Potential of individual and cluster tree cooling effect performances through tree canopy density model evaluation in improving urban microclimate

ABSTRACT

Technically, trees can provide cooling effect and able to reduce ambient temperature in its own way. This paper investigates the potential of individual and cluster tree cooling effect performances in improving urban microclimate through the evaluation of urban trees canopy density. The evaluation is based on the actual measurement of Leaf Area Index (LAI) and Leaf Area Density (LAD) and uses tested computer simulation tools ENVI-met. The study found that each tree has different capabilities in modifying each microclimate variables. However, it was revealed that the optimum effect of cooling of each tree was found during the hottest day to takes place approximately at 15:00 hours when the sun is overhead and solar angle height is close to 90°. Besides, trees with higher densities such as Ficus benjamina (i.e. LAI 9.7, LAD > 1.5) showed a remarkable reduction in comparison to the other loose density trees. It is also revealed that the implementation of cluster tree planting at larger scale could maximize the effects of cooling. Nevertheless, the downside of implementing high tree density could create a reduction of 63% of wind speed that might possibly influence the air movement in urban areas due to the drag force of tree canopy. The study concluded that the performance of tree cooling effect is well correlated with tree canopy density and it is also suggested the optimum cooling effect could achieved by higher tree density (mean LAD > 1.5) and larger tree quantities with tree cluster planting.

Keyword: Microclimate variables; LAI and LAD; ENVI-met model; Tree cooling effect performances; Tropical urban climate; Microclimate modification