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Editorial

Advances on the Influence of Vegetation and Forest on Urban Air Quality and Thermal Comfort—Series II

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Cities are composed of different types of urban obstacles such as buildings, cars, trees, hedgerows, etc. The interaction of the atmosphere with urban morphology and the different urban surface properties gives rise to complex atmospheric processes on different scales in the urban canopy layer (UCL).

Spatial distributions of atmospheric pollutants observed in urban environments are also related to these processes. The interactions between the atmosphere and buildings induce reduced ventilation in the streets and, this fact, together with high emission rates of pollutants from road traffic (NO_2, PM10, PM2.5, etc.), induce heterogeneous distributions of pollutants and high levels of pollution in the streets [1–4]. It should also be considered that indoor air quality is influenced by outdoor air pollution. Hence, populations are exposed to these high air pollutant concentrations both indoors and outdoors. Nevertheless, estimating population exposure to atmospheric pollution in both scenarios remains a major challenge [5–7].

Measures for improving air quality in cities are necessary and they are usually based on reducing pollutant emissions or implanting passive mitigation air pollution strategies, such as the so-called green infrastructures (GI). However, how do GI influence air quality? The main effects are [8,9]:

- Aerodynamic effects: trees, hedges, bushes, etc.; are porous obstacles, which modify airflow around them and consequently, the pollutant dispersion.
- Deposition effects: vegetation removes a fraction of pollutants from the air through deposition on leaves and absorption through stomata.
- Emission source of biogenic volatile compounds and pollen.

Deposition effects on air quality are always positive; however, aerodynamic effects might be positive or negative depending on vegetation types and their location and arrangement regarding emission sources and pedestrians. For instance, whereas a vegetation barrier in an open road usually contributes to improving air quality behind the barrier [8,10–12], the effects of street trees depend on several factors such as urban morphology, trees layout, or meteorology and are not always positive [13–17]. Therefore, analyzing the impact of GIs on air quality remains a major challenge due to the complex atmospheric processes involved in urban environments.

On the other hand, cities produce air overheating inside UCL. Urban overheating is driven by reduced ventilation within the streets due to building configurations, together with the spectral response of urban surfaces (which absorb much of the solar radiation) and the thermal storage capacity of urban materials, these processes favor the increase of air temperatures affecting human thermal comfort. This urban overheating has a negative impact on health causing general discomfort, respiratory problems, dehydration and fatigue. Even, in certain meteorological situations, for example, the increasing mortality rate from heat stroke during heat wave episodes. These situations, which are also becoming more frequent due to climate change, often trigger energy consumption in cities due to the massive use of air conditioning systems. In this context, urban vegetation, either integrated into the environment as GI or on the buildings as green facades or green roofs, mitigate urban overheating improving thermal comfort and promote energy savings. Thermal comfort is related to air temperature, mean radiant temperature, wind speed and related humidity. However, how does vegetation affect air temperature and thermal comfort? The main effects are [18,19]:

- Shading and/or isolation effects: trees provide shade to urban surfaces (e.g.; building façade, roads, etc.) decreasing their surface temperature. In addition, green facades and green roofs might act as a protection element for buildings since, on the one hand, they reflect a large part of solar radiation and store little heat and, on the other, their substrates act as thermal insulation for buildings.
- Cooling effects: vegetation provides transpiration cooling because the absorbed solar energy causes an increase of latent heat (water from vegetation is evaporated into the atmosphere) and thus cooling the leaf surfaces and the air around them.

Various experiences show how urbanization exacerbates heat stress increasing daytime mean temperature and green spaces counterbalance this effect providing energy savings [20]. However, the effectiveness of nature-based solutions to reduce air temperature, improve thermal comfort and decrease energy consumption in urban environments depends on many factors and is still a challenge.

In addition to microclimate regulation and air quality services, GIs provide more environmental benefits such as noise reduction or rainwater drainage [18–20], and other benefits such as aesthetic, recreational, psychological or improving perceived mental health [21–23]. GI design should be addressed to obtain a trade-off solution between the different ecosystem services and disservices provided [17]. In general, theoretical studies at the microscale, considering all thermal effects and impacts of urban vegetation on air quality, are not very common in the literature and only a few of them include all vegetation performance [9]. A better understanding of the global effects of vegetation in cities is needed to design effective strategies that contribute to improving air quality, thermal comfort and energy efficiency in cities. In this context, original research articles related to the impact of urban vegetation on air quality, local climate and energy saving in urban environments are welcomed to the current Special Issue entitled "Influence of Vegetation and Forest on Urban Air Quality and Thermal Comfort—Series II". In a previous Special Issue of this journal [24], several novel studies were presented. Zheng et al. [25] evaluated, through microscale modeling, the effects of roof greening on the indoor thermal environment finding that increased roof greening coverage improved the indoor thermal perception. Zhang and Zhao [26] investigated the cooling effects of several species of trees. Regarding the air quality effects, Yin et al. [27] computed the effects of urban park green spaces in Beijing on PM2.5 retention at multiple scales. De la Paz et al. [28] studied air quality and meteorological changes induced by future vegetation in Madrid at the city scale. This study highlights the need to combine nature-based solutions with emission-reduction measures. Santiago et al. [17] simulated at the microscale the impact of a wide set of GI scenarios on traffic-related pollutant concentrations at the pedestrian level. It was found that using GI alone is ineffective as a general air quality mitigation measure, but selecting an appropriate layout of GI elements, GI can also help to reduce exposure to air pollution even in a scenario with high buildings. The contributions of the present Special Issue can address modeling studies at micro- and/or mesoscale (e.g.; computational fluid dynamics models, urban canopy models or mesoscale models), new parameterizations on the effects of urban vegetation and/or experimental works from field and laboratory experiments. Different configurations of trees in the streets, urban parks or vegetation barriers and green facades and roofs will be investigated in relation to their effects on pollutant concentration (aerodynamic effects, pollutant deposition, biogenic emissions, etc.) and/or on local climate and energy efficiency (cooling, shading, etc.). In addition, review papers focused on the current knowledge and future studies about this topic are also welcomed to the current Special Issue.

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