Nitrate and phosphate dynamics in the mountain stream

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Mountain streams control nutrient export from forest watersheds to downstream ecosystems. Howarth et al. (1996) reported that regional nitrogen fluxes to the sea are only 20 % of the sum of anthropogenical and natural derived nitrogen inputs to rivers. Moreover, Bernhardt et al. (2003) reported that nitrate exported from forest watershed was retained in streams. Transient storage zones in streams, such as stagnant pockets or the porous areas within the streambank, are particularly important for nutrient removal in lotic systems. However, the effects of in-stream processes on nutrient dynamics in Japan have not been studied. Using an in situ nutrient addition experiment technique, we examined the nutrient dynamics of a mountain stream by estimating nutrient uptake and influence of transient storage on uptake in the stream reach.

The study area was located in the Fudoji experimental watershed, southeastern Shiga Prefecture, Japan. The study sites were located in the upper, middle and lower portion of the watershed. The watershed area of each sites were 9 ha, 166 ha and 427 ha. The experimental reach encompassed approximately 100 m. From September 2006 to October 2008, we conducted nutrient addition experiments to measure nutrient uptake in the reach. Sodium nitrate, potassium dihydrogen phosphate and sodium chloride were dissolved in a carboy using stream water in the field and injected at a constant rate into the study reach using a peristaltic pump. In addition, we monitored the time series response in conductivity from the chloride addition at the downstream end of the reach using a field probe in order to model stream transient storage. We calculated nutrients uptake in streams from the slope of background and dilution corrected changes in nitrate and phosphate concentrations versus distance downstream (Newbold et al. 1982). We used the One-dimensional Transport with Inflow and Storage (OTIS) model to estimate the hydrological characteristics of the study reach such as transient storage zone.

The experimental results suggested that the processes of nitrate and phosphate removals were different each other. Nitrate concentration decreased a little in reaches in two watersheds (9 and 166 ha) where discharge rates were relatively small. Nitrate did not decrease in the largest watershed (427 ha), although the large decrease in nitrate concentration was observed at the minimal discharge rate. These observations suggested that hydrologic conditions, such as the discharge rate, might affect the instream nitrate removal. On the other hand, the phosphate concentration decreased downstream in all watersheds. The smaller the watershed area was, the larger the removal of phosphate was. The area of transient storage zone relative to the area of riverbed was larger in the small watershed in the study area. It was, therefore, suggested that the storage zone was an active site for phosphate removal.

We will discuss biogeochemical instream processes from nutrient removal and environmental factor such as hydrological characteristics and water temperature.

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