Reactivity and Dynamics of Dissolved Oxygen in a Riparian Zone Unveiled through High Frequency Data and Fully-Integrated Modelling

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Riparian zones are areas characterized by interconnected hydro-biogeochemical and exchanges processes relevant for aquatic ecosystems. In particular the processing of dissolved oxygen (DO) plays a key role for biogeochemical turnover and aquatic ecology. We assessed the dynamics of DO in riparian groundwater (GW) through *in-situ* experiments in combination with high frequency data. Variable groGW travel-times (τ_{GW}) and DO consumption rates were obtained from GW tracer tests covering a full hydrological year. In addition, a fully-integrated numerial model was set up and calibrated against GW heads and tracer-test data to provide insights into the relationship between hydrological variability and aquifer reactivity.

Tracer tests indicate τ_{GW} increases with increasing river discharge due to the infiltrating stream water percolating deeper into the riparian aquifer, especially during discharge events. DO consumption rates (0.5-4 d^{-1}) vary in depth, while they generally increase with growing temperature and with increasing τ_{GW}, whereas the effects of the latter on consumption rates are subordinate in comparison to temprature. Higher consumption rates occur within the first meters from the river (up to 70%) and are linked to labile dissolved organic carbon (DOC) delivered by infiltrating stream water (Stream: 3-15 mg/l; GW: 2mg/l). However, during discharge events, stream water DOC is characterized by relatively heavier molecular weights, hindering GW DO consumption rates. Oxic zones in the subsurface increase during high water levels (from 5 to 10-15 m), while an overall decrease in water temperature suppresses DO consumption and consequently, other depending anaerobic processes. Furthermore, DOC pools seem to accumulate in low hydraulic conductivity zones, resulting in higher reactivity in these zones. Following winter storms, part of the area remains flooded for days with greater exchange fluxes and vertical transport from the unsaturated zone. For low temperatures (<8^{o}C) and long travel-times the system becomes slightly reaction limited in terms of DO resulting in possible nitrification.

With our multi-methodapproach we were able to assess, and to a certain extent, quantify the dynamic responses of the riparian system to variations in hydraulic conditions and seasonal temperatures.