Uncertainty analysis of the contaminant transport fate using conditional simulation of hydraulic conductivity

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On the assumption that the hydraulic conductivity field follows a lognormal distribution, the sequential Gaussian simulation (SGS), a commonly used conditional simulation method, is introduced to generate multiple realizations of hydraulic conductivity field. Then Monte Carlo method, combined with SGS method, is applied to investigate the effect of the conditional fields of hydraulic conductivity on the uncertainty regarding the contaminant transport fate. For the contaminant plume examined in the synthetic example in this study the application of conditional simulation to generating hydraulic conductivity field leads to dramatic uncertainty reduction of the results output from the transport model, compared with those results based on unconditional simulations. It is found that the change of the averaged plume in terms of both spatial moments and concentrations output from the transport model is insensitive to the number of the conditioning data of hydraulic conductivity, whereas the peak variance of the plume concentrations at node decreases with the addition of the conditional hydraulic conductivity data. Moreover, the uncertainty of the modeled plume is dominated by the spatial distribution of the certain conditional hydraulic conductivity data. Additional suggestion is made that optimization techniques be used to ascertain the number of the conditional hydraulic conductivity data at the field site.

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Modeling of regional land subsidence in Shanghai City, China

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Resulting from many factors, land subsidence is a sort of environmental geological phenomenon that causes ground elevation dropping slowly. When serious, it becomes a disaster. The main reasons of land subsidence are human activities and geological actions, especially excessive groundwater withdrawal. Many countries and areas in the world, such as Thailand, Venice, Italy, San Joaquin Valley, California, USA, Houston-Galveston region, Texas, USA, Mexico City, Mexico, have encountered this problem. In China, land subsidence mainly occurs in 17 provinces (cities) in the eastern and middle regions, including Shanghai, Tianjin and Jiangsu, Hebei provinces. It is primarily caused by groundwater overpumping. The Shanghai City, in which the land subsidence was investigated and monitored earliest in China, is one of the most serious subsidence areas. Since 1961, the dynamic groundwater level monitoring net has been built, and by constructing benchmarks and extensometers, the deformation features of different strata layers were observed. Based on the analysis of the long term-observed data, it is found that the characteristic of the land subsidence in Shanghai is very complex. Considering the complexity of deformation features of the different hydrostratigraphic units on a regional scale during the past 40 years, a coupled three-dimensional regional land subsidence model is presented. This model consists of a three-dimensional groundwater model with varying parameters and a one-dimensional vertical deformation model. According to the different deformation features, different groundwater flow equations and different deformation equations based on the corresponding strain-stress relationship are adopted in the coupled model. An iterative method based on multiscale finite element method is adopted for the numerical simulation. The simulation results match well with the observation data during the model calibration and verification. The development of land subsidence under different conditions of groundwater pumping is predicted by the presented model. The prediction show the land subsidence rate can be controlled when the groundwater pumping rate in the study area reduced to 2.5×107m3/a.