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Stable isotope-based approach to validate effects of stand structure and understory on soil water in a Japanese forest plantation

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Many researchers have studied the effects of plantation thinning on forest environments, including plantation thinning-induced changes in soil water, which recharges ground water. However, most of these studies have sampled only either preferential flow or matrix flow. To properly understand soil water movement, soil water must be classified into matrix flow and preferential flow, and we must sample and analyze them separately. Therefore, our purpose is to reveal the differences in the water stable isotope rates in soil water on different vegetation distributions to consider the change of soil water.

We used suction lysimeters adding 60kPa and zero-tension lysimeters to collect two types soil water separately. We used modular zero-tension plate lysimeters which improve the problems in conventional zero-tension plate lysimeter of both low water collection efficiency by unsaturated soil on the plate and soil disturbance by inserting the plate.

Matrix flow tended to be isotopically heavier under open canopy than under closed canopy, and isotopically heavier in areas with no understory vegetation than in areas with understory vegetation. Preferential flow tended to be almost the same water stable isotope rate as throughfall. We could see this trend better in heavy rain events than in light rain events, and the trend suggests mixing with matrix flow in the light rain. There was little difference between water stable isotope rates of throughfall in different vegetation distributions.

The implications of these results suggest that soil water which recharges ground water is isotopically heavy in a degraded plantation, and becomes isotopically heavier with the increase in forest floor evaporation after plantation thinning, but becomes isotopically lighter as understory vegetation grows.