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Hydrogeological and landscape controls on terrestrial diatoms input to the stream network during rainfall-runoff events

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We explore the dynamics of terrestrial diatoms (Bacillariophyceae) in streamflow during rainfall-runoff events collected in seven nested catchments in the Attert River basin (Luxembourg, Europe). Our main objective is to provide a sound basis for the use of these microscopic algae for the identification and understanding of spatial patterns in runoff sources.
Water samples (n=150) were simultaneously collected during precipitation events using automatic samplers. Diatom assemblages were identified and quantified (ca. 400 valves per sample). The fine-grained taxonomic treatment of the samples allowed the identification of 421 diatom species, among which 85 were considered terrestrial and/or aerophytic. Their occurrence is related to moisture content and associated to the respective hydrological category (i.e. Cat. 4: mainly occurring on wet and moist or temporarily dry places and Cat. 5: nearly exclusively occurring outside water bodies; Categories 1, 2 and 3 representing aquatic and/or very wet environments). In all seven sub-catchments terrestrial diatom abundance systematically increased during all sampled events as a response to increasing discharge and precipitation. Thus, the flushing of terrestrial diatoms mobilized during these events suggests a rapid connectivity between the soil surface and the stream water, despite the distinct richness and abundance of terrestrial diatoms in the different catchments. In event samples taken at peak discharge, terrestrial diatoms were more abundant in small forested streams reaching up to 40.8% and 70.0% of the diatom assemblages, respectively. In lowland reaches we found the lowest amount of terrestrial diatom valves (mean=0.91, min=0, max=4.2, n=15). We have also explored the effects of catchment complexity in terms of physiography, land use patterns, and lithology. The tested linear correlations between environmental factors and diatom distribution were primarily explained by land use (forest R2=0.70, grassland R2=0.59, urban area R2=0.44 and agriculture R2=0.44) and lithology categories (schists R2=0.89 and sandstones R2=0.48). Forest cover was the main landscape descriptor positively related to the highest abundances of terrestrial diatoms (r =0.75), while agriculture (r = -0.92), urban areas (r = -0.79) and grassland cover (r = -0.50) were negatively related to the maximum input of terrestrial diatoms. Although small forested areas located in the headwater streams do account for the overall richness of terrestrial diatom species, a ‘dilution’ effect (e.g. high turnover of assemblages) probably masks the presence of these species further downstream.