

Manganese Concentrations in Region 5

Manganese is a naturally occurring metal that is ubiquitous in the environment. Exposure to low levels of manganese in the diet is considered to be nutritionally essential for people and animals (ATSDR, 2012). However, exposures to elevated concentrations of manganese are harmful to human health and have been associated with subtle neurological effects, such as slowed eye-hand coordination. Manganese compounds are hazardous air pollutants emitted by iron and steel production plants, ferroalloy producers, power plants, coke ovens, and many smaller metal processing facilities. Manganese also may be contributed in border communities by vehicles using Canadian fuel with the additive methylcyclopentadienyl manganese tricarbonyl (MMT), though use of MMT in Canadian gasoline has decreased dramatically in recent years (ATSDR, 2012).

Although manganese compounds are air pollutants of concern nationwide, they are of special concern in EPA Region 5, which includes Illinois, Indiana, Michigan, Minnesota, Ohio, Wisconsin, and 35 tribes. For example, the Toxics Release inventory (TRI) shows that Region 5 has the highest manganese emissions of all EPA Regions, contributing 42 percent to the nationwide total over the past 5 years. Emissions from industrial sources in Region 5 occurred from various facilities, such as those that manufacture steel or process iron ores and alloys for steelmaking. Between 1988 and 2014, manganese emissions from point sources as reported to the TRI declined both nationally and in EPA Region 5. During this 27-year period, national manganese emissions decreased 37 percent, or 1.5 percent per year, and Region 5 emissions declined 30 percent, or 1.2 percent per year (U.S. EPA, 2016a).

EPA's National Air Toxics Assessment (NATA) is intended to provide a better understanding of the health risks resulting from inhalation exposure to air toxics. The 2011 NATA results (U.S. EPA, 2016b) identify manganese compounds as the largest contributor to neurological non-cancer health risk in the U.S. Based on the 2011 NATA, modeled estimates of ambient manganese compounds show that among the 100 census tracts with the highest concentrations nationwide, 39 are located in EPA Region 5.

This indicator presents ambient concentrations of manganese compounds measured as total suspended particulates (TSP) by direct monitoring. This indicator addresses manganese in the TSP fraction (not PM₁₀ or PM_{2.5}) because it is the most complete dataset in EPA Region 5 in terms of geographic and temporal coverage. TSP metals data have been commonly used in human health risk assessments. PM₁₀ may be a more appropriate size fraction for evaluating people's inhalation exposure to toxic metals (U.S. EPA, 2007), but PM₁₀ metals data are sparse at this time, both nationally and in EPA Region 5. Data from a limited number of sites in EPA's Air Quality System (AQS) with collocated PM₁₀ and TSP speciation monitors suggest that the proportion of manganese in PM₁₀ versus TSP is about 50 percent at most sites and can be as high as 75 percent. TSP manganese data therefore should be considered a conservative estimate of PM₁₀ manganese exposures. PM_{2.5} metals data are plentiful since the establishment of the Speciation Trends Network in 2000, but this size fraction is believed to underestimate human exposures.

Data were considered for 34 urban and suburban monitoring sites in EPA Region 5 that had a complete year of data reported to the AQS national database in 2016. Average manganese concentrations were calculated for each monitoring site. A concentration trend was determined using the 37 monitoring sites with nine or more complete years of data between 2000 and 2016. As annual average concentrations are representative of long-term inhalation exposures, the ambient monitoring data are displayed in comparison with the manganese Minimal Risk Level (MRL). The MRL was

developed by the Agency for Toxic Substances and Disease Registry (ATSDR) as an estimate of a chronic inhalation exposure that is likely to be without appreciable risk of adverse non-cancer effects during a lifetime. The MRL for manganese is 0.3 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$), based on impairment of neurobehavioral function in people. At exposures increasingly greater than the MRL, the potential for harmful effects increases (ATSDR, 2012). Monitoring sites were classified into different categories based on land use as defined in AQS.

