Geophysical Research Abstracts
Vol. 17, EGU2015-8761-1, 2015
EGU General Assembly 2015

Transient groundwater observations and modelling at a rockslide in fractured rocks adjacent to a hydropower reservoir (Kaunertal valley, Austria)

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Positive pore water pressure within the fractured network of a rock slope reduces the effective stresses. This makes the knowledge of transient pore pressure magnitudes essential to evaluate time-dependent hydro-mechanically coupled rock slope processes. Slowly moving, deep-seated rockslides are a common type of gravitational mass movements in fractured metamorphic rocks. The hydrogeological conditions in rockslides adjacent to hydropower reservoirs are of major interest given that several case studies document the hydro-mechanical coupling between seasonal variations in the rockslide deformation behaviour and the filling and drawing down of the reservoir and/or seasonal variations of pore water pressure due to rainfall-events and snowmelt. Groundwater flow and pore pressure distributions in deep-seated rockslides, composed of fractured rocks, are usually only described by simplified conceptual models because of a lack of field measurements and difficulties in transient numerical modelling. The heterogeneous degree of disintegration of the sliding mass, soil-like deformation zones and the anisotropic fractured bedrock complicate the hydrogeological measurement, interpretation and analysis.
In this study, detailed hydrogeological analyses of the Klasgarten rockslide at the Gepatsch reservoir (Kaunertal valley, Austria) are presented. A focus is set on the impact of reservoir level fluctuations, groundwater recharge along the slope and drainage by an exploring adit. The effect of various hydrogeological properties of the sliding mass, the deformation zone and the fractured bedrock on the groundwater fluctuations is discussed. Information on the groundwater flow regime, hydraulic relevant material properties and pore water pressure data are gained from borehole based investigations, a subhorizontal exploring adit and laboratory tests. Field observations are interpreted and validated on the basis of two dimensional finite element groundwater modelling. The transient numerical models consider saturated and unsaturated water flow. The reservoir at the slope toe and slope infiltration (precipitation and snowmelt) are defined as constant or transient boundary conditions in various models.
Piezometric borehole sensors show a clear communication to the hydropower reservoir with fast response times of less than one day. In comparison to that, recharge from rainfall-events and snowmelt has only a small influence on the groundwater fluctuations. The deformation zones have a minor influence on the pore water pressure. Hydraulic packer tests show that the differences in potential heads between the sliding mass and the bedrock below are small. A lowering of the groundwater level after the construction of an exploring drift is indicated by an borehole where hydraulic packer tests were performed before and after the construction of the drift. All of these observations can be reproduced and explained by the numerical models. The numerical models further suggest a reduction in groundwater fluctuations in the nearby setting of the exploring adit.