Improving air quality

East London Green Grid (ELGG)

Objectives

This study aimed to estimate the potential for a green space initiative to reduce levels of particulate matter (PM_{10}) in an area of East London (Tiwary *et al.*, 2009). It is also aimed to demonstrate how this type of integrated modelling approach can be used as a tool to target green space creation to areas where air quality is of concern.

Introduction

A potential benefit of urban green space is the role of vegetation in mitigating the effects of pollution caused by particles with a diameter of less than 10 $x10^{-6}$ m (PM_{10}). Sources of these particles include road traffic, industry and power production. PM_{10} emissions have been increasing in some major urban areas along main roads, and a range of cost-effective abatement measures have been initiated to improve air quality in these localities

Tree establishment in urban areas has been proposed as one measure to reduce ambient PM_{10} concentrations; however there is a degree of uncertainty about the mechanism for removal of PM_{10} for different vegetation types and the level of reduction that can be achieved.

History

Trees can serve as effective sinks for airborne particulates at the canopy level, via dry, wet and mist/cloud deposition mechanisms. The structure of large trees and their rough surfaces enables particles to be intercepted by disrupting the flow of air, and providing a surface area for PM_{10} capture that can be up to 12 times the area of land that they cover. Differences between tree species play an important role in estimating PM_{10} capture, and deposition models such as Urban Forests Effects model (UFORE) are available to assess the potential for particulate matter interception.

Materials and Methods

Study area

The East London Green Grid (ELGG) initiative aims to improve East London's provision of open space and supply a range of recreational uses and landscapes, promoting healthy living 'for people and wildlife'. The Grid is the London delivery end of the 'Greening the Gateway' strategy. This proposed network of interlinked, multi-purpose and high quality open spaces will be created from new and existing green space. Drivers behind the ELGG development are multifaceted and, whilst PM_{10} reduction is not a primary driver, the improvement of local air quality is consistently seen as a potential benefit of the scheme.

The study used a 10 x 10 km region of the ELGG covering the London Boroughs of Newham and Greenwich. The ELGG within this area occupies 547 ha (5.5% of the total study area) and falls within a heavily urbanised region characterised by heavy traffic, industrial activity and London City Airport. Sources of PM_{10} from the whole of Greater London were modelled using ADMS-Urban to calculate hourly PM_{10} concentrations at 1.5 m height (human receptor level) for the 10,000 ha study area; a map of average PM_{10} concentrations was then produced. This process used emissions data from the London Atmospheric Emissions Inventory and meteorological data from 2004.

Method

A canopy PM_{10} uptake model based on UFORE was then used to estimate the PM_{10} interception by the proposed ELGG within the study area. As the ELGG does not yet have specific information available on the composition of the green spaces in terms of species choice, percentage tree cover or planting design, a range of possible planting options for these green spaces were modelled. This work was completed by Forest Research. The 'most realistic scenario' of PM_{10} interception by the ELGG within the study area was then used to reproduce the PM_{10} concentration map for the area and the impact of the ELGG on PM_{10} deposition was compared with a situation of no green space establishment.

Five scenarios were used to estimate PM_{10} interception by ELGG, based on the premise that trees have a greater capacity for PM_{10} than grassland and conifers have a greater capacity than broadleaves. The five scenarios were:

1. 100% grassland
2. 50% grassland, 50% broadleaved trees: sycamore (*A. pseudoplatanus)*
3. 100% sycamore
4. 75% grassland, 20% sycamore, 5% conifers: Douglas fir (*P. menziesii);* the 'most realistic scenario'
5. 100% Douglas fir

Results

- Due to its greater deposition velocity (V_g) and leaf area index (LAI) values, Douglas fir has a significantly greater capacity to intercept particulates from the atmosphere than Sycamore.
- Sycamore appears only slightly more effective than grass (12.45 t yr^{-1} particles removed compared to 3.75 t yr^{-1} at the Lower Lea Valley, as opposed to 258.75 t yr^{-1} using Douglas fir). This represents a greater than three-fold increase when trees are included in urban green space design; equating to a removal rate of 0.12 t ha^{-1} yr^{-1}.
- The PM_{10} reductions for the whole ELGG within the study area are 17.99 t yr^{-1} (0.03 t ha^{-1} yr^{-1}) under 100% grassland, 60.49 t yr^{-1} (0.11 t ha^{-1} yr^{-1}) under 100% Sycamore , 1277.13 t yr^{-1} (2.33 t ha^{-1} yr^{-1}) under 100% Douglas fir.
- When the more realistic planting scenario of 75% grassland, 20% Sycamore and 5% Douglas fir is used the PM_{10} removal is 90.41 t yr^{-1} (0.17 t ha yr^{-1}) or 0.009 t ha^{-1} yr^{-1} over the whole 10,000 ha study area.

Conclusions

- This study suggests that greening initiatives such as those proposed by the ELGG can have a positive affect on PM_{10} concentrations. The realisation of such benefits depends heavily on which species are selected for planting, the percentage area of tree cover and planting design. Green space creation offers a cost-effective option for air quality improvement.
- Such improvements are unlikely to be the sole driver for the implementation of a greening initiative and the contribution they can bring needs to be considered alongside other benefits including climate amelioration, flood prevention, sustainable urban drainage, habitat creation and improved quality of urban life.
- The planning of urban green space needs to fully recognise its multifunctional nature and similarly, when designing green space, consideration must be given to the groups who will use the spaces to ensure that their needs are met.

Reference

Tiwary, A., Sinnett, D., Peachey, C.J., Chalabi, Z., Vardoulakis, S., Fletcher, T., Leonardi, G., Grundy, C., Azapagic, A. and Hutchings, T.R. (2009). An integrated tool to assess the role of new planting in PM_{10} capture and the human health benefits: a case study in London. *Environmental Pollution* **157**: 2645-2653.