Improved hydrodynamic modelling tools for river-groundwater interaction

L. Foglia, **W. Ruf**, P. Perona, R. Faeh, P. Molnar and P. Burlando

Swiss Federal Institute of Technology, Zurich, Switzerland
(ruf@ihw.baug.ethz.ch / Fax: +41 44-6331061 / Phone: +41 44-6332429

The interaction between river and aquifer is a key issue for groundwater management. It is also often essential for the ecological integrity of a floodplain, which can be endangered by changes of the groundwater table consequent to water abstraction due to hydropower operations. This work focuses on the investigation of the groundwater table fluctuations, and is part of an extended project, where the impact of both the altered flooding regime and the changing groundwater conditions for the floodplain and wetland vegetation is studied in a long term perspective. We work in an alpine valley (Valle Maggia, Ticino, CH) characterised by an alluvial plain which develops into a natural river braided system and by a deep aquifer (>100 m), the dynamics of which is highly connected to the Maggia River by infiltration and exfiltration processes.

A coupled modelling approach is therefore used in order to simulate groundwater exchanges with the river. MODFLOW-2000 is used for the groundwater modelling, and the interaction with the stream is modelled by means of three different approaches of increasing complexity, a fourth one based on fully coupling being envisaged as final goal. In the first two cases, the interaction is modelled by means of the integrated RIVER package tool, which is used to define the water depth throughout the whole river channel. This is considered as a steady boundary condition (i.e., no feedback effects on the river system) for the groundwater model, and is in turn kept constant (case 1) or considered spatially variable (case 2). In the latter case the spatial variability is computed by the 2D finite volume hydrodynamic model 2dMb, developed at ETH Zurich. Results from these two approaches are discussed and commented in order to identify the necessary steps aimed at defining the modelling constraints for a more dynamic interaction between the two water bodies. An advancement in the direction of a full coupling is represented by the third approach, which makes use of

the recently improved streamflow package routing tool (SFR) of MODFLOW-2000. This package performs a 1-D stepwise discretization of the river and allows for a continuous mass-exchange process between the river itself and the aquifer. Performances of this latter model are discussed to investigate the need for a full space-time variable 2-D coupling.