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, 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 37 percent to the nationwide total over the past 15 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 2013, manganese emissions from point sources as reported to the TRI declined both nationally and in EPA Region 5. During this 26-year period, national manganese emissions decreased 23 percent, or 0.9 percent per year, and Region 5 emissions declined 41 percent, or 1.6 percent per year (U.S. EPA, 2014b).

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 2005 NATA results (U.S. EPA, 2014c) identify manganese compounds as the largest contributor to neurological non-cancer health risk in the U.S. Based on the 2005 NATA, modeled estimates of ambient manganese compounds in all 3,222 U.S. counties show that among the 50 counties with the highest concentrations nationwide, 17 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 PM_{10} 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. EPA recommends PM_{10} as the most appropriate fraction for evaluating people's exposure to toxic metals (U.S. EPA, 2002), but PM_{10} 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 PM_{10} and TSP speciation monitors suggest that the proportion of manganese in PM_{10} 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 PM_{10} 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 64 urban and suburban monitoring sites in EPA Region 5 that had a complete year of data reported to the AQS national database in 2013. Average manganese concentrations were calculated for each monitoring site. A concentration trend was determined using the 39 monitoring sites with nine or more complete years of data between 2000 and 2013. 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 0.30 micrograms per cubic meter ($\mu g/m^3$), 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 2013, the median average annual ambient concentrations of manganese as TSP in EPA Region 5 were 0.016 $\mu g/m^3$ at the 19 residential sites, 0.056 $\mu g/m^3$ at the 15 sites in commercial or high-traffic areas, and 0.039 $\mu g/m^3$ at the 30 industrial sites (Exhibit 1). The 90th percentile concentrations in 2013 were 0.111 $\mu g/m^3$ at the commercial and high-traffic sites, 0.152 $\mu g/m^3$ at the residential sites, and 0.172 $\mu g/m^3$ at the predominantly industrial sites. In 2013, three of the 64 urban and suburban monitoring sites had annual average manganese concentrations higher than the MRL; two of these sites were categorized as industrial, and one as commercial or high-traffic.

The average annual manganese concentration averaged across 39 trend sites decreased by 35 percent between 2000 and 2013 (Exhibit 2). The trend sites had the following land use designations: commercial and high-traffic (10 sites), industrial (16 sites), residential (12 sites), and one site in an agricultural setting.

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, 2014a) (http://www.epa.gov/ttn/airs/airsaqs/). 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. http://www.atsdr.cdc.gov/toxprofiles/tp151.pdf (PDF) (556pp, 9.6MB).

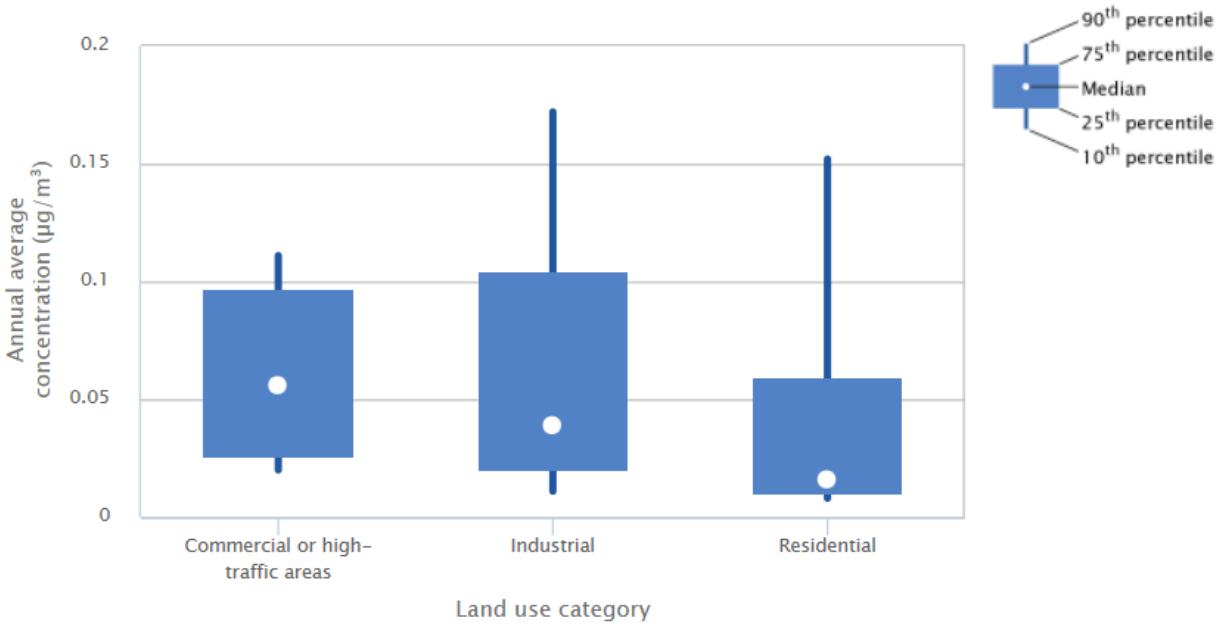
U.S. EPA (United States Environmental Protection Agency). 2014a. Data from the Air Quality System. Accessed 2014. http://www.epa.gov/ttn/airs/airsaqs/.

