Exploring environmental benefits of street trees: A city-scale study in Birmingham

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1. Street trees & ecosystem services

Street trees are critical urban infrastructure that provide multiple ecosystem services. Among which regulating services (i.e., the environmental benefits) of street trees are widely discussed.

Air pollutant removal

Carbon sequestration

Cooling

Why street trees are important?

- Street trees are co-located with air pollutants, CO_2 and urban heat islands, and can mitigate these environmental challenges
- Trees have strong cultural relevance within cities, communities and society, and are important for the mental and physical well being of urban residents.
- Low demand of land and significant potential for planting.

Distribution of ecosystem services

The distribution of urban greenery is related to socioeconomic conditions (Figure 1). However, few studies discuss how the ecosystem services provided by green infrastructures are distributed in cities.

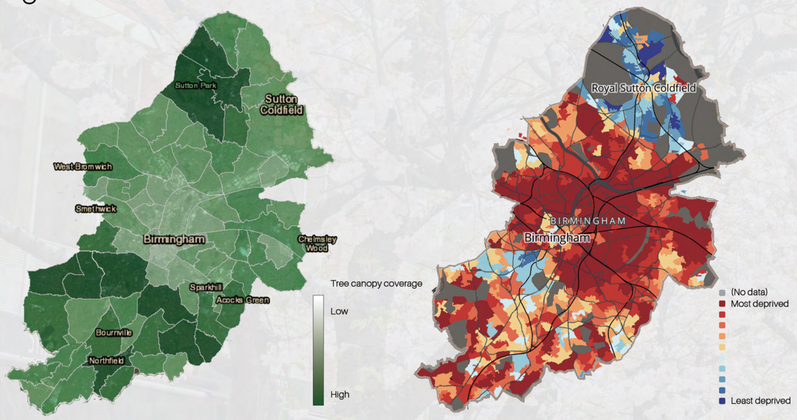

Figure 1: Comparing the distribution of tree canopy (left) [1] and deprivation (right) [2] in Birmingham. It shows a coincidence between less deprived and higher tree coverage areas.

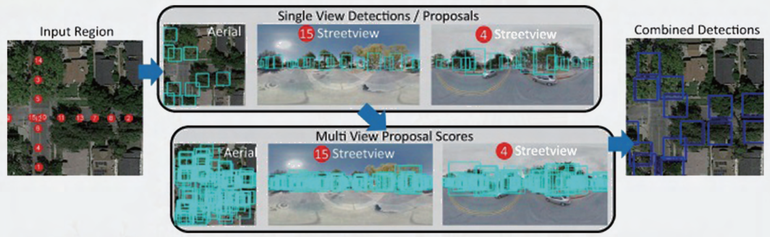

Figure 2: A case study of using deep learning (neural network) to identify and locate street trees [3].

2. Aim & objects

Aim: to quantify and map the three regulating services of Birmingham's street trees: air pollution removal, carbon sequestration and cooling, and to explore the inequalities in the spatial distribution of these services in the city.

There are three objectives to address the aim:

- Develop a new and automatic street tree auditing method based on street view images.
- Conduct city-scale research and mapping to quantify the spatial distribution of these ecosystem services.
- Explore the influencing factors of this spatial distribution, with a particular focus on the link between socioeconomic conditions and these services.

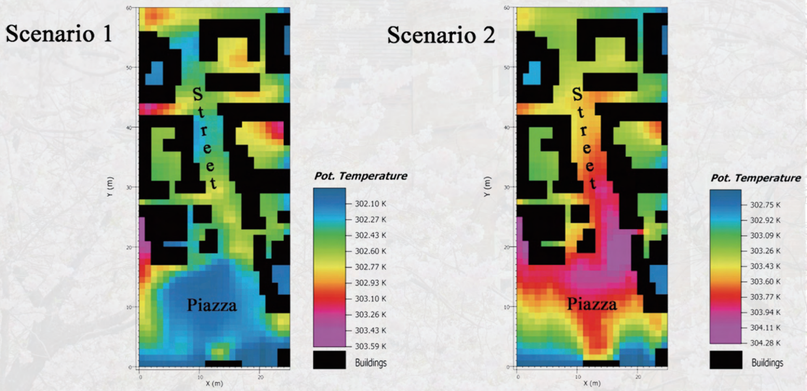

Figure 3: A case study of simulating cooling benefits of trees using ENVI-met, a commonly used 3D model. The cooling effect was estimated by comparing the situation with (left) and without (right) trees [4].

3. Methods

Street tree data collection:

Data on street trees can be collected from street view images: Using neural networks to identify tree location and canopy size (Figure 2). Other data, including diameter at breast height and species, will be collected manually.

Modelling:

Regulating services will be explored through two different routes:

- **Numerical model** will be used to quantify carbon sequestration and pollutant removal based on tree inventories.
- **3D micro-climate model** (Figure 3) can be used for exploring the cooling effect and effects of trees on the diffusion of air pollutants.

We plan to first determine the influencing factors of these services through multiple small-scale case studies in the city and then perform city-wide estimation and mapping based on these factors.

4. Expected results & Implications

We hypothesize that:

- The cooling, air pollutant removal and carbon sequestration benefits provided by street trees are unevenly distributed in Birmingham.
- Communities with low social-economic status may have relatively less of these benefits.
- The effect of street trees on pollutant diffusion can be affected by various factors. We will map and analyse this positive or negative impact of the street tree.

References

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[3] Branson, S., Wegner, J.D., Hall, D., Lang, N., Schindler, K. and Perona, P., 2018. From Google Maps to a fine-grained catalog of street trees. *ISPRS Journal of Photogrammetry and Remote Sensing*, 135, pp.13-30.

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