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ABSTRACTS

Addressing structural uncertainty of groundwater model predictions with ensemble of automatically generated models from AEM geophysical data and borehole data

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Abstract

Subsurface structural uncertainty is a major contribution to uncertainty in groundwater model transport- and travel path/time-predictions. However, the contribution from subsurface structural uncertainty is often neglected, and for practical and methodological reasons, models are represented using a single deterministic structure. In most cases, deterministic approaches will greatly underestimate the uncertainty of groundwater model predictions.

We present a method where an ensemble of subsurface structure models can be automatically generated from borehole information and airborne electromagnetic (AEM) geophysical data. Resistivity distributions obtained from the AEM data are inverted together with lithological descriptions into clay fraction values in an ACT-inversion. The output is subsequently clustered into categories using k-means clustering. Utilizing sequential indicator simulation the categories are simulated onto a regular grid; forming an ensemble of subsurface structure realizations. The uncertainty captured in this ensemble represents variable data coverage.

Each structural realization is assumed to have uniform hydraulic properties within the clusters. The values of these properties are estimated with a steady state MODFLOW-USG groundwater model by calibrating the model to head and flow observations. Based on the ability of each structural realization to fit the hydraulic dataset, a subset of behavioral models is selected for predictive purpose. In the present case well capture zones are predicted for each realization using mod-PATH3DU. From the ensemble of behavioral models, we estimate the uncertainty of well capture zones (see figure 1). The results are compared to a deterministic subsurface structure model, for which particle endpoints fall within the capture zone uncertainty area, see black dots in figure 1.

In addition to addressing groundwater model predictive uncertainty, the proposed method honors all available data, lithological, geophysical and hydrological. At the same time it is automatic, objective and entirely reproducible.

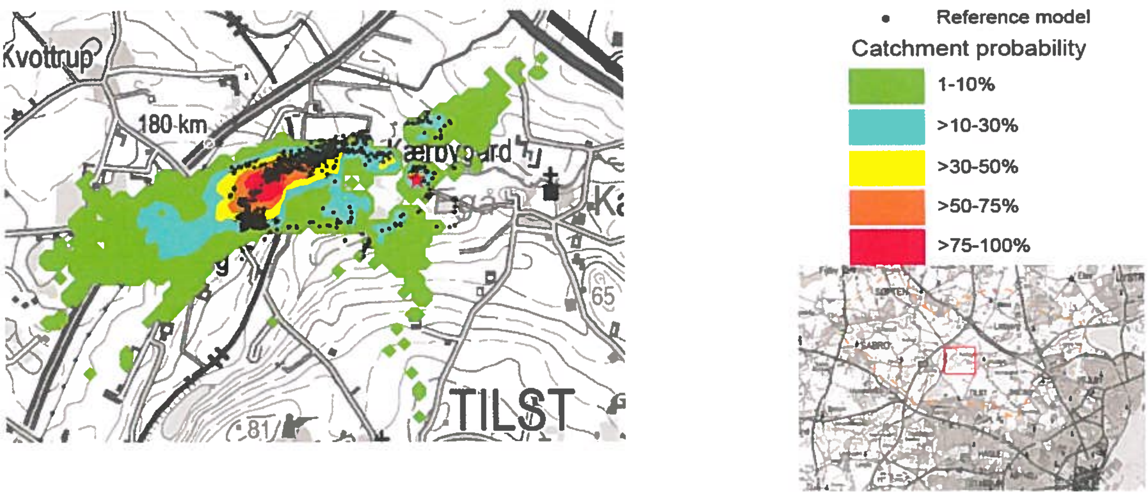

Figure 1 Probability map of well capture zone from ensemble. The colours represent percentages of the realizations where a particle endpoint falls in that given area. Black dots are particle endpoints of a deterministic structure model.

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