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Comparison of groundwater catchment estimations due to changes in the geological model

T. Wernberg
thw@watertech.dk

Groundwater models are widely used to calculate the groundwater catchment areas for abstraction wells. The uncertainties of the catchments are usually estimated using Monto-Carlo simulations of a selection of model parameters, or using less efficient methods as worst case scenarios. Most catchment uncertainty estimations are based upon the uncertainty of model parameters and are more rarely the effect on different geological models examined.

The impact on the area extent of the catchment upon re-evaluation of the geological model is shown for two different cases. Both cases use digital geological modelling and the groundwater models are setup using MODFLOW.

In the first case, the calculated catchment uses worst case scenarios and simple parameter changes, as uncertainty techniques disagreed with the common belief of the exact shape and location of the catchment areas. The geological model was redefined and a confining clay layer was changed into a sand layer with clay bodies.

In the second case, the catchment uncertainty was estimated with 36 different models, each with a unique leakage to the primary aquifer and each calibrated using inverse techniques. In the model, the reinterpretation of a buried Quaternary valley in the catchment area led to a new geological model.

The recalibration of the models did not yield better models, statistically, but the reinterpretation of the geological models had a huge impact on the calculated catchment areas. Both models showed an increase in the subsurface flow complexity. In both cases, the re-evaluation of the geological models had a much higher effect on the location of the catchment area than model uncertainties.

The conclusions of the work are that the groundwater model uncertainties in both cases are smaller than the uncertainty introduced by the geological model. Therefore, focus on the geological models is important in relation to water resource investigations. Also, due to the high complexities of the flow system, numerical groundwater models become useful for investigation and understanding the flow system in the detailed geological models.