Geophysical Research Abstracts
Vol. 13, EGU2011-12255, 2011
EGU General Assembly 2011

Using diatoms for determining the hydrological connectivity between upland, riparian and aquatic zones: application to the Weierbach catchment (Luxembourg)

Núria Martínez-Carreras (1), Jay Frentress (1), Jean François Iffly (1), Jeffery McDonnell (2), Dasa Hlúbiková (1), Luc Ector (1), Stefan Uhlenbrook (3,4), Lucien Hoffmann (1), and Laurent Pfister (1)

(1) Department Environment and Agro-Biotechnologies, Centre de Recherche Public - Gabriel Lippmann, Belvaux, Luxembourg (martinez@lippmann.lu), (2) Department of Forest Engineering, Resources and Management, Oregon State University, Corvallis, Oregon 97331, USA, (3) Water Resources Section, Faculty of Civil Engineering and Geosciences, Delft University of Technology, Delft, The Netherlands, (4) Department of Water Engineering, UNESCO-IHE, Delft, The Netherlands.

Diatoms are one of the most common algal groups; over 60,000 species have been described. These single-celled photosynthetic organisms have cell walls made of silica dioxide. They are widely distributed and species occur in almost every place where there is or has been water. They are present in most terrestrial habitats and their strongly diversified species distributions are largely controlled by physico-geographical factors (e.g. light and temperature) and water quality (e.g. acidification and eutrophication). Thus, hydrological systems largely control diatom species community composition and distribution. In return, diatoms offer the potential for the identification of reproducible flow patterns and a link to underlying watershed behaviour. The diatom cell walls can be easily transported by flowing water due to their small size ($\sim$10-200 μm). Diatoms are particularly suited to validating flowpaths, as their size precludes movement through the subsurface. As such, the presence of upland diatom species in the stream channel indicates a direct overland flow connection between the upland area and stream network.

Recently, diatoms have been used as new tracers to detect the onset/cession of surface runoff through binary classification of terrestrial and aquatic diatom species in the Attert experimental catchment in Luxembourg (Pfister et al., 2009).

In this study, this new type of information was used to constrain assumptions of the conventional tracer-based hydrograph separation (i.e. using geochemistry and stable isotopes). Specifically, diatoms were used to confirm or reject the hypothesis of existing surface runoff during rainfall-runoff events and to document the intermittent character of hydrological connectivity between, upland, riparian and aquatic zones. As an advantage, this technique is not subject to some of the inherent limitations of the classical tracer-based hydrograph separation techniques, such as unrealistic mixing assumptions, unstable end-member solutions and temporally varying input concentrations.

This study was carried out in the Weierbach headwater stream (50 ha, Luxembourg) and our preliminary results confirmed that diatoms were suitable to be used as tracers for studying water sources and hydrological connectivity during rainfall-runoff events. Results showed that aquatic diatom species prevailed at base flows, while the proportion of terrestrial species increased during the rising limbs of hydrographs.

Additionally, infrared imagery (7.5–13 μm wavelength), a new method of mapping and monitoring saturated areas in the hillslope riparian system (Pfister et al., 2010), was used to target sampling points of saturated areas and corroborate evidence of overland transport of diatoms. Infrared imagery allowed for rapid identification of areas dominated by groundwater sources vs overland flow from snowmelt. Special attention was given to better understand the seasonal influence of temperature and moisture availability on diatom community composition.

References:

Pfister, L., McDonnell, J.J., Wrede, S., Hlúbiková, D., Matgen, P., Fenicia, F., Ector, L. and Hoffmann, L. (2009): The rivers are alive: on the potential for diatoms as a tracer of water source and hydrological connectivity. Hydrological Processes, 23: 2841-2845.

Pfister, L., McDonnell, J.J., Hissler, C. and Hoffmann, L. (2010): Ground-based thermal imagery as a simple, practical tool for mapping saturated area connectivity and dynamics. Hydrological Processes, 24: 3123–3132.