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Integration of geophysical and seismological data to analyse the subsurface geometry of an unstable slope: case-study of Kainama (Kyrgyzstan)

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The Kainama site is situated in the west-southern part of the Kyrgyz Tien Shan, Central Asia. This highly seismically active mountain range is very prone to landslides. In Kainama, a large earthflow, mainly composed of loess, occurred in April 2004. Its high velocity and the long run-out zone caused the destruction of 12 houses and the death of 33 people. The presence of a thick loess layer, the rise of the groundwater level in spring time and an increased seismic activity during March and April 2004 played an important role in the formation of this landslide.

As the adjacent slope also presents a high risk of failure, a geophysical- seismological survey has been carried out in this place during summer 2005. The geophysical part of the survey consisted of seismic refraction tomography and electrical resistivity tomography, to determine the geometry, Vp and resistivity properties of the subsurface. The seismological part consisted of earthquake ground motions recordings and ambient noise measurements (H/V single station method and array method – subject of a companion paper).

In addition to these survey data, ASTER images (taken during May 2004) were used. A Digital Elevation Model (with a pixel resolution of 15 m) was created by automatic image matching of the stereoscopic pair of images (bands 3N and 3B) in digital photogrammetry. This raw DEM appeared to be very noisy and was filtered by application of mathematical morphology techniques (median filtering, classical greyscale morphology and morphological greyscale reconstruction).

The filtered and georeferenced DEM (defined as a surfometric model) has been used

as basis for the creation of a 3D geophysical model. Processing of the H/V and array measurements allows defining the depth of the upper layers. This punctual information is interpolated (with geostatistical methods) over the site area and added to the topography; in this way a 3D model is created. By adding the information from the seismic and geoelectrical profiles, it becomes possible to insert the Vp and resistivity data in the previously created 3D model and thus obtain a (simplified) 3D geophysical model of the site.