NSERC Canadian Network for Aquatic Ecosystem Services

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Stream biogeochemical resilience in the age of Anthropocene

Rick Dong, MSc
Western University
hdong43@uwo.ca
Supervisor
Dr. Irena F. Creed

Abstract

Recent evidence indicates that biogeochemical cycles are being pushed beyond the tolerance limits of aquatic systems. In streams, the consequences of passing this tolerance threshold may lead to cascading effects downstream which has a high possibility of causing algal blooms in freshwater systems. Here, we explore the question: Is there empirical evidence that global atmospheric changes are increasing the risk of biogeochemical resilience loss and are thus moving towards a new normal (i.e., new condition of ecosystem function)? Biogeochemical resilience is the ability of an ecosystem to return to equilibrium conditions after an external disturbance. Resilience can be measured using three metrics: reactivity (the highest initial response after a disturbance), return rate (the rate of return to equilibrium condition after reactive changes), and variance of the stationary distribution (the signal to noise ratio). Multivariate autoregressive models were used to derive these metrics for streams in the Turkey Lakes Watershed of Central Ontario that vary in disturbance from natural systems where global drivers would dominate, to relatively managed or modified systems where global and local drivers (i.e., forest management activates or legacies) would interact. We observed increasing risks of biogeochemical resilience loss and identified the constituent(s) that may be increasing risk from time series analysis. Non-stationary trends and stationary cycles were removed, and the standard deviation (SD) of remaining residuals were analysed to determine if there is an increase in SD over time that would indicate a pending shift towards a new normal. We observed that ammonia-nitrogen and dissolved organic carbon are increasing in SD which is indicative of a pending shift in forest stream systems. This study provides empirical support that biogeochemical cycles in streams are showing signs of exceeding tolerance levels and shifting towards a “new normal”, which can create more favourable conditions for algal blooms in freshwaters.

Keywords: Biogeochemical cycles, Stream biogeochemical resilience, Multivariate autoregressive models, Spectral anomalies analysis

Geographic Location: Turkey Lakes Watershed of Central Ontario

How does your project link to Canadian aquatic ecosystem services?

Biogeochemical monitoring of the Turkey Lakes Watershed begun in 1980 to study the long-term impact from global/regional atmospheric changes and local management activities on sensitive aquatic and terrestrial ecosystems. Our study is part of this Long Term Ecological Research program that could be used as a valuable reference in understanding the correlations between anthropogenic footprint and aquatic ecosystem services in temperate Eco-zone of Canada.