Most surface flows to the 20-km-long Maggia Valley in Southern Switzerland are impounded and the valley is being investigated to determine environmental flow requirements (EFRs). The aim of the investigation is the development of a modelling framework that simulates the dynamics of the groundwater, hydrologic, and ecologic systems. Because of the nested nature of the modelling framework, large scale models are first developed to provide the boundary conditions for more detailed models of reaches that are of ecological importance.

We describe here the initial (large-scale) groundwater/surface water model. The model was constructed using MODFLOW-2000 and its River Package, and was developed parsimoniously to avoid modelling artefacts and parameter inconsistencies. The aquifer is presently modelled with two confined aquifers; water table is considered iteratively. Model calibration includes two steady-state conditions, with and without recharge to the aquifer from the adjoining hillslopes. Parameters are defined to represent areal recharge, hydraulic conductivity of the aquifer (up to 5 classes), and streambed hydraulic conductivity. Flow input at the northern end of the system was also calibrated, as no observations were available. Several conceptual models were developed (e.g. by changing the number of hydraulic-conductivity classes), and one most likely model was identified based on fit to observations and realistic parameter estimates. Three methods of analysis were used: sensitivity analysis, cross-validation, and testing using new observations. Sensitivity analysis was used throughout model calibration. It showed, not unexpectedly, that the parameters most important to model fit are the hydraulic conductivities and the riverbed conductance, and that stream-flow observations significantly reduce the uncertainty of the estimated parameters. During cross-validation, the most likely model was used in a series of regression runs for which predictions and confidence intervals were evaluated for the removed observation(s). The analysis again revealed the importance of stream flow measurements. A new data set with measurements from recent years at new piezometers and a new stream gage provided an important test of the predictive ability of the model.