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Estimation of infiltration area of stemflow-induced water

Shin'ichi Iida[1]; Akane Suzuki[2]; Tadashi Tanaka[3]

[1] Graduate School of Life and Environmental Sciences, Univ. Tsukuba; [2] none; [3] GS, Life & Environ. Sci., Univ. Tsukuba

http://www.suiri.tsukuba.ac.jp/~iida/index.html

1. Introduction

Forest canopy intercepts rainfall and the intercepted rainfall is partitioned into throughfall and stemflow. Although throughfall is highly spatial diffused input on the forest floor, stemflow is concentrated point inputs around tree bases. Therefore, it has been considered that stemflow-induced water is more effective component for groundwater recharge than throughfall (e.g., Durocher, 1990; Tanaka et al., 1996). However, the contribution of stemflow-induced water to groundwater recharges has not been studied except for Tanaka et al. (1996) and Taniguchi et al. (1996). The reason to explain few studies is that the difficulty to evaluate infiltration area of stemflow-induced water (Ai), which is needed to estimate the contribution of stemflow (i.e. contribution of stemflow = amount of stemflow / Ai). Iida et al. (2005) found litter mark around tree bases and pointed out that litter mark is a useful indicator of Ai. On the other hand, Herwitz (1986) evaluated the area of infiltration excess as dividing the stemflow intensity by the infiltration rate. Although litter marks are formed by the infiltration excess of stemflow-induced water, the intensity of stemflow and the infiltration rate were not measured by Iida et al. (2005). In this paper, the infiltration areas of stemflow-induced water around Liquidambar formosana and Zelkova serrata are investigated by the observation of the stemflow intensity and infiltration rate, and are compared with litter marks for L. formosana.

2. Methods

We picked up 2 trees of L. formosana and a tree of Z. serrata to measure stemflow intensity by tipping bucket type flow meter. Infiltration rate was measured for 12 points around tree bases of test trees by a double rings infiltrometer. Gross rainfall was obtained from routine observation data of Terrestrial Environment Research Center, Univ. Tsukuba

3. Results and Discussion

Highly correlations between amounts of gross rainfall and stemflow were found for all test trees. Slope of regression line between gross rainfall and stemflow is largest for Z. serrata. Although the potential for stemflow generation depends on the size of crown projection area (CPA) (Crockford and Richardson, 2000), there is no significant difference in CPA between Z. serrata and L. formosana. Another importance for the potential is branch angle (Crockford and Richardson, 2000). Steeply inclined branches have a greater potential for stemflow generation than horizontal branches (Herwitz, 1987). More inclined branches of Z. serrata than L. formosana resulted in the larger amount of stemflow of Z. serrata.

During a rainfall event with total amount of gross rainfall was 63.5 mm/event and maximum rainfall intensity was 8.0 mm/30min, the maximum stemflow intensity of 1100 cm3/30sec was observed for all test trees. The maximum values of radius of Ai, which is calculated as dividing of stemflow intensity by infiltration rate, were about 20 cm smaller than that of litter marks. The underestimation of Ai can be caused by i) underestimation of stemflow intensity or ii) overestimation of infiltration rate. Stemflow intensity was measured by the tipping bucket type flow meter. During rainfall, we confirmed that there was no leakage of stemflow from the gutter fixed around a stem. It is safely concluded that stemflow intensity measurement is reasonable. Onda et al. (2005) compared infiltration rates measured by a several methods, and reported that infiltration rate by the infiltrometer was around 10 times larger than that by a large-scale rainfall simulator type with the sprinkler located above the tree crown. Referring to Onda et al. (2005), infiltration rates measured in this study may be overestimated. In future, we must measure the infiltration rate by the other method, and compare Ai with litter mark to validate the availability of litter mark for the estimation of Ai.