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Evaluating nutrient removal in a large river by in situ spiraling metric measurements

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Fluvial transports of excess nutrients can induce explosive growth of primary producers in aquatic ecosystems, thereby degrading the structure and function of downstream areas. River networks have traditionally been regarded as a conduit of such land-derived nutrient loads to coastal ecosystems. However, recent studies have increasingly identified the importance of in-stream processes that retain, transform and remove nitrogen and phosphorus from water column to benthic environments. Therefore, elucidating the pattern and mechanisms of nutrient removal processes in river networks has now become an important requirement to prevent the eutrophication of coastal waters.

Small headwater streams have been recognized as a vital element of riverine ecosystems as they are believed to be far more efficient at processing and transforming inorganic nutrients than large rivers. However, no study has hitherto directly quantified the nutrient removal rate in large rivers that exceed 18m^3/s in discharge. Therefore, the role of large rivers in controlling nutrient flux to downstream ecosystems has rarely been evaluated. In this study, we performed the in situ longitudinal measurements of dissolved inorganic nitrogen and phosphorus, as well as physico-chemical environmental gradients, to estimate the spiralling metrics (areal uptake rate, uptake velocity and uptake length) in the 6th-order mainstems of the Fuji River (Q >40m^3/s), central Japan.

The present result showed that the areal uptake rates of NH_4 and PO_4 in the Fuji River are relatively fast compared with those estimated in the 1st-to-5th order rivers by previous studies, although the net uptake rates of NO_3 were usually negative due probably to the stoichiometric imbalance of river waters. In contrast, the metrics of nutrient removal efficiency of NH_4 and PO_4 (uptake velocity and uptake length) did not differ from or even low relative to the previous findings, as a result of the high nutrient concentration and high water velocity in this steep terrain watershed. In the presentation, we will also introduce the analyses on the effects of spatial heterogeneity in river environments on the nutrient spiralling metrics in order to identify the hotspots of nutrient removal in this large river.

Keywords: spiraling metric, large river, nutrient, uptake rate, hot spot