Geophysical Research Abstracts
Vol. 19, EGU2017-14163, 2017
EGU General Assembly 2017

The spatial structure and temporal synchrony of water quality in stream networks

Benjamin Abbott (1,2), Gerard Gruau (3), Jay Zarneske (1), Lou Barbe (2), Sen Gu (3), Tamara Kolbe (3), Zahra Thomas (4,5), Anne Jaffrezic (4,5), Florentina Moatar (6), and Gilles Pinay (2)

(1) Michigan State University, Department of Earth and Environmental Sciences, East Lansing, USA (benabbo@gmail.com), (2) CNRS, UMR ECOBIO, Université de Rennes I, Rennes, France (gilles.pinay@univ-rennes1.fr), (3) CNRS, UMR Géosciences Rennes, Université de Rennes, Rennes, France (gerard.gruau@univ-rennes1.fr), (4) INRA-Agrocampus Ouest, UMR Sol Agro et hydrosystèmes Spatialisation, Rennes, France (zthomas@agrocampus-ouest.fr), (5) Agrocampus Ouest, UMR Sol Agro et hydrosystèmes Spatialisation, Rennes, France (anne.jaffrezic@agrocampus-ouest.fr), (6) Université de Tours, EA Géo-Hydrosystèmes Continentaux, Tours, France (florentina.moatar@univ-tours.fr)

To feed nine billion people in 2050 while maintaining viable aquatic ecosystems will require an understanding of nutrient pollution dynamics throughout stream networks. Most regulatory frameworks such as the European Water Framework Directive and U.S. Clean Water Act, focus on nutrient concentrations in medium to large rivers. This strategy is appealing because large rivers integrate many small catchments and total nutrient loads drive eutrophication in estuarine and oceanic ecosystems. However, there is growing evidence that to understand and reduce downstream nutrient fluxes we need to look upstream. While headwater streams receive the bulk of nutrients in river networks, the relationship between land cover and nutrient flux often breaks down for small catchments, representing an important ecological unknown since 90% of global stream length occurs in catchments smaller than 15 km2. Though continuous monitoring of thousands of small streams is not feasible, what if we could learn what we needed about where and when to implement monitoring and conservation efforts with periodic sampling of headwater catchments? To address this question we performed repeat synoptic sampling of 56 nested catchments ranging in size from 1 to 370 km2 in western France. Spatial variability in carbon and nutrient concentrations decreased non-linearly as catchment size increased, with thresholds in variance for organic carbon and nutrients occurring between 36 and 68 km2. While it is widely held that temporal variance is higher in smaller streams, we observed consistent temporal variance across spatial scales and the ranking of catchments based on water quality showed strong synchrony in the water chemistry response to seasonal variation and hydrological events. We used these observations to develop two simple management frameworks. The subcatchment leverage concept proposes that mitigation and restoration efforts are more likely to succeed when implemented at spatial scales expressing high variability in the target parameter, which indicates decreased system inertia and demonstrates that alternative system responses are possible. The subcatchment synchrony concept suggests that periodic sampling of headwaters can provide valuable information about pollutant sources and inherent resilience in subcatchments and that if agricultural activity were redistributed based on this assessment of catchment vulnerability to nutrient loading, water quality could be improved while maintaining crop yields.