Total Annual Nitrogen Deposition

This EnviroAtlas national map portrays annual nitrogen deposition (kilograms per hectare) within each 12-digit hydrological unit (HUC) for 2011. Nitrogen deposition occurs when nitrogen in the atmosphere is transferred to the earth's surface through wet or dry deposition.


Photo: Nara Souza/Florida Fish and Wildlife Commission

Why is nitrogen deposition important?

Total nitrogen deposition includes wet and dry oxidized and reduced nitrogen. Oxidized nitrogen is produced from the burning of fossil fuels as well as natural sources such as lightning, forest fires and bacterial decay. Reduced nitrogen is primarily emitted from agricultural systems but also from automobiles.

Atmospheric deposition plays an important role in terrestrial, freshwater aquatic, and marine ecosystem functioning and degradation.[1,2] For example, it is the primary source of acidifying chemicals that can cause slower plant growth, lower soil fertility, the injury or death of forest vegetation, and localized extinction of fish and other aquatic species.[3,4,5]

Atmospheric deposition is also an important source of excess nitrogen as a nutrient. Excess nitrogen alters freshwater and terrestrial biodiversity, increases susceptibility of vegetation to insects and diseases, alters surface water quality, and contaminates drinking water supplies.[6,2] Across the U.S., and in the west in particular, microbial communities, such as those associated with lichen, are altered and diminished with increased nitrogen deposition.[7,8] In the Rocky Mountains, excess nitrogen causes shifts in biodiversity and replacement of native plants.[9] Excess nutrients alter estuarine systems by increasing phytoplankton and algae, leading to eutrophication, loss of habitat, loss of dissolved oxygen, fish kills, and decreased productivity.[10] Nitrogen stressors from the atmosphere have been increasing, posing an increasingly serious problem.[11]

How can I use this information?

This map provides information from the CMAQ model showing how deposition varies across space due to complex emissions patterns and their transport and transformation. It provides spatially continuous values of concentration and deposition that can be used as input to ecological assessments and ecosystem management strategies. Atmospheric deposition is important to water quality; its contribution to nitrogen loading in a waterbody can be on the order of 15-40%. This data can be used as input to watershed models as part of Total Maximum Daily Load calculations. This map also provides important input to critical loads analyses. Critical loads can be defined on the basis of indicators such as species diversity, soil chemistry, and tree growth. Comparison of total nitrogen deposition to critical load values allows users to identify areas where attention is potentially needed to avoid or mitigate damage.

How were the data for this map created?

Because deposition in a HUC can come from a large area, air quality models are an important tool for translating emissions data into information about ecological exposure. Airsheds are very large in comparison to HUCs and they include emissions from multi-state regions. Local deposition is caused by a mix of airshed and distant emissions. This makes it difficult to predict the exposure that results from emissions without the use of a regional air quality model.

This map was created using output from the Community Multiscale Air Quality (CMAQ) Modeling System (v 5.0.2). Meteorology data was processed for 2011 using the Weather Research Forecast model (v3.4) with the Pleim-Xu land surface model. Emissions are based on the National Emissions Inventory (NEI) 2011 platform. Ammonia emissions due to fertilizer application were not included in the emissions files; instead, fertilizer scenarios were generated using the EPIC model. The output was corrected for errors in wet deposition using PRISM data and for bias in the rainwater concentrations of TNO3 and NHx using National Atmospheric Deposition Program (NADP) data.

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Model predicted values of dry deposition were not adjusted. Finally, the gridded data were summarized by 12-digit HUC. For detailed information on the processes through which this data was generated, see the metadata.

What are the limitations of these data?

Atmospheric deposition varies across the U.S. due to differences in climate and land surface. Measurements of dry deposition are challenging and expensive, so few observation data are available. The National Trends Network (NTN), a part of the NADP, provides wet deposition data at numerous sites across the U.S. While monitoring data are useful, estimates of deposition between monitoring locations can miss changes in value due to the distribution of emissions and variations in the land surface. CMAQ modeling accounts for the complex chemistry of the atmosphere and interactions between chemicals. CMAQ is based on the best available science. Still, the chemistry and physics of the atmosphere are very complicated, and there are uncertainties in the model representations and inputs that result in uncertainties in the predicted concentrations and deposition fluxes. The data have been summarized based on HUCs, but actual atmospheric deposition will vary within the HUC. Periodic updates to EnviroAtlas will reflect improvements to nationally available data.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. Data and accuracy information for the source datasets can be found on their respective web sites.

Where can I get more information?

There are numerous resources on nitrogen deposition; a selection of these publications is listed below. For additional information on how the data were created, 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 this data layer, please contact the EnviroAtlas Team.

Acknowledgments

The data for this map were generated by Jesse Bash, Ellen Cooter, George Pouliot, Rob Gilliam and Kristen Foley, EPA. The fact sheet was created by Donna Schwede, Robin Dennis, Ellen Cooter, and Jesse Bash, EPA.

Selected Publications

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