Nitrogen Oxides Emissions

"Nitrogen oxides" (NO_X) is the term used to describe the sum of nitric oxide (NO), nitrogen dioxide (NO_2), and other oxides of nitrogen. Most airborne NO_X comes from combustion-related emissions sources of human origin, primarily fossil fuel combustion in electric utilities, high-temperature operations at other industrial sources, and operation of motor vehicles. However, natural sources, like biological decay processes and lightning, also contribute to airborne NO_X. Fuel-burning appliances, like home heaters and gas stoves, produce substantial amounts of NO_X in indoor settings.

NO_X plays a major role in several important environmental and human health effects. The Nitrogen Dioxide Concentrations indicator summarizes scientific evidence for health effects associated with different durations of NO_2 exposure. NO_X also reacts with volatile organic compounds in the presence of sunlight to form ozone, which is associated with human health and ecological effects (the Ozone Concentrations indicator). Further, NO_X and other pollutants react in the air to form compounds that contribute to acid deposition, which can damage forests and cause lakes and streams to acidify (the Acid Deposition indicator). Deposition of NO_X also affects nitrogen cycles and can contribute to nuisance growth of algae that can disrupt the chemical balance of nutrients in water bodies, especially in coastal estuaries (the Lake and Stream Acidity indicator; the Trophic State of Coastal Waters indicator). Finally, NO_X also plays a role in several other environmental issues, including formation of particulate matter (the PM Concentrations indicator), decreased visibility (the Regional Haze indicator), and global climate change (the U.S. Greenhouse Gas Emissions indicator; the Greenhouse Gas Concentrations indicator).

This indicator presents NO_X emissions from traditionally inventoried anthropogenic source categories: (1) "Fuel combustion: selected power generators," which includes emissions from coal-, gas-, and oil-fired power plants that are required to use continuous emissions monitors (CEMs) to report emissions as part of the Acid Rain Program (ARP); (2) "Fuel combustion: other sources," which includes industrial, commercial, and institutional sources, as well as residential heaters and boilers not required to use CEMs; (3) "Other industrial processes," which includes chemical production and petroleum refining; (4) "On-road vehicles," which includes cars, trucks, buses, and motorcycles; and (5) "Nonroad vehicles and engines," such as farm and construction equipment, lawnmowers, chainsaws, boats, ships, snowmobiles, and aircraft. Since a substantial portion of airborne NO_X comes from fossil fuel combustion in electric utilities, this indicator includes a separate category for "selected power generators" in addition to the four categories presented in the other emissions indicators. The indicator also includes estimates of biogenic and forest wildfire NO_X emissions in 2014. Biogenic emissions were estimated using the Biogenic Emissions Inventory System Model, Version 3.61, with data from the Biogenic Landcover Database, Version 4.1, and 2014 annual meteorological data. The emissions trends indicator excludes NO_X estimates of prescribed burning, forest wildfires, and other miscellaneous sources because those data were either not readily available in the 1990 inventory or are small contributors to the total inventory and because the emissions from prescribed burning and forest wildfires are highly variable over time.

NO_X emissions data are tracked by the National Emissions Inventory (NEI). The NEI is a composite of data from many different sources, including industry through the CEM program, EPA models, and numerous state, tribal, and local air quality management agencies. Different data sources use

different data collection methods, and many of the emissions data are based on estimates rather than actual measurements. For major electricity generating units, most data come from CEMs that measure actual emissions. For other fuel combustion sources and industrial processes, data are primarily from state, local, and tribal air quality management agencies and are estimated primarily using emission factors. Emissions from on-road and nonroad sources were estimated using EPA-approved models, often using state-supplied model inputs (U.S. EPA, 2018a).

NEI data have been compiled since 1990 and cover all 50 states and their counties, D.C., the U.S. territories of Puerto Rico and Virgin Islands, and some of the territories of federally recognized American Indian nations. Data are presented for 1990, 1993, 1996, 1999, 2002, 2005, 2008, 2011, and 2014. With the exception of 1993, the NEI data are published on a triennial cycle, thus an annual trend is not readily available. The NEI data are the basis of the national and regional air pollutant emission trends shown in this indicator (U.S. EPA, 2018c).

What the Data Show

According to the NEI data, estimated nationwide anthropogenic emissions of NO_X decreased by 51 percent between 1990 and 2014 (from 25.2 million tons to 12.3 million tons) (Exhibit 1). This downward trend results primarily from emissions reductions at electric utilities, other industrial fuel combustion sources, and on-road mobile sources.

