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Stochastic modeling of hydrogeological and geological features in a changing environment.

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Evaluating water resources, contaminated or hazardous sites or the movement of toxic materials in aquifers… most of the time, have a close relation to a successful geological modeling as well as precise recognising, mapping and modeling of environmentally important parameters.

For example an aquifer that may be used as a drinking water resource for a region should be recognized well (in terms of hydraulic factors or vital points) so that we can predict the effects of contaminants on that aquifer. This is very important due to the noticeable effects of such contaminations on inhabitants' health aspect. In addition, there is a close relation between them and geological parameters. However, most of the time, just few information is available from geological and environmental parameters in our interest areas.

Geologic modeling (or modeling) can be considered in two categories: deterministic and stochastic models. The complexity of the problems and the need for having estimation uncertainties, limit the application of deterministic methods and make the use of stochastic approach essential for obtaining valuable answers to our questions.

For instance when there is an important aquifer and some contaminated sites in a region, their impact on the aquifer has to be evaluated using ground water flow and transport models which depend on the availability of hydrogeology parameters in different parts of the aquifer (e.g. hydrolaulic conductivity…). However, field measurements of such critical parameters usually have inadequate spatial density, irregular. On the other hand, we need globally accurate estimations and models to obtain such flow models.

Such modeling strategies often face problems like: insufficient and complex available data, inefficient modeling and estimation methods and the existence of heterogeneity...

In other words, we have to try to make accurate models, given limited information for different parameters (e.g. hydraulic conductivity or the concentration of hazardous heavy metals in soil) and in different accuracies.

In the following context, we are going to briefly review: traditional geostatistical approaches (Kriging, sequential Gaussian simulation), and some modern geostatistical methods (multiple-point statistics and BME approach), for modeling and estimating important parameters in such problems as water resources, and compare them with each other.

Geostatistical approaches are among the well-known advanced modeling methods, which try to improve the estimations as well as providing estimation uncertainty, honoring the spatial structure of data.

For example Kriging which is a cautious and locally accurate method (minimum estimation error variance) and, on the other hand it is not globally accurate (the lack of reproducibility of the global statistics). This may cause problems in evaluating extra important values, e.g. when simulating a groundwater flow or determining the important contaminated parts of an area. . .

Geostatistical simulation methods attempt to solve that problem (e.g. Sequential Gaussian Simulation). Such methods recognize the variability structure using one- and two-point statistics such as mean, (cross) semivariograms ...

Multiple-point statistics is an approach that goes beyond the two-point tools.

Another suggested method is Bayesian Maximum Entropy (BME) that provides facilities to incorporate more information with different qualities including primary general knowledge, hard and soft data, physical rules and the expert's knowledge. BME enjoys many advantages such as: including different data and epistemic view to the problem.