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Estimation of catchment scale water storage using high frequency and long-term tracer information

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In forested catchments, streamwater runoff process and streamwater chemistry are related catchment water storage. To investigate the mechanisms of water flow in forested headwater catchment, water sources, pathways, transit time and water storage have been estimated using chemical tracer information. Recent studies have modeled catchment streamflow and the response of isotopes and chemical composition during storm events using a conceptual model and estimated the water storage and transit time distributions within the flow regime and the relationship to the water source and flow paths.

Considering the field-based water source and time relationship, for example, previous studies have estimated the bedrock groundwater contribution using the mean transit time (MTT) of bedrock groundwater and streamwater during baseflow. However, the studies that estimated the MTT using tracer information were usually in the baseflow condition. The transit times during storm events are not clear, as field observations have not been made to test the model results. A newer methodology and observation system are needed to determine the high spatial and temporal variation in the water time and the source in forested catchments. In this study, to estimate the catchment scale water storage and the contribution on the water runoff, we considered a data collection strategy using a case study involving long-term high-frequency tracer measurements using the signal of an entire clear-cut catchment in the Fukuroyamasawa Watershed in the Tokyo University Forest, Chiba, Japan. A time series of Cl concentrations during each flow condition was used to estimate the MTT for various flow regimes. The estimated MTT was 300 to 400 days during high flow, and more than 1200 days during baseflow. From the MTT, the water storage in the catchment could be estimated. The water storage in the catchment could not be explained by the storage capacity of the soil layer alone; the bedrock water storage might contribute to water runoff and streamwater chemistry. This suggests that long-term high-frequency tracer data and focusing on the variation in tracer composition in each flow condition could be used to express the relationship between the water source and time in the flow regime.