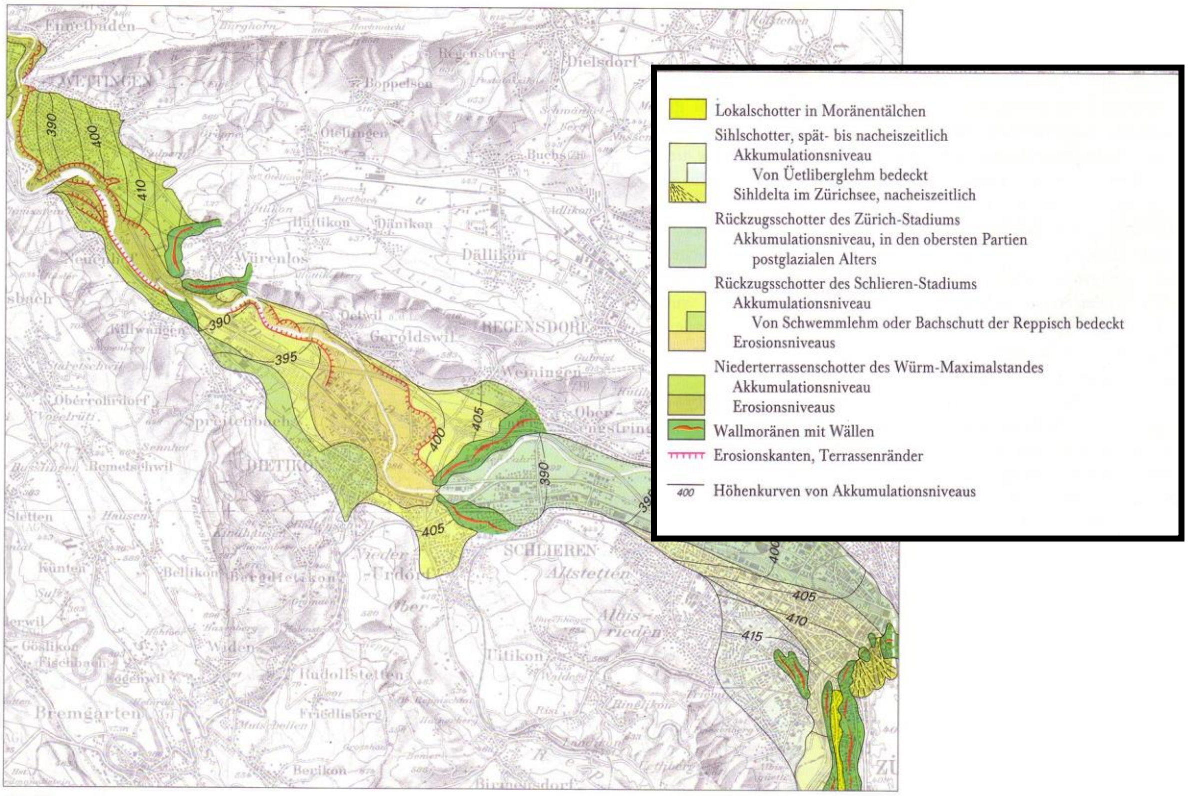

Figure 2: Sediments accumulated and eroded during the retreat of the Limmat glacier after the last glacial maximum (from Jäckli 1989)

Methods and Approach

First the landslide geological information has to be compiled from existing literature and borehole logs, which includes not only the materials involved in the landslide mass, the sliding zones and surrounding bedrock, but also the depth and infill of the glacially overdeepened Limmat valley (Figure 2). Based on drilling and geophysical mapping, the loose Quaternary sediment infill below the current alluvial plane is estimated to be about 100 m thick and composed of glacial till, periglacial lake sediments and alluvial sediments. In a second stage of the project, all geomorphological features have to mapped carefully as basis for the construction of geologic cross-sections through the landslide mass and a kinematic interpretation of the landslide displacements. In a third stage the causes of the landslide displacements will be studied with numerical models constructed along the 2D vertical sections. Major features to be explored are landslide rupture planes geometry, strength properties and pore water pressures during the retreat of the Limmat glacier. The current displacements and landslide hazards can be discussed in the framework of the resulting safety factors and their uncertainties.

Thesis Supervisors

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