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Hazard assessment of the Gschliefgraben earth flow (Austria) based on monitoring data and evolution modelling

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A rock slide on to the clayey – silty - sandy – pebbly masses in the Gschliefgraben (Upper Austria province, Lake Traunsee) having occurred in 2006 as well as the humid autumn of 2007 triggered an earth flow comprising a volume up to 5 mill m^3 and moving with a maximum displacement velocity of 5 m/day during the winter of 2007-2008. The possible damage was estimated up to 60 mill € due to possible destruction of houses and of a road to a settlement with heavy tourism.

Exploratory drillings revealed that the moving mass consists of an alternate bedding of thicker, less permeable clayey – silty layers and thinner, more permeable silty - sandy – pebbly layers. The movement front ran ahead in the creek bed. Therefore it was assumed that water played an important role and the earth flow moved due to soaking of water into the ground from the area of the rock slide downslope. Inclinometer measurements showed that the uppermost, less permeable layer was sliding on a thin, more permeable layer.

The movement process was analysed by numerical models (FLAC) and by conventional calculations in order to assess the hazard. The coupled flow and mechanical models showed that sections of the less permeable layer soaked with water were sliding on the thin, more permeable layer due to excessive watering out of the more permeable layer. These sections were thrust over the downward lying, less soaked areas, therefore having higher strength.

The material thrust over the downward lying, less soaked areas together with the moving front of pore water pressures caused the downward material to fail and to be thrust over the downslope lying material in a distance of some 50 m. Thus a cyclic process was created without any indication of a sudden sliding of the complete less permeable layer. Nevertheless, the inhabitants of 15 houses had to be evacuated for safety reasons. They could return to their homes after displacement velocities had decreased.

Displacement monitoring by GPS showed that the described process expanded in a finger-shaped form over the alluvial fan, following earlier earth flows. These earth flows had already pushed farms into the lake, as reported by chronicles.

Therefore it was decided
• to prevent soaking of water into the uppermost, less permeable layer by drainages at right angles to the movement displacements in the upper slope,
• to lower the pore water pressures by trenches filled with blocky material,
• to pump water out of the more permeable layer by well drillings above the houses in order to create a stable block below the houses and
• to remove material thrust over the stable blocks in order to avoid damage of the houses.

These mitigation measures costing 10 mill € led to a deceleration of the process to displacement velocities of some cm/month up to now. The houses and the road have not been damaged.