Pollen allergenicity from urban greenery. How to avoid hotspots in urban environments

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Urban green infrastructure supports climate regulation, improved air quality, and human well-being. However, many commonly planted urban tree species produce allergenic pollen, affecting a large fraction of the population and constituting a significant ecosystem service.

In Europe, pollen allergy prevalence reaches up to 40% and is expected to increase due to climate change-driven extensions of pollen seasons. This study assesses the spatial and seasonal distribution of allergenic potential across the city of Florence by integrating high-resolution tree mapping with allergenicity indices.

Tree species distribution was derived from object-based classification of WorldView-2 satellite imagery, combining vegetation masking, crown segmentation, and Random Forest classification. Allergenic potential was quantified using the Value of Potential Allergenicity (VPA), which integrates pollination strategy, flowering duration, and intrinsic allergenic capacity. At the green space scale, allergenic risk was evaluated using the Index of Urban Green Zone Allergenicity (IUGZA).

Results show that species with high to very high allergenic potential represent nearly 50 percent of Florence's urban forest. Very high VPA is dominated by *Cupressus*, while high VPA species are largely represented by *Quercus*, together with *Platanus*, *Olea*, *Ulmus*, and *Populus*. Low allergenicity species include *Celtis* and *Pinus*, whereas *Tilia* dominates the moderate class.

The spatial distribution of allergenicity reveals heterogeneous hotspots across the city, with strong seasonal variability linked to species-specific flowering periods. These findings highlight allergenicity as a key factor in urban green infrastructure planning. Integrating species selection, spatial mapping, and allergenicity indices can support the design of healthier urban environments while maintaining ecosystem services.