Nitrogen and phosphorus dynamics in two Japanese river networks with contrasting watershed land use

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Riverine transport of nitrogen and phosphorus from watersheds can be an important flux that affects the integrity of their downstream ecosystems. Thus, numerous nutrient-transport models have been developed to predict nitrogen and phosphorus flux from lands to the oceans. However, nutrient removal by stream ecosystems in the entire river network, from headwater streams to downstream rivers, has remained unknown. Here, we developed the nutrient transport models that explicitly incorporate stream ecosystem metabolism in order to understand the roles of in-stream processes (i.e., nutrient uptake) in controlling the nitrogen and phosphorus flux to downstream ecosystems.

We performed two field sampling campaigns covering the whole area of Yasu River and Ado River watersheds, central Japan, during September and October in 2012 and 2014, respectively. Both rivers are major tributaries of the Japan’s largest lake, Lake Biwa, with their watershed land-use patterns differing from each other significantly. Ado River watershed is characterized by forested vegetation with no strong anthropogenic impacts, while Yasu River watershed is composed of various land uses including urban development, agricultural fields (mostly rice paddies), and planted forests. In each watershed, we established a number of sampling sites in streams/rivers to measure discharge, nitrogen and phosphorus concentrations, and other physico-chemical variables. We then developed the modified version of spatially referenced process-based model (SPARROW) to describe the observed flux of nitrogen and phosphorus in the entire area of each river networks. In the models, we formulated the in-stream processes of N and P uptakes as kinetic equations of stream metabolism, which depends on water temperature, light, and/or substrate abundance.

In this presentation, we show the predictions by our models for the effects of watershed land uses on the amount of nitrogen and phosphorus exports by rivers. The model also predicts how land-use patterns, as well as other watershed attributes, affect the nutrient spiraling metrics: the estimates of areal uptake rates (U), uptake velocity (v_f) and uptake length (S_w) of nitrogen and phosphorus in the river ecosystems. The results clarify the nitrogen and phosphorus dynamics in river networks with contrasting watershed land use to emphasize that stream ecosystem function can alleviate the negative effects of watershed human activities on the nutrient transport to downstream river and lake ecosystems.

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