Manure Application

This EnviroAtlas national map displays the application rate of livestock manure nitrogen (kg N/ha/yr) to croplands within each 12-digit hydrologic unit (HUC) in the conterminous United States (excluding Hawaii and Alaska) for the year 2006. These data are based on county-scale estimates of livestock manure production from confined animal feeding operations (CAFO). The mean rate of manure application is for the 12-digit HUC, not to cropland land use/land cover within the HUC.

Why is manure application important?

Manure is often collected from confined animal feeding operations (CAFOs) and used to fertilize crops. The high nutrient (nitrogen and phosphorus) and organic matter content of manure makes it a good organic fertilizer. Use of manure also recycles some of the nutrients that otherwise would be lost to the air or to aquatic ecosystems. This map looks specifically at the application rate of nitrogen (N) in livestock manure that is collected from CAFOs and then applied to cropland.

Though nitrogen is quite abundant on Earth, much of it is in the form of N_2, which is not available for use by most organisms. Before the 20th century, availability of reactive nitrogen, which can be used by all organisms, limited plant productivity in many terrestrial ecosystems around the world. In the past century, advances in technologies associated with food production and energy consumption have increased annual inputs of reactive N to terrestrial ecosystems[1]. Currently, annual inputs of human-created N are three-to-five times higher than nitrogen inputs from natural sources in the United States.[1] Over 80% of human-created nitrogen is used for agricultural production in the US.[2] Of all crops grown in the country, 40% are used for livestock feed. Because livestock nitrogen use efficiency is quite low (only 10% of N fed to livestock is converted into meat or dairy[3]), disposal of manure, particularly from CAFOs, can be a significant source of nitrogen to different areas of the country.[1]

Though nitrogen inputs from sources like livestock manure can increase crop production, inefficient use of them can lead to countless human health and environmental problems. These problems include increased mortality and morbidity from air pollution, contamination of drinking water supplies, increased frequency and severity of harmful algal blooms and

hypoxia in freshwater and coastal marine ecosystems, and effects on global climate change.

Information on CAFO manure application to croplands can help inform policy decisions to combat nitrogen pollution. By quantifying rates of CAFO manure nitrogen inputs at local, regional, and national scales, efforts to reduce human-created nitrogen inputs can be optimized. Spatial information allows for regional assessments of CAFO manure nitrogen loading rates and its use could help in decisions on nitrogen loading criteria.

EnviroAtlas provides a measure of CAFO manure nitrogen inputs to croplands to facilitate comparisons of background nitrogen inputs across watersheds of varying size. More information on inputs of reactive N to the United States can be found in fact sheets describing N fertilizer application, cultivated biological nitrogen fixation, and biological nitrogen fixation in natural and semi-natural ecosystems.

How can I use this information?

The map, Manure Application, is one of four EnviroAtlas maps that display reactive N inputs to the conterminous US. These data can be used either alone or in conjunction with other data layers to help identify areas where CAFO manure nitrogen inputs are important. These data could also be used in models that examine the transport and cycling of nitrogen across terrestrial and aquatic ecosystems. Information on CAFO manure nitrogen could be of use for nutrient reduction strategies, credit exchanges, and payments for ecosystem services.

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How were the data for this map created?

Livestock manure N inputs to croplands for 2006 were estimated using county-level estimates of recoverable animal manure from confined feeding operations compiled for 2007. Recoverable manure is defined as manure that is collected, stored, and available for land application from confined feeding operations.[4] County-scale data on livestock populations—needed to calculate manure inputs—were only available for the year 2007 from the USDA Census of Agriculture. We acquired county-level data describing total farm-level inputs (kg N yr^{-1}) of recoverable manure to individual counties in 2007 from the International Plant Nutrition Institute Nutrient Use Geographic Information System. These data were converted to per area rates (kg N ha yr^{-1}) of manure N inputs by dividing the total N input by the land area (ha) of combined cultivated crop and hay/pasture (agricultural) lands within a county as determined from county-level summarization of the 2006 NLCD. We distributed county-specific, per area N inputs rates to agricultural lands (30 x 30 m pixels) within the corresponding county. Following this distribution, we used the spatial analyst tool in ArcMap 10.0 (ESRI, Inc., Redlands, CA) to calculate a mean rate of synthetic N fertilizer application for individual 12-digit hydrologic units (HUCs) taken from the NHDPlusV2 Watershed Boundary Dataset (WBD Snapshot).

What are the limitations of these data?

All national data layers such as NLCD and county-level manure data are, by their nature, imperfect. Nitrogen inputs generated from processing these datasets cannot be taken as absolute truth but as the best available data. National data layers continue to improve and periodic updates to EnviroAtlas will reflect those improvements. Correcting or improving these data sets is beyond the purview of this EnviroAtlas project.

We are using the best data available, but we want users to understand the limitations associated with these data. The quality of the yield data varies from state to state and county to county, which can be seen by comparing adjacent areas with similar land use/land cover in two different counties or states. The NLCD estimates land cover based on a classification of satellite imagery; the process of classifying imagery into land cover types is not 100% accurate. The user needs to be aware that the mapped data are not 100% accurate and can only be used to inform further investigation. Accuracy information for source data can be found on their respective websites.

How can I access these data?

EnviroAtlas data can be viewed in the interactive map, accessed through web services, or downloaded. Data describing national land cover can be downloaded from Multi-Resolution Land Characteristics Consortium (MRLC). Manure data can be accessed from the International Plant Nutrition Institute Nutrient Use Geographic Information System.

Where can I get more information?

Information on nitrogen cycling, livestock manure in the US, and the health and environmental impacts of nitrogen can be found in publications listed below. For additional information on how the data were created, access the metadata for the data layer from the layer list drop down menu on the interactive map. To ask specific questions about this data layer, please contact the EnviroAtlas Team.

Acknowledgments

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Selected Publications

1. Sobota, D.J., J.E. Compton, and J.A. Harrison. 2013. Reactive nitrogen inputs to US lands and waterways: How certain are we about sources and fluxes? *Frontiers in Ecology and the Environment* 11:82–90.

2. Houlton, B.Z., E.W. Boyer, A. Finzi, J. Galloway, A. Leach, D. Liptzin, J. Melillo, T.S. Rosenstock, D.J. Sobota, and A.R. Townsend. 2012. Intentional vs. unintentional nitrogen use in the United States: Trends, efficiency, and implications. *Biogeochemistry* 114:11–23.

3. Van der Hoek, K.W. 1998. Nitrogen efficiency in global animal production. *Environmental Pollution* 102: 127–132.

4. Kellogg, R.L., C.H. Lander, D.C. Moffitt, and N. Gollehon. 2000. Manure nutrients relative to the capacity of cropland and pastureland to assimilate nutrients: Spatial and temporal trends for the United States. U.S. Department of Agriculture, Washington, DC.

Compton, J.E., J.A. Harrison, R.L. Dennis, T.L. Greaver, B.H. Hill, S.J. Jordan, H. Walker, and H.V. Campbell. 2011. Ecosystem services altered by human changes in the nitrogen cycle: A new perspective for US decision making. *Ecology Letters* 14:804–815.