Improving air quality

The Chicago Urban Forest Climate Project

Introduction

Air pollution is a multi-billion dollar problem that affects most cities in the United States. Major pollutants in urban areas include carbon monoxide (CO), nitrogen oxides (NO_2), ozone (O_3), sulphur dioxide (SO_2) and particulates. Trees cover 11% of the land area in Chicago and are estimated to remove 15 metric tonnes (t) of carbon monoxide, 84 t of sulphur dioxide, 89 t of nitrogen dioxide, 191 t of ozone and 212 t of particulate matter of less than 10 microns in diameter (PM_{10}) per year. Air pollution is removed by three mechanisms: wet deposition, chemical reactions and dry deposition.

Background

Urban trees can influence air quality in a variety of ways. Trees can reduce the energy used by buildings by decreasing conductive heat loss and by shading buildings, and this reduction in energy use in turn helps to reduce pollution emissions from power stations. Trees can also lower air temperatures through transpiration, and lower air temperatures reduce the formation of ozone in urban areas. Air quality can be directly altered by trees through the absorption of gaseous pollutants and interception of particles at leaf surfaces, and the production of oxygen through photosynthesis

Objective

The objective of this study was to estimate air pollution removal through dry deposition of CO, NO_2, O_3, SO_2, and PM_{10} by trees in the Chicago region during 1991.

Study area

The study area across Chicago, Cook and Du Page counties was divided into 117 community areas for detailed analyses of tree canopy cover, pollution concentrations and total pollutant flux. The average hourly concentrations for each pollutant and hourly pollutant flux to trees were determined in each of the 117 community areas and these were combined to yield estimates of pollutant removal for the entire study area.

To analyse the potential effects of future tree planting in the study area, the available growing space (grass and soil area) was analysed by land-use type throughout the study area. The future scenario estimated various percentages of additional tree cover on the different land use areas. The scenario assumed that none of the agricultural land would be planted with trees, but that 5% of commercial-industrial land, 10% of institutional land, 15% of residential land, 20% of landscaped commercial land and

25% of roads and free-land would be planted with trees. Removal of pollutants by the additional trees was calculated based on average removal per acre (0.4 ha) of existing tree cover multiplied by the number of new acres of tree cover that result from new planting.

Results

In 1991 total estimated pollutant removal by trees in the study area was 5575 t, with the highest removal of PM_{10} and O_3. Monthly removal rates for each pollutant varied, but these rates were similar in all counties and removal occurred mostly in the in-leaf season. Large individual trees have the greatest estimated pollution removal due to their relatively large leaf surface area.

The proposed tree planting scenario that would fill available grass and soil space on various land uses from 0 to 25% with trees would increase overall tree cover in the study area by 4.1% (from 19.4 to 23.5% tree cover). It is likely that this additional cover would have removed an additional 1180 t of pollution (45 t CO; 150 t SO_2; 170 t NO_2; 390 t PM_{10}; 425 t O_3) and reduced air pollution concentrations by another 0.05%.

Conclusion

Urban trees can improve air quality, and an increase in air quality of 5-10% can be obtained by increasing and sustaining healthy tree cover.

Future plans

Research is needed to investigate the interactive relationships of pollution removal, trace-gas emissions, air temperature and the effects of trees on building energy use on overall air quality.

Reference

Nowak,D.J. (1994). Air pollution removal by Chicago's urban forest.In:*Chicago's urban forest system:results of the Chicago Urban Forest Climate Project*, eds E.G.McPherson,D.J.Nowak and R.A. Rowntree. General Technical Report NE-186. USDA Forest Service Northeastern Forest Experiment Station, Radnor, Pennsylvania, 83-94.