Geophysical Research Abstracts,
Vol. 11, EGU2009-7460-1, 2009
EGU General Assembly 2009

Kinematics of a mass movement constrained by sparse and inhomogeneous data

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At Dunaszekcsö, Hungary, about 20 km north of the boundary to Serbia and Croatia the right river bank of the river Danube is formed by a steep, about 50 m high wall in fine grained alluvial sediments. During March 2008 a slope collapse occurred in this area over a distance of 220 m along the river bank, destroying one farm house and threatening several others nearby. An about 10 m high scarp was generated on top of the slope and the river bed in front of the collapsing slope rose above water level, thus forming a visible bulge protruding nearly 40 m from the original bank into the river. Observational data of this mass movement is rather sparse and inhomogeneous. The goal of this study is to explore, to which extent we are able to constrain the kinematics of the mass movement, and to estimate its sensitivity against varying pore pressure (e.g. water level of Danube) by the few exact data, additional morphological observations and interpretations, and the implementation of modelling.

We have aerial photos (oblique and near vertical) from times before and after the slide, all other data concerns only the situation after the slide. Geodetic observations define the top of the scarp and the plane behind the scarp. The displacement and tilt of two blocks in front of the scarp, and an uplift of the flat terrace near the river bank was derived from geodetic data and a reconstruction of the terrain based on the aerial photos and morphological considerations. The distal edge of the mass movement is well defined by the front of the newly generated bulge in the Danube. The thickness and volume of this bulge can roughly be estimated, including information from profiles of the river bed near our site. The longitudinal extent of the basal sliding surface is defined by the scarp on top of the mass movement and the front of the bulge in the Danube. A second zone of deformation about 20 m behind the bank was localized by the help of terrestrial photos. It indicates the outcrop of a second sliding surface. We fitted 2D rotational slider block models to this data and found that a combination of two slider blocks fits the observations within their accuracy and significance. The sliding surface of the larger block reaches about 40 m below the water level of Danube. The slider block model allows for the estimation of residual friction angle at the sliding surfaces and an estimation of possible reactivation of the slide by high water level in the Danube. We are aware that complete geodetic data (e.g. high resolution DTMs before and after the slide) would be highly desirable for an in depth, kinematic analysis of the slide. However, we were able to demonstrate that few exact data in combination with morphological considerations can constrain a kinematic model and allow for an estimate of the further development of the mass movement.