This indicator focuses on trends in NO_X emissions from anthropogenic sources. However, NO_X emissions from biogenic sources and forest wildfires were estimated for 2014 to provide a sense of the relative contributions of natural versus anthropogenic emissions (Exhibit 2). Nationally, biogenic emissions from vegetation and soils were estimated to contribute approximately 7 percent and forest wildfires to contribute 1 percent to the NO_X emissions from all sources during 2014 (Exhibit 2).

Estimated anthropogenic NO_X emissions in all 10 EPA Regions decreased between 1990 and 2014 (Exhibit 3). The percent change in emissions over this time frame ranged from a 26 percent decrease (in Region 10) to a 69 percent decrease (in Region 2). The largest absolute reduction (2.9 million tons) occurred in Region 5.

Limitations

- NO_X emissions estimates through the NEI are provided only for the triennial NEI years starting with 1990 and continuing through 2014, with the exception of 1993.
- NO_X emissions from "miscellaneous sources," including forest wildfires and prescribed burning, are not included in the total anthropogenic emissions. Yearly fluctuations in forest wildfire emissions have the potential to mask trends in anthropogenic emissions and therefore have been excluded from this indicator's exhibits.
- Though NO_X emissions from most electric utilities are measured directly using continuous monitoring devices, NO_X emissions data for most other source types are estimates. These estimates are generated using well-established approaches, including extensively reviewed mobile source models, but the estimates have uncertainties inherent in the emission factors and emissions models used to represent sources for which emissions have not been directly measured.
- The methodology for estimating emissions is continually reviewed and is subject to revision. Trend data prior to any revisions must be considered in the context of those changes.
- Not all states and local air quality management agencies provide the same data or level of detail for a given year.

- NEI emissions from on-road mobile sources prior to 2002 were estimated using the MOBILE model, and 2002, 2005, 2008, 2011, and 2014 emissions for this source category were estimated using different versions of the MOVES model which applied different methods. Therefore, the outputs may not be directly comparable across years; the change in model is reflected as part of the trend shown.

Data Sources

Summary data in this indicator were provided by EPA's Office of Air Quality Planning and Standards, based on biogenic and anthropogenic NO_X emissions data in the NEI. The most recent data are taken from Version 2 of the 2014 NEI (U.S. EPA, 2018b). These and earlier emissions data can be accessed from EPA's emission inventory website (https://www.epa.gov/air-emissions-inventories/national-emissions-inventory). The MOVES data used for 2002 and 2005 are not available through the 2002 and 2005 NEI website, but these data can be accessed from EPA's emission modeling website (https://www.epa.gov/air-emissions-modeling). This indicator aggregates NEI data by source type (anthropogenic, biogenic, or forest wildfire), source category, and EPA Region.

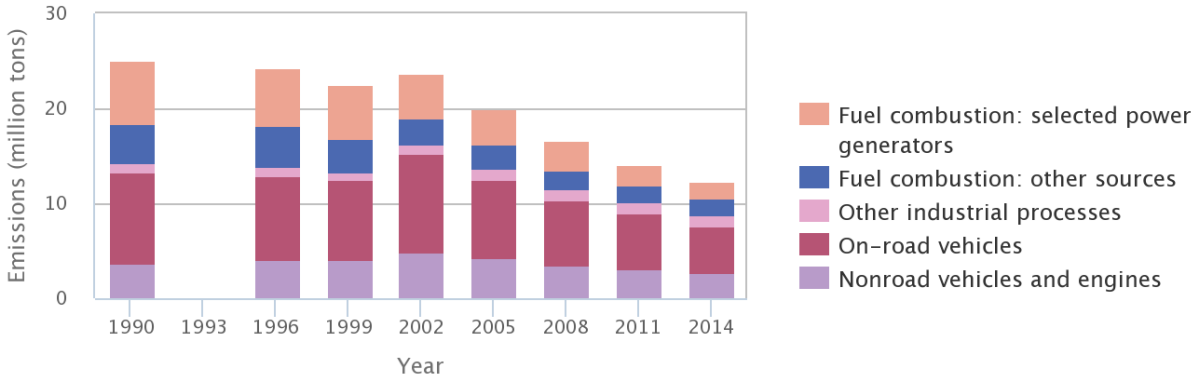
References

U.S. EPA (United States Environmental Protection Agency). 2018a. 2014 National Emissions Inventory, Version 2, technical support document. https://www.epa.gov/sites/production/files/2018-07/documents/nei2014v2_tsd_05jul2018.pdf (PDF) (414 pp, 9.7MB).

