



Collaboration for
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Systematic Review No. 41

TITLE: How effective is 'greening' of urban areas in reducing human exposure to ground level ozone concentrations, UV exposure and the 'urban heat island effect'?

Summary

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Cover Sheet

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Summary

1. Background

Climate change is likely to have direct and indirect impacts on human health. Changes in temperature, ground-level ozone (O₃) and ultra-violet radiation (UV) are recognised public health issues, particularly in urban areas and their effects may be modulated by climate change. 'Urban greening' has been proposed as one possible intervention that may mitigate the human health consequences of these changes.

2. Objectives

This review evaluates the available evidence on whether urban greening interventions, such as tree planting or the creation of parks, affects temperature, ground-level O₃ and its precursors (volatile organic compounds, VOCs, or Nitrogen oxides, NO_x) or UV within the surrounding urban area.

3. Methods

Searches were performed using electronic databases, internet search engines and specialist websites and articles subjected to pre-defined inclusion criteria in a series of filters (title, abstract and full text) to identify the subset relevant for the review. The relevant articles were then grouped according to the type of green site under study (e.g. park or green area, tree, green roof, ground vegetation) and the basic methodology used to collect data. Further information on methodology, study characteristics and results were recorded from each study. Due to the diversity of studies, a narrative synthesis was conducted for most of the literature but a meta-analysis was performed on a subset of studies when appropriate.

4. Main results

In total, 212 relevant articles were found. Most studies address the effects of greening on temperature, with O₃ and UV being less studied.

The effects on temperature were assessed by three different methodologies: ground-level data collection, remote sensing data collection and modelling. The review focused on the 71 studies using ground-level data collection and these mostly suggest that a green site could be cooler than a non-green site. A meta-analysis conducted on park temperatures estimated that an urban park is on average around 1°C cooler than a built-up site in the day. A number of variables were identified that

could affect this relationship including factors of the green sites such as its area and vegetation type and other factors such as time of day or year. However, these studies were mostly site comparisons that sampled relatively small numbers of green sites. We did not find any studies that evaluated the effectiveness of an urban greening programme as part of a climate change adaptation strategy.

Studies on O₃ and greening addressed a number of different questions. Empirical studies investigated the ability of plants to release volatile organic compounds (VOCs) and suggested that some plants may contribute to O₃ production. Larger-scale empirical studies investigated the concentrations of ozone within urban green areas and demonstrated the complexity of interactions between O₃, its precursors and temperature.

Few UV studies were identified and they mostly investigated the ability of trees to provide protection by reducing human exposure.

The review did not identify any studies that investigated the direct effects of urban greening on human exposure to high temperatures, O₃ or UV, or any health-related consequences in the context of these variables. However, some articles were identified which predicted the human 'thermal comfort' of green and non-green environments, based on temperature and humidity measurements.

5. Conclusions

A considerable number of studies were identified that have aimed to assess how land cover including parks, green areas and trees affect temperature and to some extent O₃. These studies suggest that it may be possible to use greening interventions as an adaptation strategy to climate change, however, the evidence is based on observational studies rather than more rigorous experimental examination. Most studies have investigated temperature differences between green and non-green sites within an urban area but the impact of greening on nearby non-green areas is a subject requiring more research. Studies on O₃ indicate that any attempt to use greening to improve air quality would need to consider the biogenic emission of VOCs shown for some species, in order to estimate net air quality benefits. Few studies have been conducted on the effect of greening on UV.

There is insufficient evidence to guide the design of an urban greening programme. Further research is necessary to investigate the importance of the abundance and

distribution of vegetation on the effectiveness of urban greening, for instance, the optimal distribution of parks; the difference between planting single versus clumps of trees and the importance of factors that may modify the significance of greening to temperature such as regional climate. Any urban greening programme that is implemented would need to be monitored to continue to test the hypothesis that they can improve urban areas for human health through reducing temperature, UV and ozone concentrations.