Percent Particulate Matter (PM10) Removed Annually by Tree Cover

This EnviroAtlas community map estimates the mean percent of particulate matter 2.5–10 microns in size removed annually by tree cover in each census block group.

Why is PM10 removal important?

Particles that are larger than 2.5 microns and smaller than 10 microns in diameter (2.5< PM<10) are known as "inhalable coarse particles" that are regulated by EPA under the National Ambient Air Quality Standards (NAAQS). Particulate matter (PM) is a mixture of extremely small particles (e.g., dust) and liquid droplets (e.g., acids). The size of a particle is directly linked to its potential for causing health problems. EPA is concerned about particles that are 10 microns in diameter and smaller because of their ability to be easily inhaled and cause damage to the heart and lungs.[1] In addition to creating negative human health effects, particulate matter can also reduce visibility and affect water quality. Trees are capable of removing particulate matter from the atmosphere, thus contributing to environmental quality and public health.

Particles in the atmosphere can affect human health and quality of life. Human health problems from air pollution include aggravation of respiratory and cardiovascular disease, decreased lung function, increased frequency and severity of respiratory symptoms (e.g., difficulty breathing and coughing), increased susceptibility to respiratory infections, effects on the nervous system (e.g., impacts on learning, memory, and behavior), cancer, and premature death.[2] People with pre-existing conditions such as heart disease, asthma and emphysema, as well as older adults and children, are at greater risk for air pollution-related health effects. Despite improvements in overall air quality, approximately 127 million people live in areas that exceeded air quality standards in 2008.[2]

Particulate matter has environmental impacts in addition to potential health effects. Air pollution affects the climate by either absorbing or reflecting energy that can lead to climate warming or cooling, respectively. Most particles are reflective and lead to net cooling, while some (especially black carbon) absorb energy and lead to warming.[2] Atmospheric particles also reduce visibility in outdoor environments by creating hazy conditions.

Trees can remove particulates by directly intercepting airborne particles. Some particles can be absorbed into the

tissues of the tree, though most particles that are intercepted are retained on the plant surface. Many of the intercepted particles are eventually re-suspended back to the atmosphere, washed off by rain, or dropped to the ground with leaf and twig fall.[3] Thus, vegetation is only a temporary retention site for many atmospheric particles, while the removal of gaseous pollutants is more permanent. Healthy trees can remove significant amounts of air pollution in cities, where it is often concentrated.

How can I use this information?

The map, Percent Particulate Matter (PM_{10}) Removed Annually by Tree Cover, estimates and illustrates the variation in the amount of inhalable coarse particles removed by trees. These data could be used to explore patterns of PM_{10} removal by trees in communities that do not meet the standards set by the EPA's NAAQS. For compliant areas, the map can identify neighborhoods that potentially have higher PM_{10} concentrations compared to other neighborhoods. When used with EnviroAtlas data and maps that look at near-road environments, users can explore areas where high percentages of the block group population are in close proximity to roadways that have notably low volumes of PM_{10} removed by trees. When overlaid with demographic data such as the percent of elderly individuals, this map could be used to identify areas where particulate reduction would most benefit highly vulnerable populations. Communities and researchers that have access to health data may be able to use this map and its underlying data to continue to research the relationships among trees, PM_{10}, and human health.

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How were the data for this map created?

The data for this map are based on land cover derived for each EnviroAtlas community and 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 summarized as the percentage in 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 the closest pollution monitoring data. Additionally, the 2001 National Land Cover Dataset (NLCD) was used to determine the percentage of trees that were 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. Assuming a leaf area index value of 4.9, hourly estimates of pollution removal by trees were combined with atmospheric data to estimate hourly percent air quality improvement due to pollution removal for each pollutant.[3]

As PM_{10} covers particles less than 10 microns, the estimate for PM_{10} would include the particle range covered by $PM_{2.5}$. To avoid double counting of $PM_{2.5}$ within the PM_{10} estimate, $PM_{2.5}$ values were removed from the PM_{10} estimates such that the PM_{10} removal estimate is for particulate matter larger than 2.5 microns and smaller than 10 microns.[4]

What are the limitations of these data?

All of the EnviroAtlas community maps that are based on land cover use remotely-sensed data. Remotely-sensed data in EnviroAtlas have been derived from imagery and have not been verified. These data are estimates and are inherently imperfect. This map also uses estimation methods for pollution removal. To accomplish this, average leaf area index values from urban areas were used. These averages may not accurately reflect local conditions, but since local values are not available, these are the best usable estimates. This limitation is not particularly significant because leaf area index values do not vary substantially and have a relatively small impact on the estimate. Additionally, this map uses weather and pollutant monitoring data to represent local conditions, though a city's average weather and pollutant conditions do not depict potential variability of conditions within the community. The daily $PM_{2.5}$ concentration data are used to represent hourly values with the assumption that there is a constant concentration throughout a day.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. The EnviroAtlas land cover maps created for each community are available under the Supplemental Maps tab in the interactive map table of contents.

Where can I get more information?

There are numerous resources where additional information on particulate matter as an air pollutant can be found; a selection of these resources is listed below. For information on EPA air pollution rules, regulations, and monitoring programs, please visit the Agency's website. To learn more about i-Tree tools and how they can be used to support research, planning, and policy efforts, visit the i-Tree website. For more information on how air pollution and its removal may affect human health, visit the Clean Air section of the Eco-Health Relationship Browser. For additional information on the data creation process, access the metadata for the data layer from the drop down menu on the interactive map 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

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