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Parametric numerical study of seismic slope stability and the Newmark method

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2D dynamic modelling of seismic slope stability is applied to a landslide-prone area in Central Asia, the Mailuu-Suu Valley, situated in the south of Kyrgyzstan. The calculations are made with models constructed from over 30 profiles located in the target area, presenting different geological, tectonic and morphological settings. One part of the profiles were selected within landslide zones, the other part was selected in stable areas. Many of the landslides are complex slope failures involving falls, rotational sliding and/or planar sliding and flows. These input data were extracted from a 3D structural geological model built with the GOCAD software. Geophysical and geomechanical parameters were defined on the basis of results obtained by multiple surveys performed in the area over the past 15 years. These include geophysical investigation, seismological experiments and ambient noise measurements.

Dynamic modelling of slope stability is performed with the UDEC version 4.01 software that is able to compute deformation of discrete elements. Inside these elements both elasto-plastic and purely elastic materials (similar to rigid blocks) were tested. Various parameter variations were tested to assess their influence on the final outputs. For a few models groundwater flow is included. The total parametric study involved more than 100 different models (about 800 computation hours).

Preliminary results allow us to compare Newmark displacements computed using different GIS approaches (Jibson et al., 1998; Miles and Ho, 1999, among others) with the displacements computed using the original Newmark method (Newmark, 1965, here simulated seismograms were used) and displacements produced along joints by the corresponding 2D dynamical models. The generation of seismic amplification and its impact on peak-ground-acceleration, Arias Intensity and permanent slope movements (total and slip on joints) is assessed for numerous morphological-lithological settings (curvature, slope angle, surficial geology, various layer dips and orientations) throughout the target area. The final results of our studies should allow us to define the limitations of the simplified GIS-based Newmark displacement modelling; thus, the verified method would make landslide susceptibility and hazard mapping in seismically active regions more reliable.