Paper Number: 1235

The importance of scale in studying interactions between groundwater habitats and surface waters

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The hyporheic zone is the saturated zone beneath and beside streams, rivers, lakes, and wetlands where groundwater and surface water actively mix and exchange. At a theoretical level the temporal dynamics of the hyporheic zone are often emphasized in terms of the movement into shallow subsurface sediments and back to stream channels over time scales of seconds to days. Nevertheless, it is known that several important processes in the hyporheic environment show strong changes during the year, especially in temperate regions, in relation to fluctuations in discharge: (i) the supply of oxygen and nutrients from stream water to sediments, (ii) the rate of nutrient consumption by hyporheic microbes, which depends on the contact time between water and sediments, and (iii) microbial activity and nitrogen transformation rates. In a previous study of the Aries River, one of the most polluted rivers in Romania (Europe), it was shown that heavy metals associated with mining pollute surface streams and the hyporheic zone, by using hypogean invertebrates as proxy for pollution [1]. While the impact on the hyporheic zone communities was expressed as a spatial reduction in the number of invertebrate species in the polluted sectors of the Aries River, it appeared that the factors other than just water chemistry influenced the distribution of hyporheic zone species [2]. Accordingly, it was decided that regular monitoring was required to take account of temporal variations. However, the optimum time interval for such sampling was unknown. For this purpose, the results of monthly versus seasonal sampling were compared. The concentrations of major ions, metals, and nutrients in hyporheic zone water were measured using an Inductively Coupled Plasma Optical Emission Spectrometer and an Inductively Coupled Plasma Mass Spectrometer. Sampling of the hyporheic zone showed contrasting biodiversity and abundance patterns at different time scales. Monthly composition of the most abundant Crustacea and Oligochaeta showed a little correlation with physical and chemical parameters. In contrast, when subsets of the monthly samples of the most abundant species were analyzed, there were strong correlations with at least some of the major physical and chemical parameters (temperature, flow rate, Al, and Fe) in each of the three possible seasonal series. Moreover, correlations between seasonal series were sometimes contradictory and appeared to be artifacts related to sparse data. It is suggested that monthly or more frequent sampling is required for the complete assessment of processes in the hyporheic zone and to study the exchanges at the interface between groundwater and the surface river ecosystem.

References:

[1] Moldovan et al. (2011) Hydrobiol 669:63-82

[2] Moldovan et al. (2013) Ecol Ind 2: 412-420