Reduced Nitrogen Wet Deposition

This EnviroAtlas national map portrays annual wet deposition of reduced nitrogen (kilograms per hectare) within each subwatershed (12-digit HUC) for 2006. Nitrogen deposition occurs when nitrogen in the atmosphere is transferred to the earth's surface through wet deposition or dry deposition.

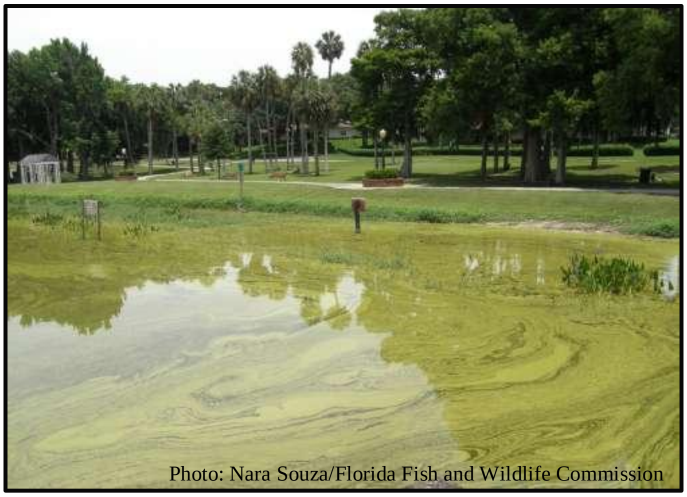
Photo: Nara Souza/Florida Fish and Wildlife Commission

Why is reduced nitrogen wet deposition important?

Reduced nitrogen includes ammonia (NH_3) and particulate NH_4; it 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.[9,8] 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.[3,2,4]

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.[5,8] Across the US, and in the western U.S. in particular, microbial communities, such as lichen, are altered and diminished with increased nitrogen deposition.[6,11] In the Rocky Mountains, it causes shifts in biodiversity and replacement of native plants.[1] 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.[7]

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 species diversity, soil chemistry, tree growth, and many other indicators. 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?

This map is based on data from the Community Multiscale Air Quality modeling system (CMAQ). Because deposition in a watershed 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 the watershed and 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 v 5.0.2. Meteorology data was processed for 2006 using the Weather Research Forecast model v3.4 with the Pleim-Xu land surface model. Emissions are based on the National Emissions Inventory (NEI) 2006 platform. Ammonia emissions due to fertilizer application were not included in the emissions files; instead, fertilizer scenarios were generated using the EPIC model. Model predicted values of dry deposition were not adjusted. Finally, the gridded data were summarized by 12-digit HUC, using the 2011 Watershed Boundary Dataset.

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For detailed information on the processes through which these data were generated, see the metadata.

What are the limitations of these data?

All national data layers are inherently imperfect; they are an estimation of the truth based on the best available science. The mapped data are not perfect and 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. due to differences in climate and land surface. 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. The 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.

For more technical details about the limitations of these data, refer to the metadata. Accuracy information for the source data sets can be found on their respective web sites.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded.

Where can I get more information?

There are numerous resources on nitrogen deposition; a selection of these resources is below. To ask specific questions about this data layer, please contact the EnviroAtlas Team. Information about the models used can be found at their respective websites.

Acknowledgements

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Selected Publications

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[2]DeHayes, D. H., P. G. Schaberg, G. J. Hawley, et al. 1999. Acid rain impacts on calcium nutrition and forest health. BioScience 49:789-800.

[3]Dennis, R., R. Haeuber, T. Blett, et al. 2007. Sulfur and nitrogen deposition on ecosystems in the United States. EM December 2007:12-17.

[4]Driscoll, C. T., G. B. Lawrence, A. J. Bulger, et al. 2001. Acidic deposition in the northeastern United States: Sources and inputs, ecosystem effects, and management strategies. BioScience 51:180-198.

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[7]Galloway, J. N. and E. B. Cowling. 2002. Reactive nitrogen and the world: 200 years of change. AMBIO: A Journal of the Human Environment 31:64-71.

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[10]Paerl, H., R. Dennis, and D. Whitall. 2002. Atmospheric deposition of nitrogen: Implications for nutrient over-enrichment of coastal waters. Estuaries 25:677-693.

[11]Pardo, L. H., M. E. Fenn, C. L. Goodale, et al. 2011. Effects of nitrogen deposition and empirical nitrogen critical loads for ecoregions of the United States. Ecological Applications 21:3049-3082.