U.S. EPA. 2018b. Data from the 2014 National Emissions Inventory, Version 2. Accessed 2018. https://www.epa.gov/air-emissions-inventories/2014-national-emissions-inventory-nei-data.

U.S. EPA 2018c. Data from the Air Pollutant Emission Trends Data website. Accessed 2018. https://www.epa.gov/air-emissions-inventories/air-pollutant-emissions-trends-data.

Exhibit 1. Anthropogenic NOx emissions in the U.S. by source category, 1990–2014



During some parts of the period of record, inventories were only developed every three years, hence the three-year intervals shown here. Data are available for inventory year 1993, but these data have not been updated to allow comparison with data from the other years shown.

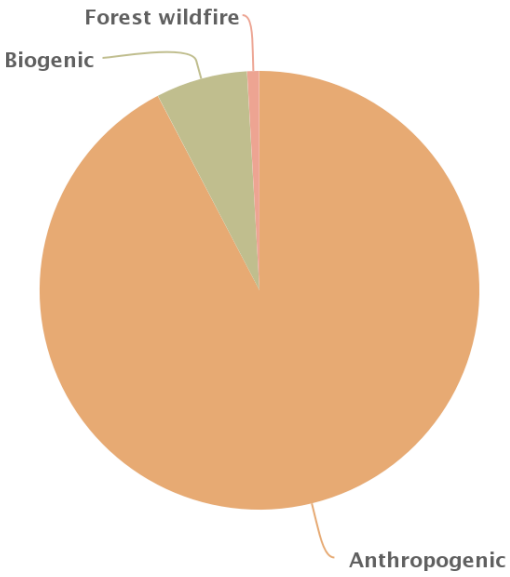
The "selected power generators" category includes emissions from only those power plants required to use continuous emissions monitors under the Acid Rain Program.

Changes shown from 1990–2014 include both emissions changes and methods changes. While trends shown are generally representative, actual changes from year to year could have been larger or smaller than those shown.

Information on the statistical significance of the trends in this exhibit is not currently available. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2018b

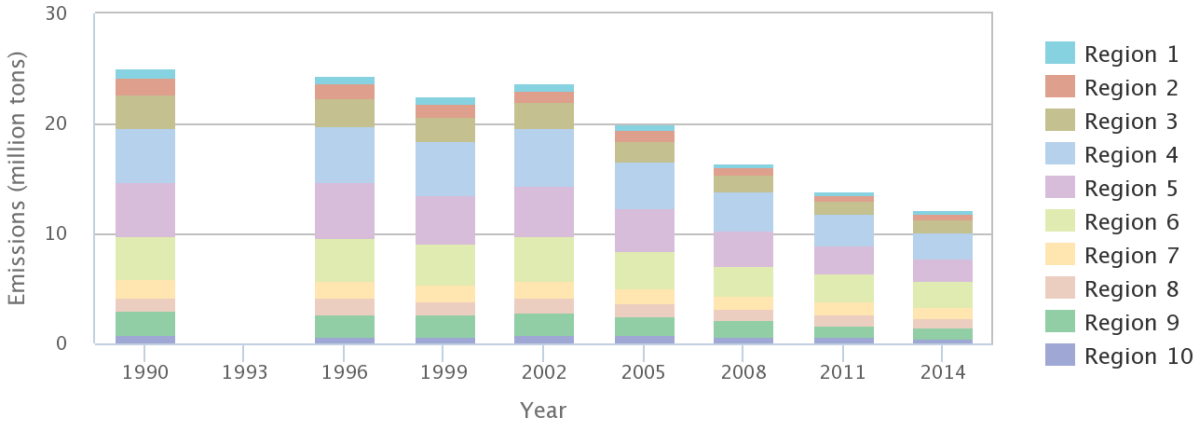
Exhibit 2. Relative amounts of U.S. NOx emissions from anthropogenic, biogenic, and forest wildfire sources, 2014



Trend analysis has not been conducted because these data represent a single snapshot in time. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2018b

Exhibit 3. Anthropogenic NOx emissions in the U.S. by EPA Region, 1990–2014



During some parts of the period of record, inventories were only developed every three years, hence the three-year intervals shown here. Data are available for inventory year 1993, but these data have not been updated to allow comparison with data from the other years shown.

Changes shown from 1990–2014 include both emissions changes and methods changes. While trends shown are generally representative, actual changes from year to year could have been larger or smaller than those shown.

Information on the statistical significance of the trends in this exhibit is not currently available. For more information about uncertainty, variability, and statistical analysis, view the technical documentation for this indicator.

Data source: U.S. EPA, 2018b