Value of Health, Ecosystem, and Materials Damage Avoided due to Carbon Monoxide Removed by Tree Cover

This EnviroAtlas community map estimates the value in dollars associated with annual damage to health, ecosystems, and materials that may be avoided by carbon monoxide (CO) removal by trees in each census block group.

Why is avoiding CO damage to health, ecosystems, and materials important?

Carbon monoxide is a colorless, odorless gas that is emitted from combustion processes. CO is a common air pollutant, one of the six criteria pollutants regulated by EPA under the National Ambient Air Quality Standards (NAAQS). Ambient CO concentrations are often higher in urban areas, because most CO emissions come from mobile sources.[1] EPA estimates that exhaust from motor vehicles contributes roughly 60 percent of all nationwide carbon monoxide emissions, and up to 95 percent in urban areas.[2]

CO can harm people by reducing oxygen delivery to the body's tissues and organs, such as the heart and brain. Carbon monoxide poisoning, which is often associated with malfunctioning heating and cooling systems and indoor air quality, can be severely debilitating or even fatal. The health effects of outdoor exposure to carbon monoxide are usually less severe, but they can still be of significant concern for certain individuals with health problems. For example, people with heart disease are at particular risk for problems resulting from CO exposure because it is already difficult for them to pump oxygenated blood to the heart.[3]

In addition to its potential health effects, atmospheric pollution can have negative impacts on vegetation by direct toxic effects or indirectly through changes in soil pH. Increased exposure to CO can reduce photosynthesis and carbohydrate and sucrose content from the production of reactive oxygen species by affected plants.[4] Air pollutants can also damage manmade materials by degrading organic coatings and polymers (e.g. plastics, rubbers, foams, paints and sealants).[5]

Trees help reduce the potential adverse health and environmental effects of CO by removing significant quantities of it from the air. Gaseous air pollutants are taken in primarily through openings in the leaf (stomata), though some gases are removed directly at the surface of leaves and stems. 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.[6] The removal of gaseous pollutants is more permanent than the removal of air 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, Value of Health, Ecosystem, and Materials Damage Avoided Due to Carbon Monoxide Removed by Tree Cover ($/yr), is one of six EnviroAtlas maps that illustrate the economic benefits of air pollutants removed via 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 to common air pollutants. EnviroAtlas provides census 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 one-meter resolution land cover data 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

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aerial photography through remote sensing methods; tree cover was then summarized as the percentage of tree cover within each census block group. The i-Tree pollution removal module used the tree cover data, the closest hourly meteorological monitoring data for the community, and the closest pollution monitoring data to each block group. 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 evergreen. Assuming a leaf area index value of 4.9, annual estimates of CO removal (kg/year) by trees were calculated using hourly pollution concentration data combined with atmospheric data to estimate annual percent air quality improvement due to removal of CO by trees. Based on this value, annual value of CO removal was estimated using national median externality values ($/year).[7]

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 unverified imagery. These data are estimates that are inherently imperfect. This map also uses estimation methods for CO removal and its economic value. 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 averages were the best usable estimates. This limitation is not particularly significant because index values do not vary substantially, and they have a relatively small impact on the estimate. Additionally, this map uses weather and pollutant monitoring data from just one or a few stations to represent block-group conditions; 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. 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?

There are numerous resources concerning carbon monoxide as an air pollutant; a selection of references is provided 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 found in the layer list drop-down menu for map layers in the EnviroAtlas interactive map. To ask specific questions about these data, please contact the EnviroAtlas Team.

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Selected Publications

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2. United States Environmental Protection Agency (EPA). 2016. Learn about air. Accessed October 2020.

3. United States Environmental Protection Agency (EPA). 2016. Carbon monoxide (CO) pollution in outdoor air. Accessed October 2020.

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6. Smith, W.H. 2012. *Air pollution and forests: Interactions between air contaminants and forest ecosystems*. Springer-Verlag, New York. 379 p.

7. 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.