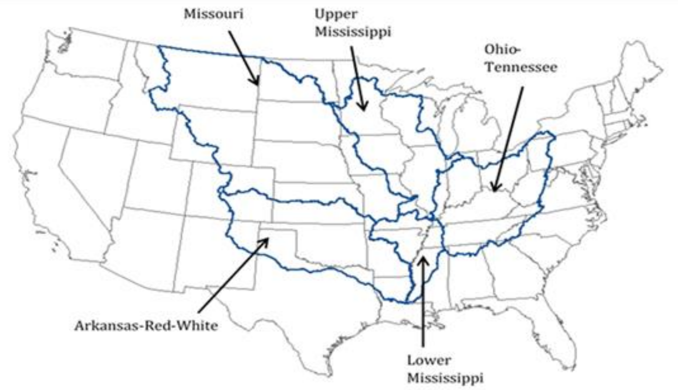
Dissolved Nitrogen in Non-tile Drain Subsurface Flow from Agricultural Fields

This EnviroAtlas national map provides modeled estimates of the movement (flux) of nitrogen (N) in subsurface (lateral) flow at the outer edges of non-tile drained agricultural fields within each 12-digit hydrologic unit (HUC) for 2002 in metric tons. This layer only includes flow from fields without tile drainage. Tile drainage is used in agriculture when a field is too wet to grow plants; pipes are placed under the soil to drain away excess water.



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Why is edge of field water quantity and quality important?

The control of N emissions to the air at power plants, industrial facilities, and from vehicles has led to significant air and water quality improvements.[1,2] Many remaining environmental threats involve complex chemical and physical processes that cascade across air, land, and water. For instance, N and phosphorus (P) are both nutrients that are critical to the existence of life on earth, but excess nutrients in fresh and near-coastal waters can result in algal blooms. Algal blooms can interfere with fishing and recreation and make drinking water difficult to treat; they can produce toxins that can make people sick and cause fish kills. The decay of particularly large blooms can reduce oxygen levels (a condition known as hypoxia) in offshore waters to a point that is too low for many aquatic species to survive, creating "dead zones."

Each year, the waters of the Mississippi River transport nutrient pollution from the Mississippi/Atchafalaya River Basin (MARB) to the Northern Gulf of Mexico coastal zone, resulting in the summertime formation of the largest dead zone in the US. The MARB contains some of the most productive agricultural land in the world and crop production here is critical to the health and economy of our nation. However, approximately 85% of the excess N and P contributing to the development of dead zones in the Northern Gulf of Mexico originates from nonpoint sources in MARB agricultural landscapes.[3]

How can I use this information?

This map can be used to better understand nutrient sources and perhaps help to find innovative solutions to nutrient pollution in the MARB and Gulf of Mexico. The movement of nutrients is part of a biogeochemical cycle (a process by which chemicals like N or P cycle though the earth, air, and water). Combining this information with other data about other sources of nutrients and the quantities of water and sediment that transport them helps to expose ways in which the biogeochemical systems in the MARB might respond to future changes in land management and environmental policies.

These layers are informative to planners; they can be used with other EnviroAtlas maps to identify potential sources of nutrient pollution. They may also be viewed with layers describing water demand to suggest where nutrient pollution might pose a risk to water supply. While the model output is based on 2001/2002 data that may not represent current conditions, the information about the movement of nutrients in water and sediment at the edge of agricultural fields can be used as a baseline to compare with current and future projections.

How were the data for this map created?

These data were created using the Fertilizer Emissions Scenario Tool for CMAQ (FEST-C). FEST-C combines Meteorology data for 2002 produced by the Weather Research Forecast model v3.4 and wet and dry atmospheric deposition to agricultural soils estimated by bidirectional CMAQ5.2[4] with field-level biogeochemistry and edge-of-field water movement simulated by the Environmental Policy Integrated Climate (EPIC) model. Simulations were performed for more than 100,000 rectangular grid cells (12km on a side) that form a continuous modeling layer across the conterminous U.S.

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These EPIC simulations are representative of regional rather than local-scale conditions and assume conservation tillage on representative soils for specific crops at the HUC-8 (subbasin) scale. Irrigated and rain fed management simulations were performed for each of 22 major commercial crops. The results were then aggregated across all agricultural land in a simulation grid cell.[5] In order to pair land use with the meteorological and emission scenarios, the agricultural area in each grid cell was estimated using National Land Cover Database (NLCD) 2001 and US Department of Agriculture (USDA) 2002 Census of Agriculture county-level data. The gridded data are summarized by 12-digit HUC. For detailed information on how this data was generated, see the metadata.

