Role of riparian zone on sulfur and nitrogen export to forest stream

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Solutes in stream water in forest basin are important as nutrients in aquatic and estuary ecosystems. These steam chemistry is formed as a result of biogeochemical processes in the forest watershed. The understandings of the temporal and spatial pattern of formation mechanisms of solutes in water in the watershed, therefore, are very important to assess the function of the forest basin for conservation of water quality.

In northern Hokkaido, basin topography is relatively gentle compared to those in the southern part of Japan, resulting that wide riparian zone tends to exist near stream channel. Riparian zone include unique internal cycling in vegetation and soil system with shallow groundwater although the land area of riparian zone is typically smaller than other parts (slope and ridge) of the basin. As most water has pass through the riparian zone before entering stream water, the effect of riparian zone would be important to understand formation mechanisms of stream chemistry. However, the details of biogeochemical processes in riparian zone and their role on stream chemistry have not known well at this point. We investigate solute concentration in stream water and various soil solutions with different vegetation, topography and soil moisture in M3 watershed in Uryu Experimental Forest of Hokkaido University, located in northern Hokkaido, Japan to clarify the differences of soil solution chemistry among the sites and their relation to stream chemistry.

We established the four plots in the ridge and one plot in the riparian zone for monitoring of soil solution chemistry. We collected soil solution using tension lysimeter with ceramic porous cup and stream water during non-snowy period from 2004 to 2005. The concentrations of major ions in soil solution and stream water were analyzed using ion chromatography. The dominant vegetation in the basin is cool-temperate mixed forest including evergreen coniferous species (Todo fir, Glehn's spruce and so on) and broad-leaved deciduous species (Erman's birch, Mongolian oak, Painted maple and so on). The dense Sasa dwarf bamboo is covered as forest floor vegetation. In the riparian site, wet vegetation, Alder and Manchurian ash are dominant with butterbur and skunk cabbage as understory vegetation. The soil of the basin is acidic brown forest soil (Inceptisols) and the bedrock is Tertiary Andesite.

Stream pH is almost neutral and major cations and anions are sodium, calcium, magnesium, chloride and sulfate, respectively. The ion concentrations in soil solution were different between the ridge and riparian sites. Nitrate concentration in soil solution in riparian site tended to be smaller than those in the ridge site, although the absolute value of nitrate concentration was small in all samples. The sulfate is also same tendency with extremely low concentration in riparian zone. Based on the mixing analysis of soil solution chemistry and comparison with stream water, it was suggested that the effect of riparian zone on stream chemistry is very large, especially for nitrate and sulfate. In riparian ground, soil moisture is often extremely abundant, causing unique microbial metabolisms of nitrogen and sulfur under reduced environment including denitrification and sulfur reduction. As results, it was suggested that the export of nitrogen and sulfur to forest stream is controlled by the biogeochemical processes in riparian zone.