Geophysical Research Abstracts
Vol. 21, EGU2019-3293, 2019
EGU General Assembly 2019

Model-based data worth analysis in multi-purpose groundwater monitoring networks

Thomas Wöhling (1,2) and Moritz Gosses (1)

(1) Institute of Hydrology and Meteorology, Chair of Hydrology, Technische Universität Dresden, Dresden, Germany (thomas.woehling@tu-dresden.de), (2) Lincoln Agritech Ltd, Hamilton, New Zealand

Groundwater monitoring networks are designed to provide information for environmental monitoring and water resources management which includes not only the temporal and spatial availability water resources, but potentially also other system states such as the mean travel time of water at abstraction locations or the flow at groundwater-fed springs. The aim of this work is to assess the degree of information provided by different observation types and locations for predicting different groundwater-system states. Further we investigate whether there is a common "core" set of information, i.e. a monitoring network design that provides information simultaneously for all required management purposes.

A model-based data-worth analysis and experimental design framework is proposed, where pragmatic data-worth estimation methods from the suite of PEST utilities are used. These methods have been extended for discrete multilocation, multitype monitoring network design which is still pragmatic and efficient. The application of the framework requires a predictive groundwater flow model to be set up for the investigated groundwater system. Since models are inherently simplifications of reality, model predictions are subject to error and uncertainty. However, data from monitoring networks can inform models and thereby reduce predictive uncertainty. Therefore, data worth is defined here as the utility of data to reduce the predictive uncertainty of a quantity of interest.

We demonstrate our methods on the application of the framework to the Wairau Plain Aquifer system which covers a small proportion of the Wairau catchment in the Marlborough District of New Zealand. The aquifer is almost exclusively recharged by surface water from the Wairau River and serves as the major resource for drinking water and irrigation in the region. A numerical flow model has been previously set up for the Wairau Plain to predict river-groundwater exchange flows, groundwater heads and storage, spring flows, aquifer storage and mean-travel times. We investigate the degree of information (data worth) of groundwater head data, hydraulic conductivity, specific yield, river-bed conductance, and hydraulic properties of the braided Wairau River bed for these predictions.

Not surprisingly, our analysis revealed that data worth is purpose-specific. Different predictions are informed by different data types and monitoring locations. There is common data worth only for some predictions and there are also "hot-spots" of information location. Rather intuitive results are that specific yield is informative for aquifer storage; spring-bed conductance and groundwater head in the vicinity are informative for spring flows; and hydraulic conductivity and heads best inform mean travel times. But there are also some not so obvious results such as the impact of the hydraulic parameters of the braided-river bed of the Wairau River and of the assumption about deep groundwater losses toward the sea. Often, data worth is not independent and the best information gain can be achieved from a combination of data types and locations. This is an important aspect to be considered in the design of multi-purpose groundwater monitoring networks.