EGU21-3530
https://doi.org/10.5194/egusphere-egu21-3530
EGU General Assembly 2021

Impact of different sub-tropical trees on outdoor thermal comfort in an Indian city – A microclimatic modelling approach

Sana Javaid[1], Kameswara Yashaswini Sista[2], and Stephan Pauleit[1]
[1]Chair for Strategic Landscape Planning and Management, Technical University of Munich, Freising, Germany (pauleit@tum.de)
[2]School of Forest Science and Resource Management, Technical University of Munich, Freising, Germany (yashaswini.sista@tum.de)

Indians cities are facing incessant urbanization with lack of adequate green spaces exposing inhabitants to heat stress and increased mortality. Reduction of heat stress or optimization of outdoor thermal comfort (OTC) has been recognized as one of the multiple benefits of urban green infrastructure across different climatic zones. However, there is dearth of such studies in humid-subtropical (Cwa) context, especially India. 'Urban trees' are most preferred vegetation type concerning OTC, whereas, 'parks, streets and gardens' are most preferred urban green settings in a residential neighbourhood, as indicated by social survey results of another part of this study. But role of urban trees in enhancing OTC in different urban settings remains underexplored. In particular, it needs to be better understood how different morphological characteristics of trees influence their thermal benefits. Hence, we investigated nine sub-tropical tree species in these urban settings of a typical residential neighbourhood in the mid-sized, humid-subtropical city of Dehradun in north India. A sizeable world population inhabits humid-subtropical climates and almost 1/3rd of Indians reside in mid-size cities, making this study widely relevant.

We used a modelling approach enabling comparison of different trees in similar urban settings which is not possible through on-ground studies. 70 tree species were identified through field surveys and further filtered based on frequency, canopy density, morphology and growth habit. Finally, nine species were selected, three for each urban setting and modelled using Albero, a plugin of the 3D microclimatic simulation software, ENVI-met. Parameters such as tree height, trunk height, canopy shape and density, leaf area density, root spread and diameter etc. were considered for tree modelling. Modelling was validated using the field measurements and indicated a high correlation of 90%. Total nine scenarios were created using ENVI-met for each tree species in the respective urban setting maintaining canopy cover area. Their performance was evaluated by air temperature, relative humidity and mean radiant temperature at 15:00 and 19:00 hours of a peak summer day (2nd July 2019). Thermal comfort was also evaluated using PET (Physiologically Equivalent Temperature) between 9:00-20:00 hours.

Our results indicate that Mangifera Indica, Azadirachta Indica and Alstonia Scholaris perform best on an average for all parameters in gardens, park and streets respectively. These three trees had dense canopy i.e. high leaf area density (LAD) values and an average tree height between 11-15m.

It should be noted that we did not have trees bigger than 15m on our site so results need to be further verified for taller trees. It can, however, be inferred that LAD value and tree height influenced cooling benefits more than trunk height or canopy shape in all urban settings. These results will be used to explore most suitable plantation arrangement in these urban settings. We acknowledge limitation of tree modelling using a software, however, forthcoming ENVI-Met 2021 release will enable detailed tree modelling and further improvise the study. Our results can be used in green space planning in humid subtropical climatic zones with similar urban settings or for further exploration of role of urban tree species.