Japan Geoscience Union Meeting 2012
(May 20-25 2012 at Makuhari, Chiba, Japan)

U05-10 Room:IC Time:May 21 14:30-14:45

Transpiration evaluated by sap flow measurements and bandpass eddy covariance method in a Cambodian deciduous forest

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Introduction

Cambodia still retains forests in the lowland plains, unlike Thailand and Vietnam, where the remaining forests are mostly in mountainous areas (Tani et al., 2007). However, few studies have examined the hydrologic and/or environmental processes in the unique and valuable forests in Cambodia. Recently, intensive observations were started and knowledge of hydrologic and ecological features is accumulating for the evergreen forest located in Kampong Thom province, Cambodia (e.g., Shimizu et al., 2007). On the other hand, deciduous forests occupy 44% area of total forest in Cambodia, and larger than evergreen forest covering 34% (FAO, 2010). Thus, also for the deciduous forest, accumulating the results of observation is highly required to understand the hydrologic and ecological processes. We obtained the transpiration in the stand scale by the sap flow measurement (SFM) and compared it with the estimations by the bandpass eddy covariance method (BECM) in a deciduous forest.

Method

We established an observation plot in a tropical broadleaved deciduous forest in Kratie Province, some 200 km northeast of Phnom Penh, Cambodia (12.55'N and 106.11'E). The main tree species in the stand were *Dipterocarpus tuberculatus* and *Terminalia tomentosa*. A 30-m-high observation tower was built and the measurements were initiated in February 2009. A stand density of 350 stems/ha, a mean tree height (TH) of 11.3 m, and a mean diameter at breast height (DBH) of 24.5 cm were obtained within an area of 20 by 20 m near the tower. The forest had open canopy, and leaf area index at five points by the plant canopy analyzer (Licor, type LAI-2000) during the main foliated period were 0.9. More detailed information was described in Iida et al. (in press).

We measured sap flux density (F) for 12 deciduous trees near the tower: 3 trees of *D. tuberculatus*, 3 trees of *T. tomentosa*, 5 trees of *Shorea obtusa* and a tree of *Xylia xylocarpa* by using handmade Granier sensors. Details of these trees were described in Iida et al. (2011). Based on the wood core sampling, we determined the width of the sapwood (SW) and obtained sapwood area (SA). When SW is less than 20 mm we applied the correction (Clearwarer et al., 1999). The single-tree transpiration (q) can be calculated as q = F x SA. Finally, we obtained the stand-scale transpiration (TR_SFM) as dividing a total q of 12 trees by the plot area. On the other hand, we applied BECM over and under the canopy, and evaluated the evapotranspiration from whole ecosystem (ET) and from the forest floor (ETfloor). As a result, transpiration from overstory trees estimated by BECM (TR_BECM) was calculated as TR_BECM = ET - ETfloor.

Results and concluding remarks

Daily TR_SFM corresponded well with TR_BECM (TR_BECM = 0.91 x TR_SFM, R^2=0.79), and we concluded that SFM is a useful tool for evaluating transpiration in this site. During the period from June 2010 to May 2011 including lack of data occurred from September to December 2010, TR_SFM and ET were 310 and 520 mm, respectively. The contribution of overstory trees to ET (TR_SFM/ET) was 60%, while that of TR_BECM (TR_BECM/ET) was 50%. The other source of ET, that is the understory vegetation on the forest floor, occupies 40 to 50% of ET: evapotranspiration from the understory vegetation is nearly equal to that from overstoty trees in this site.

References

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Keywords: Cambodia, lowland deciduous forest, transpiration, sap flow, bandpass eddy covariance method