What the Data Show

In 2016, the median of the annual average ambient concentrations of manganese as TSP in EPA Region 5 were $0.012 \mu\text{g}/\text{m}^3$ at the 10 residential sites, $0.063 \mu\text{g}/\text{m}^3$ at the 8 commercial sites, and $0.063 \mu\text{g}/\text{m}^3$ at the 16 industrial sites (Exhibit 1). The 90th percentile concentrations in 2016 were $0.16 \mu\text{g}/\text{m}^3$ at the residential sites, $0.16 \mu\text{g}/\text{m}^3$ at the commercial sites, and $0.20 \mu\text{g}/\text{m}^3$ at the industrial sites. In 2016, one of the monitoring sites had annual average manganese concentrations higher than the MRL; this site was categorized as industrial.

The average annual manganese concentration averaged across 37 trend sites decreased 40 percent between 2000 and 2016 (Exhibit 2). The median of site averages decreased 21 percent between 2000 and 2016. The trend sites had the following land use designations: commercial (10 sites), industrial (17 sites), and residential (10 sites).

Limitations

- AQS data represent several sites per state, but do not have full geographic or temporal coverage. Some emissions “hotspots” are included, while others may exist that have not been monitored.
- The land use categories are only generally indicative of the area represented by an ambient air monitor. For example, a site categorized as “industrial” may adjoin a densely populated community where many residents are exposed to ambient pollution.

Data Sources

Summary data in this indicator were provided by EPA Region 5, based on ambient air monitoring data for manganese compounds reported in EPA’s AQS (U.S. EPA, 2018) (<https://www.epa.gov/aqs>). Trends in this indicator are based on the subset of monitoring stations located in EPA Region 5 that have sufficient manganese concentration data to assess trends over the period of record.

References

ATSDR (Agency for Toxic Substances and Disease Registry). 2012. Toxicological profile for manganese. Atlanta, GA: U.S. Department of Health and Human Services. <https://www.atsdr.cdc.gov/toxprofiles/tp151.pdf> (PDF) (556 pp, 9.6MB).

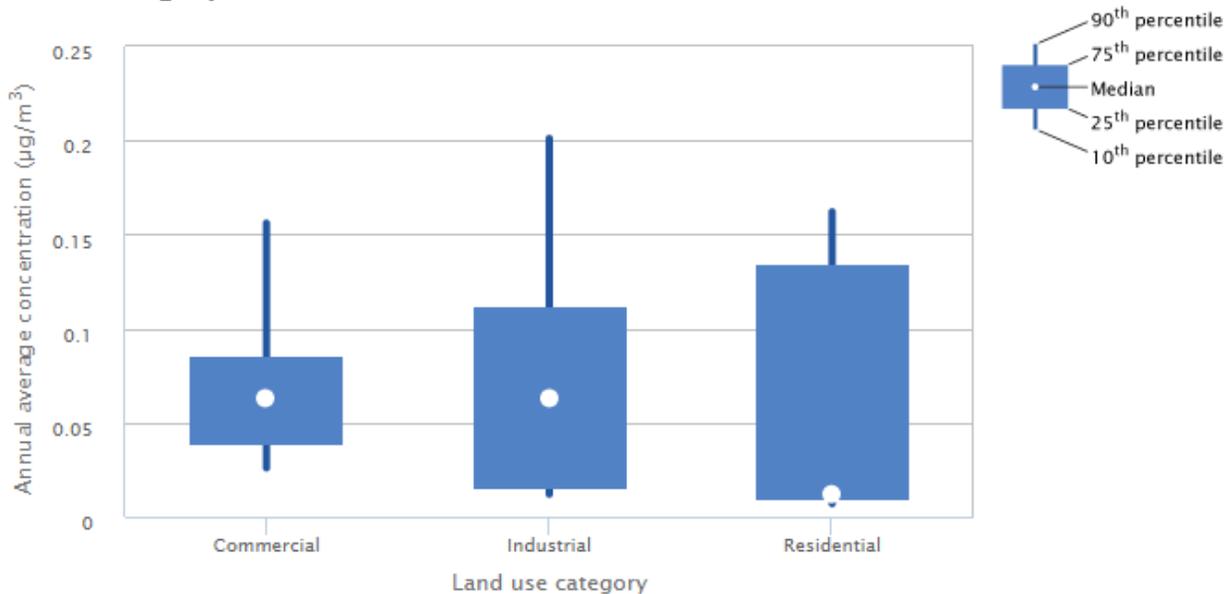
U.S. EPA (United States Environmental Protection Agency). 2018. Data from the Air Quality System. Accessed 2018. <https://www.epa.gov/aqs>.

