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Uncertainty propagation in up-scaling of subsoil parameters, no fixed distributions allowed

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When creating numerical groundwater models, the structure and properties of the subsoil is indispensable information. Like all model data, these data are subject to uncertainty. Building a groundwater model, the available geological information, like the geological structure and parameter values, has to be up-scaled and aggregated to layers at model scale. If the uncertainty of the geological data is known, in principle, the uncertainty of the up-scaled model layer can be evaluated. The up-scaling from borehole point data to aquifer scale data can be performed by kriging interpolation. However, using this technique, the possibilities to propagate the uncertainty of the borehole data are limited. The most common way to assess the uncertainty is to use kriging in combination with methods like Monte Carlo simulation. If many parameters are involved this is a time consuming process, which does not always yield a useful result. We propose a method, in combination with kriging interpolation, to perform the uncertainty propagation of the subsoil parameters by taking into account the complete probability density functions (PDF) of all individual parameters. This method does not rely on a specific type of distribution function of the PDFs and can therefore widely be used.

In the Netherlands, like in many other countries, a large database is available containing borehole data. Interpretation of these data involves assigning hydraulic conductivity values to all the identified thin geological layers. These conductivity values, derived from all kinds of tests, are not fixed values but are represented by a certain range that can be described by a (log-normal) PDF. Beside the uncertainty of the conductivities also the layer depth and thickness are subject to uncertainty and can be described by PDFs. When performing the interpolation of the borehole point data to the desired groundwater model grid, the PDFs of the conductivities and layer depths are used throughout all calculations instead of only their mean values. In this way the complete PDF of the conductivities of every grid cell of the groundwater model is known and can be used for further analysis.

We will illustrate the proposed method by a real world example.