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Determining Accuracy of Thermal Dissipation Methods-based Sap Flux in Japanese Cedar Trees

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Thermal dissipation method, one kind of sap flux measurement method that can estimate individual tree transpiration, have been widely used because of its low cost and uncomplicated operation. Although thermal dissipation method is widespread, the accuracy of this method is doubted recently because some tree species materials in previous studies were not suitable for its empirical formula from Granier due to difference of wood characteristics. In Taiwan, *Cryptomeria japonica* (Japanese cedar) is one of the dominant species in mountainous area, quantifying the transpiration of Japanese cedar trees is indispensable to understand water cycling there. However, no one have tested the accuracy of thermal dissipation methods-based sap flux for Japanese cedar trees in Taiwan. Thus, in this study we conducted calibration experiment using twelve Japanese cedar stem segments from six trees to investigate the accuracy of thermal dissipation methods-based sap flux in Japanese cedar trees in Taiwan.

By pumping water from segment bottom to top and inserting probes into segments to collect data simultaneously, we compared sap flux densities calculated from real water uptakes (F_{d_actual}) and empirical formula ($F_{d\_Granier}$). Exact sapwood area and sapwood depth of each sample were obtained from dying segment with safranin stain solution.

Our results showed that $F_{d\_Granier}$ underestimated 39 % of F_{d_actual} across sap flux densities ranging from 10 to 150 ($cm^3m^{-2}s^{-1}$); while applying sapwood depth corrected formula from Clearwater, $F_{d\_Granier}$ became accurately that only underestimated 0.01 % of F_{d_actual}. However, when sap flux densities ranging from 10 to 50 ($cm^3m^{-2}s^{-1}$)which is similar with the field data of Japanese cedar trees in a mountainous area of Taiwan, $F_{d\_Granier}$ underestimated 51 % of F_{d_actual}, and underestimated 26 % with applying Clearwater sapwood depth corrected formula.

These results suggested sapwood depth significantly impacted on the accuracy of thermal dissipation method; hence, careful determination of sapwood depth is the key for the accurate transpiration estimates. This study also apply the derived results to long-term field data in the mountainous area in Taiwan.