



Tree Conservation Notes

Athens-Clarke County Community Tree Program

Trees and Air Quality

Research completed by David J. Nowak and others at the USDA Forest Service in Syracuse, New York, has shown that trees and other urban vegetation directly and indirectly affect air quality and alter the urban atmospheric environment. Following are some results of their research.

Temperature Reduction

- Tree transpiration and tree canopies affect air temperature, radiation absorption and heat storage, wind speed, relative humidity, turbulence, surface albedo, surface roughness and the evolution of the mixing layer height.
- Maximum mid-day air temperature reductions due to trees are in the range of 0.07°F to 0.4°F per percent canopy cover increase.
- Beneath individual and small groups of trees over grass, mid-day air temperatures at approximately 5 feet above ground are 1.3°F to 2.3°F cooler than in an open area.
- Reduced air temperatures due to trees improve air quality because the emission of many pollutants and/or ozone-forming chemicals is temperature dependent and decreased air temperature can reduce ozone formation.
- Trees usually contribute to cooler summer air temperatures, however their presence can increase air temperatures in some instances with scattered tree canopies and reduction of atmospheric mixing due to the tree canopy.

Removal of Air Pollutants

- Trees remove gaseous air pollution by uptake via leaf stomata, by the plant surface, or by intercepting airborne particles.
- Particles may be resuspended to the atmosphere, washed off by rain, or dropped to the ground with leaf and twig fall; vegetation is only a temporary retention site for many atmospheric particles.
- Pollution removal rates vary according to the amount of air pollution, length of in-leaf season, precipitation, and other meteorological variables.
- Pollution removal rates measured in Atlanta equal .033 ounces per square foot of tree canopy cover per year.
- Large healthy trees greater than 30 inches in diameter remove approximately 70 times more air pollution annually (3.1 lb/yr) than small healthy trees less than 3 inches in diameter (0.04 lb/yr).

- Air quality improves with increased percent tree cover and decreased mixing-layer heights.
- In urban areas with 100% tree cover (contiguous forest stands) the short-term improvements in air quality (one hour) from pollution removal by trees can be as much as 15% for ozone, 14% for sulfur dioxide, 13% for particulate matter, 8% for nitrogen dioxide, and 0.05% for carbon monoxide.

Emission of Volatile Organic Compounds

- Emissions of volatile organic compounds (isoprenes, monoterpenes, thousands of others) by trees can contribute to the formation of ozone and carbon monoxide.
- VOC emission rates vary by species; trees such as sweetgum, oak, blackgum, sycamore, black locust, and willow are high VOC (isoprene) emitters.
- In atmospheres with low nitrogen oxide concentrations (e.g., some rural environments), VOCs may actually remove ozone.
- Because VOC emissions are temperature dependent and trees generally lower air temperatures, increased tree cover lowers the overall VOC emissions and, consequently, ozone levels in urban areas.
- The use and combustion of fossil fuels to power tree maintenance equipment leads to an increase in carbon dioxide emissions and other chemicals such as VOCs, carbon monoxide, nitrogen and sulfur oxides, and particulate matter.
- Trees in parking lots can affect evaporative emissions of VOCs from vehicles, particularly through tree shade.

Energy Effects on Buildings

- Trees reduce building energy use by lowering temperatures and shading buildings during the summer and blocking winds in winter.
- Trees can increase energy use in winter by shading buildings and may increase or decrease energy use in summer by blocking breezes.
- Proper tree placement near buildings is critical to achieve maximum building energy conservation benefits.
- Lower energy use results in lower pollutant emissions from power plants.

Management Strategies

The researchers recommend the following urban forest management strategies to improve air quality:

1. Increase the number of healthy trees (increases pollution removal).
2. Sustain existing tree cover (maintains pollution removal levels).
3. Maximize the use of low VOC emitting trees (reduces ozone and carbon monoxide formation).
4. Sustain large, healthy trees (large trees have the greatest per tree effects).
5. Use long-lived trees (reduces long-term pollutant emissions from planting and removal).
6. Use low maintenance trees (reduces pollutant emissions from maintenance activities).

7. Reduce fossil fuel use in maintaining vegetation (reduces pollutant emissions).
8. Plant trees in energy conserving locations (reduces pollutant emissions from power plants).
9. Plant trees to shade parked cars (reduces vehicular VOC emissions).
10. Supply ample water to vegetation (enhances pollution removal and temperature reduction).
11. Plant trees in polluted areas or heavily populated areas (maximizes tree air quality benefits).
12. Avoid pollutant sensitive species (increases tree health).
13. Utilize evergreen trees for particulate matter reduction (year-round removal of particles).