Acute Respiratory Symptoms Avoided Due to Ozone Removed

This EnviroAtlas community map estimates the number of acute respiratory symptoms cases in each census block group avoided per year due to ozone removed by trees. This dataset identifies one of the adverse health effects that can be reduced by trees in a community. These data are estimated using the U.S. EPA's Environmental Benefits Mapping and Analysis Program (BenMAP).

Why is avoiding acute respiratory symptoms important?

Acute respiratory symptoms include upper respiratory symptoms such as nasal congestion, wet cough, and eye irritation, as well as lower respiratory symptoms such as cough, chest pain, phlegm, and wheezing. An estimated 40% of the U.S. population experiences upper respiratory symptoms each year; the occurrence of lower respiratory symptoms is estimated to be the same.[1] Acute respiratory symptoms may be, but are not necessarily, asthma related.

Ground-level ozone, a highly reactive gas, is formed primarily by reactions involving two types of air pollutants: volatile organic compounds and nitrogen oxides.[2] When inhaled, ground-level ozone can induce upper and lower acute respiratory symptoms, reduce lung function, and cause airway inflammation.[3] Young adults, people with high body mass index (BMI), and asthmatics may be especially susceptible to the effects of ozone inhalation. Short-term ozone exposure and its resulting health effects have also been associated with hospital visits and school absences.

Trees help reduce the potential adverse health effects of ozone by removing it from the air. Gaseous air pollutants are taken in primarily through the leaf stomata (pores), though some gases are removed by the plant surface. Once inside the leaf, gases diffuse into intercellular spaces and may be absorbed by water films to form acids or react with inner-leaf surfaces.[4] The removal of gaseous pollutants is more permanent than the removal of particles because the gases are often absorbed and converted within the leaf interior. Healthy trees can remove significant amounts of air pollution in cities, where it is often concentrated.

How can I use this information?

The map, Acute Respiratory Symptoms Avoided Due to Ozone Removed by Tree Cover (cases/year), is one of four EnviroAtlas maps that illustrate negative health outcomes avoided from annual pollutant removal by tree cover.


Photo: Eric Vance, U.S. EPA

Used in conjunction with near-road and overall tree cover data available in EnviroAtlas, this map can highlight which areas are likely receiving the benefits of tree cover and which may lack natural buffers for common air pollutants. EnviroAtlas provides demographic data that may be overlaid to visualize the distribution of sensitive populations relative to the health benefits of tree cover. This map can also be used with urban planning and local health data to aid in current and future decision-making processes, such as land development, public health program implementation, or policy changes, which could involve changes in tree cover.

How were the data for this map created?

This data layer was derived from a high resolution community land cover map. For each U.S. Census block group, the total amount of tree cover (m^2) was determined. The i-Tree pollution removal program was then run for each block group, assuming a leaf area index value of 4.9 and utilizing the closest hourly meteorological and pollution data. Percent of county tree cover that is evergreen was derived from the most current National Land Cover Dataset 30-m resolution land cover maps. Local leaf on and leaf off dates were used to vary canopy cover daily based on the amount of tree cover classified as evergreen. Hourly estimates of pollution removal by trees were combined with atmospheric data to estimate annual percent air quality improvement due to pollution removal for several pollutants.[5]

Selected adverse health effects avoided due to tree cover were calculated using BenMAP. The BenMAP model

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estimates health impacts and related costs or savings based on the local population and change in pollutant concentration. For EnviroAtlas, county-level multipliers of health impact per person per change in O_3 were calculated, then applied to the block group. The final values incorporated the block-group changes in pollutant concentrations from i-Tree, and U.S. Census Bureau age distribution data reallocated from census tracts. For more information on these methods, see the layer's metadata or the publications below.

What are the limitations of these data?

Pollutant removal estimates are related to the use of leaf area index values that have been averaged from multiple study areas; specific values are unavailable for most communities. The relatively few existing weather stations and pollutant monitors are used to represent conditions across many block groups. Similarly, nearest atmospheric boundary layer height measurements and an assumption of a well-mixed boundary layer are used, but these may not reflect the local boundary layer. An additional limitation is the assumption that the age distribution for a census tract is mirrored in its block groups.

For more technical details about the limitations of these data, refer to the layer's metadata. EnviroAtlas data are estimates founded on the best available science. These estimates reflect research on the relationships between tree canopy and ozone and ozone and acute respiratory symptoms. They do not consider potential acute respiratory symptoms due to pollen or other respiratory irritants generated by the trees themselves. Such effects vary widely with tree species and are not yet fully understood. It is advisable to consult with an arborist or urban forester on local tree planting decisions.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. The EnviroAtlas 1-meter land cover grids created for each community are available under the Supplemental Maps tab in the Interactive Map.

Where can I get more information?

To learn more about i-Tree tools and the BenMAP program and how they can be used to support research, planning, and policy efforts, visit their respective websites. There are numerous resources on the relationships among trees, ecosystem services, and human health and well-being; a selection of these resources is below. In-depth information on the relationships between trees and human health and wellbeing can be found in EPA's Eco-Health Relationship Browser. For additional information on the data creation process, access the corresponding metadata found in the drop-down menu for each community map layer listed in the EnviroAtlas table of contents and click again on metadata at the bottom of the metadata summary page for more details. To ask specific questions about these data, please contact the EnviroAtlas Team.

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Selected Publications

1. US EPA. 2015. Environmental Benefits Mapping and Analysis Program – Community Edition: User's Manual Appendices. Accessed August 2015.

2. US EPA. 2017. Basic information about ozone. Accessed January 2018.

3. US EPA. 2017. Health effects of ozone pollution. Accessed January 2018.

4. Smith, W.H. 1990. *Air pollution and forests*. Springer- Verlag, New York, 618 p.

5. Nowak, D.J., R.E. Hoehn, D.E. Crane, J.C. Stevens, J.T. Walton, and J. Bond. 2008. A ground-based method of assessing urban forest structure and ecosystem services. *Arboriculture and Urban Forestry* 34(6):347–358.

6. Nowak, D.J., D.E. Crane, and J.C. Stevens. 2006. Air pollution removal by urban trees and shrubs in the United States. *Urban Forestry and Urban Greening* 4:115–123.

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