Ecosystem services of urban trees in the reduction of thermal stress

Abstract

With the projection that by 2050 approximately 68% of the world's population will be living in urban settlements, urban forestry is gaining more and more importance. Indeed, many studies are focusing on urban forests, as they play a crucial role in improving the environmental quality of cities. Urban trees are an essential part of the urban landscape, with the potential to provide many environmental, social and economic benefits for cities and their citizens. One major benefit is the shade casting during hot sunny days, which reduces the heat stored in concrete and lowers the heat load on people, increasing their comfort. As the consequence of shade provided by the canopies of trees, a noted reduction of short-wave radiation reaching ground level can be observed. Furthermore, aside from shade casting, through evapotranspiration trees can cool their leaf surface and thus reducing the amount of heat available to warm the air surrounding them, while increasing the air humidity. These advantages of urban trees are of particular importance, as urban spaces are shown to have significantly higher temperatures during summer, in comparison to rural areas, referred to as the urban heat island effect. Furthermore, the importance of urban greenspaces in regulating temperature becomes even more evident bearing in mind the forthcoming climate change scenarios, predicting the increase of air temperature, reduction of precipitations with more expressed drought periods.

Tree cooling varies with climate, tree species and environmental conditions. Namely, the different environmental conditions often noted within the urban settlements as compared to its surroundings can affect the physiology of plants, which consequently affect their capacity to provide ecosystem services, including diminution of the heat stress and discomfort. Furthermore, as there is a great variation of functional traits between species, such as crown architecture and size, leaf area and anatomical structure, this difference is also expected to be reflected in the ecosystem services they provide. The health condition and vitality of trees are important determinants of the quality of provided ecosystem services. Although there is an increasing number of studies related to the benefits of urban forestry, there is still a lack of knowledge and pressing need for understanding related to the magnitude, pattern and processes of urban trees in mitigating the urban heat in heterogeneous urban landscapes. This is of key importance in order to provide concrete information that could be used for planning urban greenery resilient to forthcoming climate changes.

Having the above-mentioned in mind, the study proposed for this Short-Term-Scientific Mobility is designed to assess, estimate and quantify the positive effects of urban trees on the species level on heat stress mitigation and thermal comfort of citizens of Florence, Italy. Therefore, three commonly planted tree species', namely *Tilia x europea, Quercus ilex, Celtis australis* heat mitigation effects will be assessed and compared in areas with grass coverage (urban park) and with concrete coverage (city streets). During a hot summer month, the assessment of different heat mitigating effects of the studied species will be conducted through microclimate measurements with the help of weather stations and WBGT device, recording the air temperature, relative humidity, air velocity, radiant temperature at studied city street and parks. These data will be paired with structured interviews and *in situ* observations and mapping of the activities of urban park and street users providing information about the user's body mass, psycho-physical state, metabolic rate, activity. Furthermore, to gain a more profound understanding of the thermal stress reduction effect of the studied city trees, the plant visual vitality index will be assessed in May 2021 on-site.

The importance of this study lays in providing a useful methodological approach to quantify the heat stress mitigation and thermal comfort provided by urban trees, widely applicable in other urban areas, as well.