EnviroAtlas
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Fact Sheet
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Reduction in Mean Chemical Oxygen Demand [COD] Due to Tree Cover

This EnviroAtlas community map estimates the annual change (kg/yr) in mean concentration of chemical oxygen demand (COD) measured in urban stormwater runoff due to filtration by trees within each census block group. The estimates were produced using the i-Tree Hydro analysis tool developed by the USDA Forest Service.

Why is chemical oxygen demand reduction important?

Chemical oxygen demand (COD) is an indicator of the total amount of dissolved oxygen required to oxidize all organic matter in a sample of stormwater into carbon dioxide and water. COD differs from biochemical oxygen demand (BOD, see data fact sheet) in that it represents the consumption of all organic matter, not just the portion that is oxidized by bacteria.[1] The COD test takes just a few hours rather than the 5 days required for BOD testing, making it a useful routine water quality test.[1]

Common reasons for higher COD in urban stormwater runoff include plant debris, animal and food waste, trash, gasoline and motor oil, heavy metals, fertilizers, and pesticides. As oxygen is depleted from surface water through the decomposition of organic matter, it degrades aquatic habitats and negatively affects the survival of aquatic life.[1]

Urban stormwater runoff contributes untreated nonpoint source pollutants such as sediments, nutrients, and metals directly to local streams and lakes. Polluted stormwater runoff affects the hydrology, channel structure, and water quality of local waterways as well as recreational opportunities, public health, and community aesthetics and well-being for local residents.[2] The proportions of tree cover relative to impervious surfaces in community neighborhoods influence the quantity of urban stormwater runoff and the speed at which it enters nearby waterways. Impervious surfaces increase peak runoff magnitude following precipitation events.[3] Reduced dissolved oxygen concentrations in urban streams often occur soon after major storms because of this pulse of oxygen-demanding substances into streams.[1]

Urban tree cover can benefit communities by reducing the influx of organic materials that increase chemical oxygen demand in local waterbodies. Trees in an urban setting intercept rain water, slow the passage of stormwater to drains, and filter out nutrients and pollutants. Toxic substances in organic pollutants may be modified by microorganisms in the soil into less harmful forms and made available for plant growth.[4]

This EnviroAtlas map helps to visualize the varying relationships among impervious surfaces, tree cover, and estimates of potential annual change in mean concentration of chemical oxygen demand. Estimates of potential COD reduction are lower in city center areas with higher impervious surface area and greater in suburban and rural areas having more tree cover. The COD data layer can serve as an important planning tool for mitigating oxygen depletion in receiving waterbodies.

How can I use this information?

The map, Reduction in Mean Concentration of Chemical Oxygen Demand Due to Tree Cover, illustrates variations in the reduction of pollutants in stormwater runoff from filtration by urban trees. Users can compare the estimated reductions in mean annual COD among community census block groups. This layer can be combined with other community ecosystem service layers in EnviroAtlas (e.g., air pollution removal, carbon storage and sequestration, and air temperature effects) to calculate the magnitude of multiple ecosystem services contributed by trees within a given area. Using this surface water runoff information, planners and other interested users can identify the community neighborhoods and block groups with the highest proportion of impervious surfaces where additional tree planting might improve the retention and filtration of runoff following heavy precipitation. Users might also overlay National Hydrography Dataset (NHD) flowline data (available in

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Supplemental Data) to explore where tree planting would have the greatest return in terms of improving water quality in nearby waterbodies.

How were the data for this map created?

This data layer was derived from a high resolution tree and impervious cover map provided by the US EPA for selected communities. To estimate the effect of changes in tree and impervious cover on runoff, the i-Tree Hydro model was run to simulate cover change effects on a local or nearby watershed. The model was calibrated using hourly stream flow conditions and run numerous times to produce estimates in changes in runoff due to changes in tree and impervious cover. To estimate the block group effect, the runoff outputs of the watershed were determined for each possible combination of tree cover (0-100%) and impervious cover (0-100%), giving a total of 10,201 possible responses (101 x 101). For each block group, each percent tree cover and percent impervious cover combination was matched to the watershed hydrologic response output for that combination (actual streamflow data). The hydrologic response outputs were calculated as either percent change or absolute change in units of kg of pollutant per square meter of land area. These per square meter values were multiplied by the square meters of land area in the block group to estimate the tree effects at the block group level. To estimate the change in chemical oxygen demand due to trees, national mean event-mean-concentration (EMC) values (measured as a mass of pollutant per unit volume of water [mg/l]), were multiplied by the volume of runoff to determine estimated changes in kg/yr of COD.

What are the limitations of these data?

To generate the data for this map, modeled results for a local or nearby watershed were transformed into runoff results for all of the census block groups in the community. Trees within each block group were assumed to have a similar hydrologic effect as trees within the modeled watershed. In addition, national water quality EMC values were substituted for actual local concentration values of runoff, which are unknown. Finally, the model is more illustrative of the effects of changes in cover than it is predictive of actual stream pollutant load.

How can I access these data?

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

Where can I get more information?

A selection of resources related to trees and urban runoff is listed below. For additional information on the data creation process, access the 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 this data layer, please contact the EnviroAtlas Team.

Acknowledgments

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Selected Publications

1. Erickson, A.J., P.T. Weiss, and J.S. Gulliver. 2013. Chapter 2: Impacts and composition of urban stormwater. Pages 11–22 *in* Optimizing stormwater treatment practices: A handbook of assessment and maintenance. Springer Science+Business Media, New York, 349 p.

2. The National Academy of Sciences. 2009. Urban stormwater management in the United States: 2009. Report prepared by the Committee on Reducing Stormwater Discharge Contributions to Water Pollution, National Academies Press, Washington, D.C.

3. Wang, J., T.A. Endreny, and D.J. Nowak. 2008. Mechanistic simulation of tree effects in an urban water balance model. *Journal of the American Water Resources Association*. 44(1):75–85.

4. Nowak, D.J., J. Wang, and T. Endreny. 2007. Chapter 4: Environmental and economic benefits of preserving forests within urban areas: air and water quality. Pages 28–47 *in* de Brun, C.T.F. (ed.), The economic benefits of land conservation. The Trust for Public Land, San Francisco, California.

Strassler, E., J. Pritts, and K. Strellec. 1999. Preliminary Data Summary of Urban Storm Water Best Management Practices, EPA-821-R-99-012, U.S. Environmental Protection Agency, Office of Water, Washington, D.C.

Wang, L., J. Lyons, P. Kanehl, and R. Bannerman. 2001. Impacts of urbanization on stream habitat and fish across multiple spatial scales. *Environmental Management* 28(2):255–266.