What are the limitations of these data?

EnviroAtlas uses the best data available, but there are still limitations associated with these data. These data layers contain substantial uncertainties; they are based on models and large national geospatial databases. This layer reflects assumptions about soil, weather, crop variety, and crop-specific management conditions in each 12-digit hydrologic unit (HUC). Given that 2001 and 2002 deposition, land use, and management practices data were used in the modeling effort, the data layer may not be representative of current conditions. Early simulation design and performance evaluation for 2002 yield, fertilizer use, and predicted plant and harvest dates are reported in Cooter et al.[5] These simulations represent nutrient applications that roughly follow regional nutrient management practices, on the most prevalent agricultural soils as identified in the National Resources Inventory at the HUC-8 level. The use of average grid cell slope could result in the over-estimation of horizontal water and nutrient losses by the model for some crop/soil combinations, particularly for tile drainage systems. Regional-scale studies of edge-of-field N and P losses are not generally available. Comparison of some of these 2002 EPIC nutrient export results for the Upper Mississippi River Basin (UMRB), which lies within the larger MARB, to other published modeling studies are presented in Cooter et al.[6] Further comparison of model estimates of crop yield, fertilizer application amounts and timing, crop planting and harvest dates, and irrigation water use agree with USDA and US Geological Survey (USGS) estimates that rely heavily on site-specific survey information representing long-term average conditions in terms of overall spatial pattern and magnitude.[7,8]

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. The NLCD 2001 can be downloaded from the MRLC and the Census of Agriculture can be downloaded from the USDA's website.

Where can I get more information?

A selection of publications related to dissolved nutrients is listed below. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

The data for this map were generated by Ellen Cooter (FEST-C) and Jesse Bash (CMAQ), Computational Exposure Division, US EPA, Limei Ran, Dongmei Yang, UNC Institute of the Environment and Verel Benson, Benson Consulting (FEST-C). Ellen Cooter, Computational Exposure Division (CED), Atmospheric Model Analysis and Application Branch, US EPA, created this fact sheet.

Selected Publications

1. Lamsal, L.N., B.N. Duncan, Y. Yoshida, N.A. Krotkov, K.E. Pickering, D.G. Streets, and Z. Lu. 2015. U.S. NO_2 trends (2005–2013): EPA Air Quality System (AQS) data versus improved observations from the Ozone Monitoring Instrument (OMI). *Atmospheric Environment* 110:130–143.

2. National Atmospheric Deposition Program (NADP) Total Deposition Maps. Accessed 1/24/2018.

3. Robertson, E.M., and D.A. Saad. 2013. SPARROW Models used to understand nutrient sources in the Mississippi-Atchafalaya River Basin. *Journal of Environmental Quality* 42:1422–1440.

4. Appel, K.W., K.M. Foley, J.O. Bash, R.W. Pinder, R.L. Dennis, D.J. Allen, and K. Pickering. 2011. A multi-resolution assessment of the Community Multiscale Air Quality (CMAQ) model v4.7 wet deposition estimates for 2002–2006. *Geoscientific Model Development* 4:357–371.

5. Cooter, E., J. Bash, V. Benson, and L. Ran. 2012. Linking agricultural crop management and air quality models for regional to national-scale nitrogen assessments. *Biogeosciences* 9:4023–4035.

6. Cooter, E.J., L. Ran, D. Yuan, and V. Benson. 2017. Exploring a United States maize cellulose biofuel scenario using an integrated energy and agricultural markets solution approach. *Annals of Agricultural and Crop Sciences* 2(2):1031.

7. Brakebill, J.W., and J.M. Gronberg. 2017. County-level estimates of nitrogen and phosphorus from commercial fertilizer for the conterminous United States, 1987–2012: U.S. Geological Survey data release.

8. Yuan, Y., R. Wang, E. Cooter, L. Ran, P. Daggupati, D. Yang, R. Srinivasan, and A. Jalowska. 2018. Integrating multimedia models to assess nitrogen losses from the Mississippi basin to the Gulf of Mexico. *Biogeosciences* 15:7059–7076.