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Using biodiversity of diatoms to identify hydrological connectivity in the hillslope-riparian zone-stream system

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In recent years, there have been increasingly calls for new eco-hydrological approaches to answer questions on water source and connectivity in the landscape. Diatoms are one of the most common and diverse algal groups, and offer the potential for the identification of reproducible flow patterns and a link to underlying watershed behaviour. Our preliminary investigations on the potential for terrestrial diatoms to detect the onset/cessation of surface runoff suggested that diatoms can contribute to confirm or reject the existence of a surface runoff component in total runoff, thereby helping to constrain assumptions made on a potential surface runoff component in a conventional tracer based hydrograph separation. Our investigations currently focus on the Attert River basin (Luxembourg, Europe) and the HJ Andrews experimental forest (Oregon, USA). Here we show results from the schistose Weierbach experimental catchment (0.45 km2), located in the Attert River basin.

Ordination analysis revealed a clear distinction between communities belonging to the river bed substrate and the riparian zone. Drift samples corresponding to stream water show a mixed composition of diatoms stemming from the river bed substrate and the riparian zone. Ongoing investigations focus on the composition of hillslope communities.

In winter, long-lasting low intensity rainfall events generate a two-tailed hydrograph response of the Weierbach, consisting in an immediate reaction to precipitation, followed by a delayed and much more significant rise of the hydrograph. For these events, mixing diagrams (SiO_2 & Absorbance) suggest a substantial contribution of the soil water component to total runoff, with groundwater and especially overland flow remaining insignificant. Terrestrial diatom abundance appeared to be very sensitive to incident precipitation (rising to +/- 15% of the total diatom population), suggesting a rapid connectivity between the soil surface and the stream.

In summer, short and very intense rainfall events cause a single-tailed rather small rise of the hydrograph in the Weierbach. Mixing diagrams suggest a very brief and intense switch from groundwater to soil water contribution. Almost simultaneously to incoming precipitation, terrestrial diatom abundance increases to 20-30% inside the stream.

Species composition was also seasonally structured. During winter season (November 2010 and January 2011 events) the diatom drift was characterized and dominated by colony forming species (e.g. Fragilaria nevadensis Linares-Cuesta & Sánchez-Castillo and Fragilariforma virescens (Ralfs) Williams & Round), while summer events were characterized by a large number of small aerophytic species (i.e. Chamaepinnularia evanida (Hustedt) Lange-Bertalot, Eolimna tantula (Hustedt) Lange-Bertalot, Navicula obsoleta Hustedt, Navicula parsura Hustedt and Stauroneis thermicola (Petersen) Lund).

Chemical tracers suggest a substantial role of soil water contributions to storm hydrographs in the Weierbach, regardless of the season, with overland flow playing no prominent role at all. Meanwhile, terrestrial diatom abundance in drift samples strongly increases during precipitation events, suggesting a rapid onset of connectivity between the soil surface and the stream. We assume the terrestrial diatoms to be mobilized during precipitation and eventually flushed to the stream through a subsurface network of macropores in the shallow soils and cracks in the fractured and weathered schistose bedrock.