Geophysical Research Abstracts, Vol. 7, 06513, 2005
SRef-ID: 1607-7962/gra/EGU05-A-06513

Calibration, sensitivity, and uncertainty analysis of a groundwater model with variable recharge estimated by a distributed rainfall-runoff model.

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The 20-km-long Maggia Valley in Southern Switzerland is being investigated to determine environmental flow requirements (EFRs) because most of the water is impounded, resulting in much reduced streamflows. The long-term aim of the investigation is the development of a modelling framework that simulates the joint dynamics of the groundwater, hydrologic, and ecologic systems. A nested modelling framework is selected for the purpose. Large scale models are first developed to provide the boundary conditions for more detailed models of ecologically interesting reaches.

The initial (large-scale) groundwater (GW) model is constructed using MODFLOW-2000 and its RIVER package. The model robustness is tested using sensitivity analysis and a cross-validation method, whereas its predictive capability is assessed with a completely independent set of data. A further step is the use of the new STREAMFLOW routing package for MODFLOW-2000 to account for the volume of river-aquifer interactions. Results are discussed.

The GW model is then evaluated by accounting for the recharge boundary conditions as predicted by a raster-based, physically oriented and continuous in time rainfall-runoff (R-R) model. This model has proven to perform very well in the investigation area and can compute the surface and shallow sub-surface flow over the entire floodplain. Thus, it can provide an input to the GW model, which can be investigated by

measuring the changes in the GW model performance when substituting these inputs for the hill slope and floodplain recharge.

The shallow subsurface flows simulated for selected periods or events are used to assess the importance of realistic recharge to the groundwater model. The goodness of the model fit is also considered using both calibrated and areally distributed recharge values.

Sensitivity analysis is carried out for both the GW and the R-R model separately. GW parameters correlations, as well as prediction uncertainty are also addressed and discussed.

The influence of using the areally distributed recharge jointly with a more precise representation of the bedrock obtained by means of gravimetric measurements along the valley is finally also discussed. The effects of the new aquifer geometry are investigated, thereby including a test against new data, and the predicted capabilities of the model modified in its geometry and components are evaluated.