# Acute Respiratory Symptoms Avoided Due to Particulate Matter ($PM_{2.5}$) Removed by Tree Cover

This EnviroAtlas community map estimates the number of acute respiratory symptoms cases in each census block group avoided per year due to particulate matter ($PM_{2.5}$) 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.

Fine particles, or $PM_{2.5}$, are solid particles of mixed composition with a maximum diameter of 2.5 micrometers.[2] $PM_{2.5}$ can be emitted into the air from a variety of sources such as fires, construction sites, power plants, industries, and automobiles.[2] Because $PM_{2.5}$ is so small, it can penetrate deep into the lungs when inhaled. Short-term exposure to particulate matter can irritate the lungs and induce acute respiratory symptoms, while long-term exposure is associated with decreased lung function and even premature death for those with pre-existing heart or lung disease.[3] Older adults, children, asthmatics, and people with heart or lung diseases may be especially susceptible to the effects of $PM_{2.5}$ inhalation.

Trees can remove particle pollution by intercepting these airborne particles. Some particles can be absorbed into the tree's tissues, though most particles that are intercepted are retained on the plant surface. Many of the particles that are intercepted are eventually re-suspended back to the atmosphere, washed off by rain, or dropped to the ground with leaf and twig fall.[4] Thus, vegetation is only a temporary retention site for many atmospheric particles, though the removal of gaseous pollutants is more permanent. Healthy trees can remove significant amounts of air pollution in cities, where it is often concentrated.


Photo: Eric Vance, U.S. EPA

## How can I use this information?

The map, Acute Respiratory Symptoms Avoided Due to Particulate Matter ($PM_{2.5}$) Removed by Tree Cover (cases/year), is one of four EnviroAtlas maps that illustrate annual negative health outcomes avoided attributable to pollutant removal by tree cover.

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?

The data for this map are based on the land cover derived for each EnviroAtlas community and the pollution removal models in i-Tree, a toolkit developed by the USDA Forest Service. The land cover data were created from aerial photography through remote sensing methods; tree cover was then summarized as the percentage of each census block group. The i-Tree pollution removal module uses the tree cover data by block group, the closest hourly meteorological monitoring data for the community, and modeled pollution concentration data. For $PM_{2.5}$ pollution data, the EPA's

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Fused Air Quality Surfaces for census tracts was used. If a block group's tract was missing, the nearest tract was used. As $PM_{2.5}$ data are daily estimates, the value was assumed to remain the same across the day. Additionally, the most current National Land Cover Dataset was used to determine the percent of these trees that are deciduous or evergreen. Local leaf-on and leaf-off dates were used to vary canopy cover daily based on the amount of tree cover classified as deciduous. $PM_{2.5}$ removal estimates include resuspension and deposition rates that vary with wind speed.[5]

Selected adverse health effects avoided due to tree cover were calculated using BenMAP. The BenMAP model 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 $PM_{2.5}$ were calculated and 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 listed 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. The daily $PM_{2.5}$ concentration data are used with the assumption that concentration is constant throughout the day. 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 $PM_{2.5}$ and $PM_{2.5}$ 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. To find the EnviroAtlas 1-meter land cover grids created for each community, enter *land cover community* in the interactive map search box.

## 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 listed 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.

## Acknowledgments

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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. 2016. Health and Environmental Effects of Particulate Matter (PM). Accessed January 2018.

3. US EPA. 2017. Particulate Matter (PM) Pollution. Accessed January 2018.

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

5. 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.

Nowak, D.J., S. Hirabayashi, A. Bodine, and E. Greenfield. 2014. Tree and forest effects on air quality and human health in the United States. *Environmental Pollution* 193:119–129.