U.S. EPA. 2014b. Toxics Release Inventory data 1988-2013. Accessed 2014. http://www.epa.gov/tri.

U.S. EPA. 2014c. 2005 national-scale air toxics assessment. Accessed 2014. http://www.epa.gov/ttn/atw/nata2005.

U.S. EPA. 2007. Quality assurance guidance document—model quality assurance project plan for the national air toxics trends stations. Washington, DC. http://www.epa.gov/ttn/amtic/files/ambient/airtox/NATTS_Model_QAPP.pdf (PDF) (143pp, 614K).

Exhibit 1. Ambient annual manganese concentrations in EPA Region 5 by land use category, 2013



Coverage: 64 monitoring sites in EPA Region 5, with 15 sites in commercial or high-traffic land use areas, 30 sites in industrial areas, and 19 sites in residential areas.

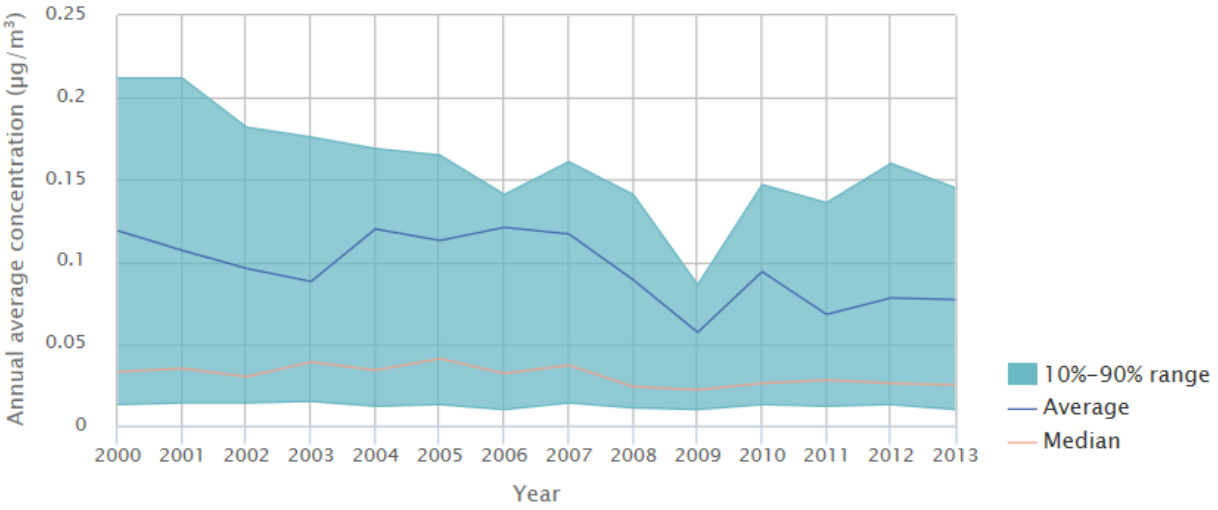
Concentrations are for manganese in total suspended particulate matter.

The manganese 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.

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, 2014a

Exhibit 2. Ambient annual manganese concentrations in EPA Region 5, 2000–2013



Coverage: 39 monitoring sites in EPA Region 5 (out of a total of 64 urban and suburban monitoring sites measuring manganese in 2013) that have sufficient data to assess manganese trends since 2000.

Concentrations are for manganese in total suspended particulate matter.

The manganese 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, 2014a