Geophysical Research Abstracts
Vol. 19, EGU2017-3501, 2017
EGU General Assembly 2017

Stochastic Modeling of the Environmental Impacts of the Mingtang Tunneling Project

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This paper investigates the environmental impacts of a major tunneling project in China. Of particular interest is the drawdown of the water table, due to its potential impacts on ecosystem health and on agricultural activity. Due to scarcity of data, the study pursues a Bayesian stochastic approach, which is built around a numerical model. We adopted the Bayesian approach with the goal of deriving the posterior distributions of the dependent variables conditional on local data. The choice of the Bayesian approach for this study is somewhat non-trivial because of the scarcity of in-situ measurements. The thought guiding this selection is that prior distributions for the model input variables are valuable tools even if that all inputs are available, the Bayesian approach could provide a good starting point for further updates as and if additional data becomes available. To construct effective priors, a systematic approach was developed and implemented for constructing informative priors based on other, well-documented sites which bear geological and hydrological similarity to the target site (the Mingtang tunneling project). The approach is built around two classes of similarity criteria: a physically-based set of criteria and an additional set covering epistemic criteria. The prior construction strategy was implemented for the hydraulic conductivity of various types of rocks at the site (Granite and Gneiss) and for modeling the geometry and conductivity of the fault zones. Additional elements of our strategy include (1) modeling the water table through bounding surfaces representing upper and lower limits, and (2) modeling the effective conductivity as a random variable (varying between realizations, not in space). The approach was tested successfully against its ability to predict the tunnel infiltration fluxes and against observations of drying soils.