Nitrogen Dioxide Removed Annually by Tree Cover

This EnviroAtlas community map estimates the total kilograms of nitrogen dioxide removed annually by trees in each census block group.

Why is nitrogen dioxide removal important?

Nitrogen dioxide (NO_2) is the indicator component for the larger group of gases known as nitrogen oxides (NOx). NO_2 forms very quickly in the atmosphere, largely from mobile sources, power plants, and off-road equipment.[1] NO_2 is a common air pollutant, and it is one of the six criteria pollutants regulated by EPA under the National Ambient Air Quality Standards (NAAQS). NO_2 affects air and water quality, contributes to the formation of important greenhouse gases, and negatively affects respiratory health. Trees are capable of removing NO_2 from the atmosphere, thus contributing to air and water quality, climate stabilization, and public health.

Nitrogen dioxide, along with other air pollutants, can have significant effects on human health, including: aggravation of respiratory and cardiovascular diseases, decreased lung function, increased frequency and severity of respiratory symptoms (e.g., difficulty breathing and coughing), and increased susceptibility to respiratory infections.[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 air quality, approximately 127 million people live in areas that exceeded the NAAQS in 2008.[2] Additionally, the number of people with asthma is growing, with about 1 in 12 people (25 million, 8% of U.S. population) having asthma in 2009, compared with 1 in 14 (about 20 million, or 7%) in 2001. [3]

In addition to its potential health effects, NO_2 also has environmental impacts. Nitrogen oxides contribute to the acidification and nutrient enrichment of surface water.[2] Deposition of nitrogen can lead to fertilization, eutrophication, or acidification of terrestrial, wetland, and aquatic (e.g., fresh water bodies, estuaries, and coastal water) systems, potentially affecting water quality.[1] Thus, cleaner air means fewer pollutants that can redeposit onto land and water bodies, degrading water quality.

Air pollution affects the Earth's climate by either absorbing or reflecting energy that can lead to climate warming or cooling, respectively.NO_2 contributes to the formation of

ground level ozone, methane, and particles, which have associated environmental and climatic effects.[2] Ozone and methane (CH_4) are two potent greenhouse gases (GHGs) that warm the atmosphere. Thus, the removal of NO_2 may contribute to a more stable climate by helping to reduce the amount of GHGs in the atmosphere.

Trees help reduce the potential adverse health and environmental effects of NO_2 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 particulates 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, Nitrogen Dioxide Removed Annually by Tree Cover, estimates and illustrates the variation in the amount of air pollution removed by trees. These data could be used to explore the patterns of NO_2 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 NO_2 concentrations compared to other neighborhoods. When used with EnviroAtlas data and maps that look at near-road environments, users can explore areas where high

CONTINUED ON BACK

percentages of the block group population are in close proximity to roadways that have notably low volumes of NO_2 removed by trees. Additionally, 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, nitrogen dioxide, and human health.

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 by which tree cover was 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 the closest pollution monitoring data. Additionally, the 2001 National Land Cover Dataset (NLCD) was used to determine the percent 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.[5]

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.

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 nitrogen dioxide 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

EnviroAtlas is a collaborative effort by EPA, its contractors, and project partners. The data for this metric were generated by Satoshi Hirabayashi and Allison Bodine, Davey Tree Expert Co. and David J. Nowak, USDA Forest Service. The fact sheet was created by David J. Nowak, USDA Forest Service, Jessica Daniel, EPA Student Services Contractor, and Laura Jackson, EPA.

Selected Publications

1. United States Environmental Protection Agency (EPA). 2003. National air quality and emissions trends report—2003 special studies edition. Research Triangle Park, NC. Accessed February 2013.

2. United States Environmental Protection Agency (EPA). 2010. Our nation's air: Status and trends through 2008. Accessed February 2013.

3. Centers for Disease Control and Prevention (CDC). 2012. Asthma in the U.S: Growing every year. Accessed February 2013.

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.