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Water flow pathway and the organic carbon discharge during rain storm events in a coniferous forested head watershed, Tokyo, central Japan

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The current intense discussion of the green house effect, that has been one of the main focuses on the carbon cycle in environmental systems of the earth, seems to be weakened the importance related to the effect of carbonic materials on substance movement in the aquatic environments; though it has just begun to be referred recently. Because dissolved organic carbon (DOC) in stream flows believes to play a main role of the carbon cycle in the fresh water environment, seasonal changes in DOC discharge were investigated in catchments with various scale and land use, especially in forested catchments which are one of the important sources of DOC.

In order to understand the fundamental characteristics of the discharge of dissolved organic materials, stream flows, DOC, and fulvic acid like materials (FA) included in stream flows were measured in a coniferous forested head watershed. The watershed is located at the southeast edge of the Kanto mountain and is 40 km west of Tokyo with the elevation from 720 to 820 m and mean slope gradient of 38 degrees. Geology of the watershed is underlain by the sequence of mud and sand stones in Jurassic and the soil in the watershed is Cambisol (Inceptisols). The watershed composes of a dense cypress and cedar forest of 45 years old with poor understory vegetation. Observations were carried out for 6 rain storms of which the total precipitations ranged between 16.2 and 117.4 mm. The magnitude of the storms was classified into small, middle, and big events on the basis of the total precipitation of around 20, 40, and more than 70 mm. Stream flows were collected during the storm events by 1 hour interval and were passed through the 0.45 μm filters, and then the DOC concentrations in the flows were measured with a total organic carbon analyzer. The relative concentrations of fulvic acid (FA) in the flows were monitored with three dimensional excitations emission matrix fluorescence spectroscopy, because fulvic acid shows distinctive fluorescence peaks at around the excitation wave length of 340 nm and emission wave length of 440 nm.

The timing of the peaks in DOC and FA occurred simultaneously or within 30 minutes prior to those in the stream flows. The relationship between DOC and stream flow showed linear correlations with various gradients in each event. However, the relationship between FA and stream flow showed the linear correlations only for the small and middle events and clockwise hysteresis relations occurred in the big storm events. The relationship between DOC and FA showed the linear correlations both for the extracted water of the shallow soil and for stream base flow composed mostly of groundwater discharge. However, the relationship in the storm flow closely distributed at that in the extracted water of the shallow soil. This thing reveals that DOC and FA were mainly flashed out from the shallow soil during the rain storm events. The quick rising and recession of the fulvic acid was likely provided by quick rain water discharge through the surface or near surface of the slope. However, the overland flow were rare in the watershed during the rain storms. This indicates that the rapid shallow subsurface flow, passed mainly through preferential flow pathways at the slope surface within the loose litter and root-permeated zone, was the main cause of the difference in discharge regimes between DOC and FA. The shallow subsurface flow may have flushed the FA in the near-surface of the soil, and then the relatively predominant discharge of DOC must have been caused during the big rain storm event.