Field measurement and numerical simulation of water flux in a forest soil

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To clarify the movement of dissolved substances, such as by nitrogen leaching in forest soil, it is necessary to quantify the water flux. However, measuring water flux in unsaturated soils is not easy. Porous plate tension lysimeters (PPTL), which automatically control the vacuum according to the wetness of the soil, are considered to be one of the suitable methods for this purpose. In this study, the PPTL method was applied to evaluate the seasonal change of water flux in a forest soil. Furthermore, we simulated the observed seasonal water flux by numerical calculation using the experimentally measured soil hydraulic characteristics. In a Japanese cypress forest, a ceramic porous plate was installed in the soil at a depth of 1 m and connected to the vacuum system, and the amount of water flux was measured continuously. Throughfall was measured using a tipping rain gauge and soil water storage was measured using time domain reflectometry sensors. Then, the water balance in the soil layer was determined. The observation period was divided into shorter periods so that the soil water storage at the beginning and end of the period was equal. The average daily water losses (transpiration) in each small period were calculated to be within the range of about 0.2 mm/d in winter to about 3 mm/d in summer. The observed water flux by PPTL was simulated by numerical calculation using water content–potential–hydraulic conductivity relationships determined by laboratory experiments. The numerical simulations were conducted using the HYDRUS1D program. Using the daily water loss by field observation as the value of root water uptake, the water flux for each period was simulated. The simulated temporal change of water flux was comparable to the observed value obtained by PPTL.

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