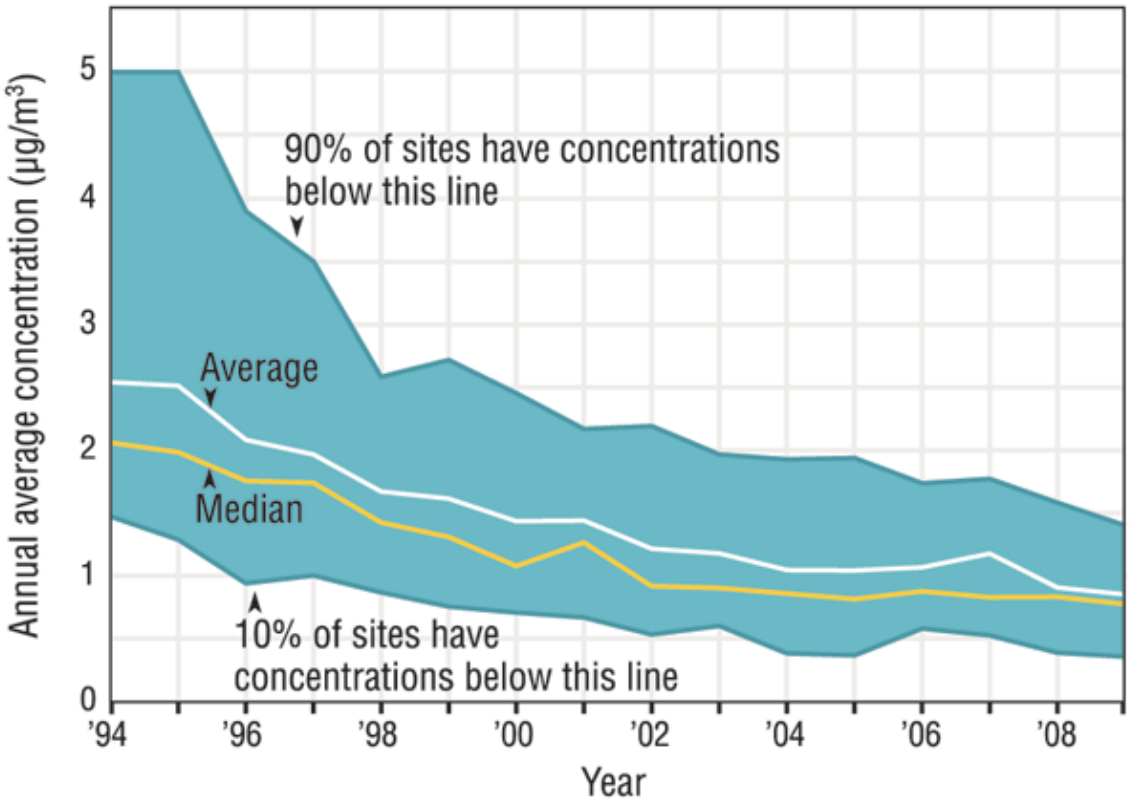
Ambient Concentrations of Benzene

Exhibits

Exhibit 2-43. Ambient benzene concentrations in the U.S., 1994-2009[a]



[a] **Coverage:** 22 monitoring sites nationwide (out of a total of 339 sites measuring benzene in 2009) that have sufficient data to assess benzene trends since 1994.

Data source: *U.S. EPA, 2010*

Introduction

Benzene is an air toxic emitted from gasoline service stations, motor vehicle exhaust and fuel evaporation, the burning of coal and oil, and various other sources. In addition to being a common air pollutant, benzene may also contaminate water. Urban areas generally have higher ambient air concentrations of benzene than other areas.

People exposed to benzene at sufficient concentrations may experience various health effects, including cancer and damage to the immune system, as well as neurological, reproductive (e.g., reduced fertility), developmental, respiratory, and other health problems. Plants and animals may also be harmed by exposures to benzene (U.S. EPA, 2003).

