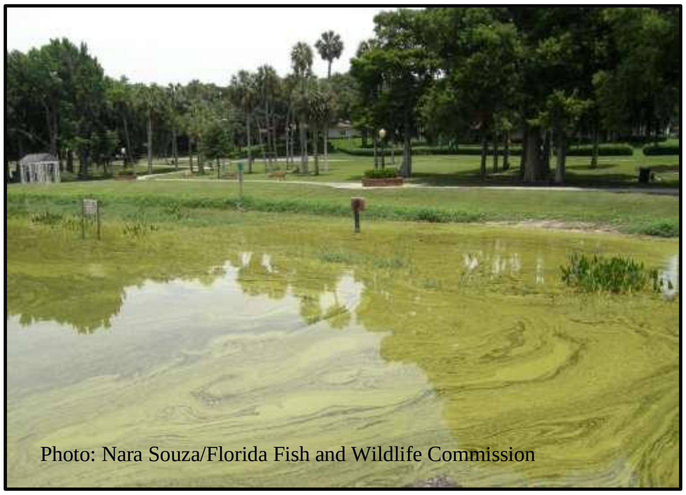
Total Annual Oxidized Nitrogen Deposition

This EnviroAtlas national map portrays annual wet and dry deposition of oxidized nitrogen (kg/ha) within each 12-digit hydrological unit (HUC) for 2017. It is based on data from Community Multiscale Air Quality modeling (CMAQ).



Why is oxidized deposition important?

Oxidized nitrogen includes nitric acid (HNO_3), nitric oxide (NO), nitrogen dioxide (NO_2), ammonia (NH_3), and particulate nitrate (NO_3); it is produced from the burning of fossil fuels as well as from natural sources such as lightning, forest fires and bacterial decay. Nitrogen deposition occurs when nitrogen in the atmosphere is transferred to the earth's surface through wet or dry deposition. 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 cause slower plant growth, lower soil fertility, the injury or death of 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?

The map, Total Annual Oxidized Nitrogen Deposition, provides information from the CMAQ model showing how deposition varies across space because of 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 to avoid or mitigate damage.

How were the data for this map created?

This map is based on data from the Community Multiscale Air Quality modeling system (CMAQ). 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 CMAQ Modeling System v5.3.2. Meteorology data were processed for 2017 using the Weather Research Forecast model v4.1.1 with the Pleim-Xu land surface model. Anthropogenic emissions are from the EPA's Air Quality Time Series (EQUATES) 2017 modeling platform. The output was corrected for errors in the wet deposition using PRISM data and for bias in the rainwater concentrations of TNO3, NHx, and sulfate using National Atmospheric Deposition Program (NADP) data. Model predicted values of dry deposition were not adjusted. Model output was summed to create total annual deposition values for each grid cell. Finally, the gridded data were summarized by taking the mean for each 12-digit HUC.

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What are the limitations of these data?

The mapped data are estimates that should be used to inform further investigation. Periodic updates to EnviroAtlas will reflect improvements to nationally available data. Atmospheric deposition varies across the U.S. from 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 monitoring sites across the US. Though useful, these 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. 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.

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 resources is listed below. Information about the models used can be found at their respective websites. 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 layer list. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

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Selected Publications

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