Geophysical Research Abstracts
Vol. 20, EGU2018-10220, 2018
EGU General Assembly 2018
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A coupled catchment scale modelling-monitoring system to identify and quantify hydrological impact of underground construction

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In decision making, it is of great importance for both industry and governmental institutions to have effective tools to identify and quantify hydrological impact due to underground construction work. Groundwater drawdown may drain lakes and wetlands, reduce the capacity of drinking water wells, or reduce stream water flow. However, natural climate variations such as long periods of draught may lead to the same hydrological changes as changes induced by anthropogenic impacts. Therefore, we need to develop tools that can identify the cause of hydrological change. Here we present a coupled hydrological modelling-monitoring system aiming at facilitating decision making related to hydrological protective measures. The system is developed for the Forsmark site in Sweden where the Swedish Nuclear Fuel and Waste Management Company (SKB) has submitted a licence application to start construction of a deep geological repository for spent nuclear fuel. SKB has carried out multidisciplinary site investigations in Forsmark since 2003 which have resulted in a wealth of geoscientific data. Based on this information, a physically based, spatially distributed hydrological model on catchment scale is established. This model is driven by local meteorological time-series and is carefully calibrated on and tested against site-specific time series of groundwater levels, surface water levels and discharges. The model represents the present hydrological situation in Forsmark with very high accuracy, which is a prerequisite to use the model to predict future hydrological change. The coastal Forsmark site is characterized by a flat landscape with several wetlands being habitats for rare species of amphibians and orchids. Those areas, with high nature values, might be affected by groundwater extraction from the repository tunnel system and it is therefore of great importance to monitor the hydrology during the construction and operational phase of the repository. The monitoring system with high resolution in both space and time, contains observation points for meteorology, groundwater and surface water levels and discharges. Real-time data from this system will automatically be provided to and used by the hydrological models in scheduled simulations. Data import, quality control, model simulations, post processing and publishing of results to a web interface will be automatically scheduled. Hindcast simulation for historical evaluation as well as short term (weeks) and long term (months) forecasting for risk assessment are carried out. Two models will run in parallel, one model describing Forsmark without the tunnel system and one model where the successive development of the tunnel system is implemented in the model. That is, in one model only non-anthropological processes influence hydrology, while in the other model hydrology is not only influenced by non-anthropological processes but also by the underground constructions. By analysing the results from the two models SKB has a tool to identify whether a potential hydrological change is caused by natural weather variations or by the construction of the repository. This tool will facilitate in decision making on protective measures such as possible infiltration in wetlands.