U.S. EPA. 2016a. Toxics Release Inventory data 1988-2014. Accessed 2016. <https://www.epa.gov/toxics-release-inventory-tri-program>.

U.S. EPA. 2016b. 2011 national-scale air toxics assessment. Accessed 2016.
<https://www.epa.gov/national-air-toxics-assessment/2011-nata-assessment-results>.

U.S. EPA. 2007. Framework for metals risk assessment. Washington, DC.
<https://www.epa.gov/sites/production/files/2013-09/documents/metals-risk-assessment-final.pdf>
(PDF) (172 pp, 2MB).

Exhibit 1. Ambient annual manganese concentrations in EPA Region 5 by land use category, 2016



Coverage: 34 monitoring sites in EPA Region 5, with 8 sites in commercial areas, 16 sites in industrial areas, and 10 sites in residential areas.

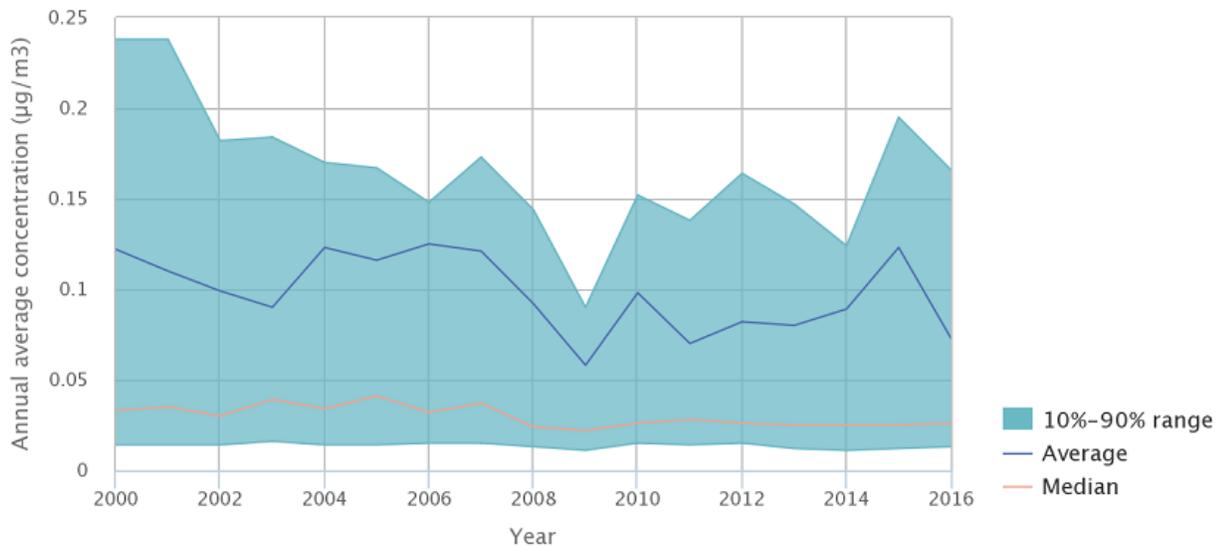
Concentrations are for manganese in total suspended particulate matter.

The manganese chronic inhalation Minimal Risk Level (MRL) is $0.3 \mu\text{g}/\text{m}^3$. The MRL is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

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, 2018

Exhibit 2. Ambient annual manganese concentrations in EPA Region 5, 2000–2016



Coverage: 37 monitoring sites in EPA Region 5 that have sufficient data to assess manganese trends since 2000.

Concentrations are for manganese in total suspended particulate matter.

The manganese chronic inhalation Minimal Risk Level (MRL) is 0.3 µg/m³. The MRL is an estimate of a continuous inhalation exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime.

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, 2018