Master Thesis – Environmental Engineering
Workload: 30 ECTS, 900 hours

Topic: Impact of hydropoeaking on groundwater flow and transport: a case study in the Adige Catchment

Study Objective:
Among the hydrological, geochemical and ecological stressors that affect the Adige River catchment, a basin located in the Alpine region of Italy, hydropoeaking is the most important one (Chiogna 2016). Hydropoeaking is defined as a sharp transient fluctuation in the water level caused by the operation of water reservoirs for hydropower production and affects not only the hydrological regime of a river, but also the ecological status. (Fette, 2005). Moreover, the fluctuations due to hydropoeaking can also propagate to the groundwater. For instance, in a previous study to evaluate the exploitability of the aquifer of the Adige Valley, Castagna et al. (2015) already observed a strong correlation between the surface water and the groundwater in the shallow aquifer. In the also Alpine catchment of the Rhône river, Fette (2005) found that the groundwater level rises shortly after an elevation in the stream stage. Therefore, understanding the implications of hydropoeaking in the system dynamics is of vital importance to find proper solutions of water management in the Adige catchment. The area in which the Noce and the Adige river merge is of particular interest since both rivers are strongly affected by hydropower production, which in addition raises the question if the surface water fluctuations can lead to transient conditions in the groundwater capable of enhance mixing. In fact, theoretical studies have showed that mixing enhancement is possible in groundwater systems under pulsed sink/pump systems, which generates transient conditions in the flow (e.g. Neupauer et al., 2014).

This work will consider two previous study projects done at this chair. The first one consisted in setting up a model in MODFLOW for the area of the Adige Valley where the Noce and Adige river merge (Glisoni, 2017) and the second one focused in applying a particle tracking algorithm and a controlled reactive transport model to study mixing enhancement in transient groundwater flow fields (Basilio Hazas, 2016). Both of them serve as a basis for studying the impacts of hydropoeaking in the aquifer of the Adige Valley and the possibility of mixing enhancement.
Task:
The overall aim of the master thesis is to study the interaction between the surface and the groundwater in the Adige catchment, focusing on the hydropeaking from both Noce and Adige rivers and its possible effects on mixing processes in the aquifer. This will be done by modeling a cross section of the Adige aquifer and analyzing the effect of hydropeaking in a 2D flow. For that, following steps are proposed:

1. From the available 3D model, a 2D model will be constructed in Modflow using PMWIN. The selected cross section is from well 37 to 343.
2. Data of the hydraulic head will be collected (conversion from discharge to hydraulic head could be necessary). Piezometer 343 will be used for head boundary condition and piezometer 37 for validation.
3. A first field campaign in Trento will be organized in order to select the piezometers for the monitoring points, install the probes and download already collected data. Later, a second field campaign will be organized to collect the new data.
4. For the hydraulic conductivity, the available field will be used. The calibration of the storativity will be performed. The calibration of storativity in transient simulations will be manual at the beginning and it will start with a homogeneous specific storage. Then the complexity is to be increased.
5. Two models will be prepared: one of hourly scale for the period of one week during the winter; a second one at a daily scale for one year.
6. The model will be set up and some scenarios will be performed.
7. The particle tracking algorithm (MODPATH) in the groundwater and of a mixing-controlled reaction will be implemented.
8. Eventually some simplified 3D scenarios will be considered.

Time:
Total duration of the thesis: May-December
First field campaign in Trento: 21st -23rd June
Second field campaign in Trento: to define
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Bibliography:


3. Chiogna, Gabriele; Majone, Bruno; Cano Paoli, Karina; Diamantini, Elena; Stella, Elisa; Mallucci, Stefano et al. (2016): A review of hydrological and chemical stressors in the Adige catchment and its ecological status. In The Science of the total environment 540, pp. 429–443. DOI: 10.1016/j.scitotenv.2015.06.149.

