SOME INVERSE PROBLEMS FOR GROUNDWATER

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Bayesian inference provides a framework in which measurement and model uncertainties are modelled as probability distributions. Solution of a given inverse problem in the Bayesian context is given as summary statistics over the posterior distribution of parameters relative to measurement data, in which uncertainty quantification (UQ) is an essential ingredient in the solution. Perhaps the most appealing aspect of Bayesian inference is that it makes proper use of data. The downside, of course, is the computational bottleneck often encountered, particularly for high-dimensional inverse problems, due to the need to run the forward map many times.

Low dimensional inverse problems for groundwater may capture the essential physics and provide guidance on what is important in the solution of their higher dimensional cousins, and are therefore worthy of study. While the need to quantify uncertainties is regarded as important, less evident is what to do with the information, particularly in engineering applications. Recent work of the authors shows how UQ may be used to inform the judicious design of pump tests so that parameters of interest are determined within acceptable bounds.

The solution to higher dimensional inverse problems is often guided by approaches found in image processing, rather than consideration of the underlying physics of the problem, sometimes resulting in larger scale problems than is strictly necessary. We will present some recent work on calibrating models with spatially varying storativities and hydraulic conductivities using Markov Chain Monte Carlo.

The recent suite of earthquakes in the south island of New Zealand presents a rich source of data for understanding Christchurch's multilayered aquifer. We will present some recent work on seismic wave propagation in groundwater, and the associated dual inverse problem of identifying aquifer and wave parameters.