Faculty of Geosciences
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Bayesian update of hydrogeological model parameters making use of calibrated groundwater flow models

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Introduction

Hydrogeological models are indispensable for the construction of groundwater flow models. Irrespective of the effort put into the creation of the hydrogeological models, the parameterization will always be subject to uncertainty. Therefore, the groundwater flow models are calibrated to make them worthwhile. These calibrated data contains valuable information which we use to improve the quality of the hydrogeological model. The calibrated parameters are often an aggregation of multiple parameters of the hydrogeological model. Therefore, the update is performed by using a Bayesian network.

Objectives

- Improve the quality of the hydrogeological model
- Use calibrated model data as update information
- Find updated probability distributions (posterior distributions) of the model parameters (**layer thickness** and **conductivity**)
- Use a direct method which avoids Monte Carlo simulation

Methods

- Describe the uncertain parameters of the hydrogeological model by probability distributions
- Create a Bayesian network of these parameters per model layer of the groundwater flow model
- Use the calibrated values (at each grid cell) as an observation
- Update the distributions of the parameters of the hydrogeological model

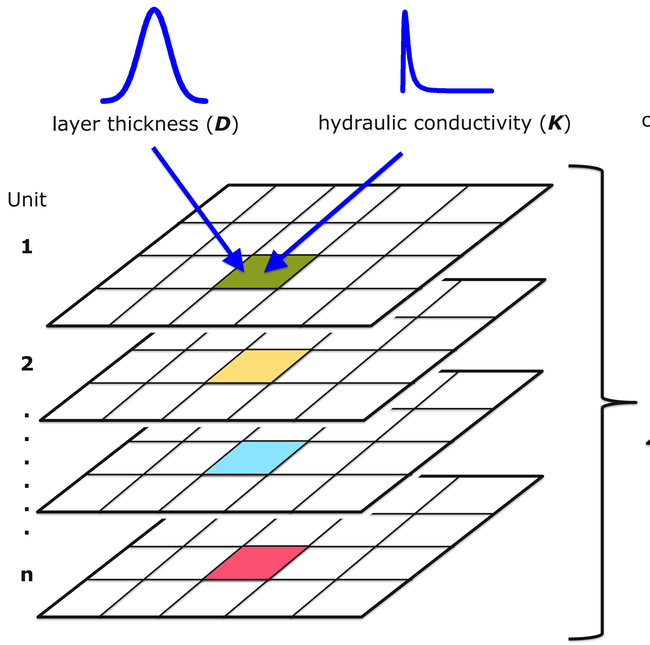
Results

After evaluation of the Bayesian network, given the calibrated values of the groundwater flow model, the posterior distributions of the parameters of the hydrogeological units are achieved.

All probability distributions are defined as **piecewise linear functions**, which makes the calculations tractable and doesn't depend on conjugate stochastic models.

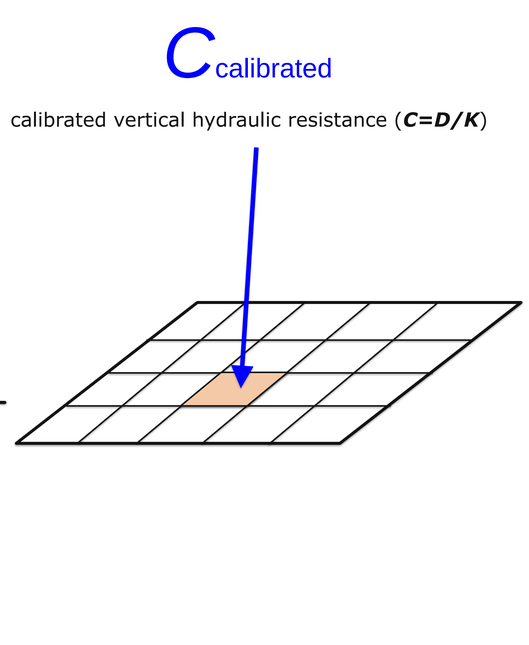
Hydrogeological units

For each unit in the hydrogeological model a probability distribution is defined for the **layer thickness** and the **hydraulic conductivity**. This are the prior distributions.



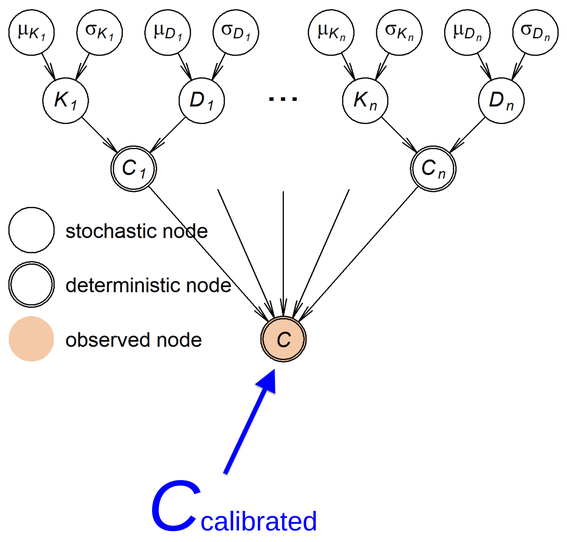
Groundwater flow model

Multiple hydrogeological units are aggregated to one model layer in the groundwater flow model, e.g. an **aquitard**. This parameter is calibrated.



Bayesian network

A Bayesian network describes the dependencies between the prior distributions of the hydrogeological units and the calibrated parameters.



Posterior distributions

After marginalization, the posterior distributions are found. The results below are for one grid cell, using one observation.