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Research on dissolved inorganic phosphorus concentrations forming process in a forested mountainous stream

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Since the ecosystems of river, lake, and ocean are supported by P supply from terrestrial area, it is important to understand the mechanisms behind the P discharge from the catchments through the aquatic system. It has generally been considered that loss of P from a forested area through a headwater stream is small, because it is preserved tightly within forested ecosystem. It has previously been reported that heavy rainfalls lead to a large P loss from forested catchments, and major fractions of exported P is particulate form absorbed onto soil particles. Therefore, many studies have focused on particulate P load during high flow condition. However, it has been still poorly understood about the controlling mechanisms of sources and transport of dissolved inorganic phosphorus (DIP), which is directly available for organisms. In order to explain the controlling mechanisms of DIP discharge, we conducted field investigations on the DIP dynamics through the elemental hydrological processes in the hill slopes of a headwater catchment, and illustrated the spatial distribution of DIP concentrations of the stream network in meso-scale catchment.

The study site was Fukuroyamasawa experimental watershed located in The University of Tokyo Chiba Forest and Inokawa watershed including Fukuroyamasawa. The size of Fukuroyamasawa is 1 ha, and that of the Inokawa watershed is 503 ha. Through fall water, stem flow water, litter layer infiltration water, soil water, groundwater and stream water were sampled once every two weeks from August 2013 to November 2013. Rainwater was collected at the meteorological station located near by Fukuroyamasawa. In Inokawa watershed, flow observation and stream water sampling at the point with various watershed area on low-flow period in September 2013 and December 2013. The samples were filtered by 0.45 micrometer membrane filters immediately after the sampling. Then DIP was analyzed using molybdenum blue (ascorbic acid) absorptiometry.

The average DIP concentration of rainwater was 0.2 micromol / L during the observation period. That of through fall, stem flow and litter layer infiltration water were 0.9, 1.7 and 10.9 micromol / L respectively. DIP concentration felt remarkably with soil layer passage, and the average DIP concentration of soil water, groundwater and steram water was 0.6 micromol /L. DIP concentration in Inokawa stream water ranged from minimum limit of determination, 0.1 micromol /L, or less to 9.2 micromol / L. When we investigated the relation between DIP concentration and a contributory area, DIP concentration differed in about 2 km2 or less, and it increased at the larger than 2 km2 as the contributory area became large. There was a strong positive correlation between DIP concentration and EC.

In Fukuroyamasawa, it was shown that DIP added during canopy passage was almost absorbed in the soil layer at particles, and was removed from the water, and hardly contributing to the outflow to a mountain stream. EC is an index for underwater dissolved matter concentration, and it turns out that the amount of the dissolved matter concentration of mineral origin is shown at Inokawa watershed. Therefore, the relationship of DIP concentration and EC has suggested that mountain stream underwater DIP mainly originates in bedrock weathering, and that the spatial distribution of DIP concentration is determined with the contribution of a groundwater course which passes bedrock.

Keywords: Dissolved Inorganic Phosphorus (DIP), forested mountainous stream, spatial distribution, catchment area