Geophysical Research Abstracts
Vol. 12, EGU2010-3542-1, 2010
EGU General Assembly 2010

Short-term groundwater fluxes in the hyporheic zone as a consequence of changing river stages; numerical simulation by HYDRUS 2D/3D.

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All hydrological handbooks contain methods for direct runoff and base-flow separation. The semi-log separation method is the most classical one. One can, however, question the physical base for such method. In addition, the water fluxes in the riverbed are important for ecology and water quality. In our study an 2-D cross-section including the river and the surrounding aquifer was set-up in HYDRUS 2D/3D. Initial conditions were a steady-state subsurface flow feeding the river with a recharge from the soil surface. A surface runoff event was simulated by a rise and recession of the water level in the river. Differences between summer and winter situation were explored by given representative temperatures to the different components of the river-aquifer system.
The simulations show that the fluxes are very different along the riverbed. Even during steady state baseflow we see that the fluxes through the bottom were 2 to 3 times smaller as compared to the side banks. During the hydrographs the proportion can become up to 5 times. Another interesting result is that within the time frame of the hydrograph and its immediate recession relatively little water, which pentetrated in the aquifer, returns to the river. Most of the water replenishes the aquifer and there is only a very small rise of baseflow. In our simulation we returned to the original level as before the hydrograph, so in reality even less or no rise in baseflow may occur immediately after a hydrograph. Of course, in a longer time-frame the recharge of the aquifer will give a rise to the actual subsurface drainage.
The change in seasonal temperatures within the river-aquifer system has a substantial effect. For identical river stage hydrograph changes the hyporheic exchange fluxes are more intense in summer than in winter. If we define the hyporheic zone as the extedn to which the water fluxes from the river can penetrate, then we see that this zone is wider on the sides as compared to the bottom of the river. These findings should be validated in the field but have potentially important implications for ecology and mitigation of river water pollution. The fluxes through the side of the river cross-section appear to be more intense.