Benzene is one of the most widely monitored air toxics. Data from the National Air Toxics Trends Sites network is expected to provide trends information for other air toxics in the next Report on the Environment.

This indicator reflects ambient concentrations in micrograms per cubic meter ($\mu g/m^3$) of benzene from 1994 to 2009, based on the annual average. This indicator displays trends averaged over 22 urban monitoring sites that have consistent data for the period of record from Photochemical Assessment Monitoring Stations, Urban Air Toxics Monitoring Stations, and Non-Methane Organic Compound Monitoring Stations.

What The Data Show

Average benzene concentrations declined 66 percent from 1994 to 2009 (Exhibit 2-43).

Also shown in Exhibit 2-43 are the 90^{th} and 10^{th} percentiles based on the distributions of annual average concentrations at the 22 monitoring sites. These data provide additional graphical representation of the distribution of measured concentrations across the monitoring sites for a given year: the shaded area in the exhibit displays the concentration range where 80 percent of measured values occurred for each year.

Limitations

- In order to provide trend data for 1994–2009, only 22 monitoring sites met this indicator's site selection criteria, and these sites were primarily located in urban areas.
- Because of the limited number of sites that are primarily located in urban areas, Exhibit 2-43 does not necessarily represent an overall national trend in benzene concentrations.
- Benzene, while an important air toxic, is only one of many toxics typically found in outdoor air.

Data Sources

Summary data in this indicator were provided by EPA's Office of Air Quality Planning and Standards, based on benzene ambient air monitoring data in EPA's Air Quality System (U.S. EPA, 2010) (http://www.epa.gov/ttn/airs/airsaqs/). National trends in this indicator are based on the subset of benzene monitoring stations that have sufficient data to assess trends since 1994.

References

U.S. EPA (United States Environmental Protection Agency). 2010. Data from the Air Quality System. Accessed 2010. http://www.epa.gov/ttn/airs/airsaqs/

U.S. EPA. 2003. National air quality and emissions trends report—2003 special studies edition. EPA/454/R-03/005. Research Triangle Park, NC. http://www.epa.gov/air/airtrends/aqtrnd03/

Metadata (Technical Documentation)

Identification

1. Indicator Title

Ambient Concentrations of Benzene

2. ROE Question(s) This Indicator Helps to Answer

This indicator is used to help answer one ROE question: "What are the trends in outdoor air quality and their effects on human health and the environment?"

3. Indicator Abstract

This indicator presents trends in ambient concentrations of benzene for 22 locations across the U.S. from 1994 to 2009. Benzene is a hazardous air pollutant that may cause cancer as well as damage to reproductive, immune, and neurologic systems in exposed populations.

4. Revision History

May 2008	–	Original indicator posted
December 2008	–	Indicator updated
December 2009	–	Indicator updated
March 2010	–	Metadata updated

Data Sources

5. Data Sources

Data used for this indicator came from three EPA monitoring programs: (1) the Photochemical Assessment Monitoring Stations (PAMS) Program, (2) the Urban Air Toxics Monitoring Program (UATMP), and (3) the Non-Methane Organic Compound (NMOC) Monitoring Program. In addition, these data from national monitoring programs were supplemented by information collected by individual state efforts. These monitoring networks conform to uniform criteria for monitor siting, instrumentation, and quality assurance.

6. Data Availability

The complete set of benzene monitoring data used to prepare this indicator can be queried from the publicly available Air Quality System (AQS) database. Summary data in this indicator were provided by EPA's Office of Air Quality Planning and Standards, based on queries run on the raw benzene ambient air monitoring data in AQS (http://www.epa.gov/ttn/airs/airsaqs/). Data also are available through

http://www.epa.gov/air/data/index.html. Information about AirData and AQS can be found at http://www.epa.gov/air/data/info.html and http://www.epa.gov/air/data/aqsdb.html.

Methodology

7. Data Collection

Survey Design

This indicator is based on 1994–2009 ambient air quality data retrieved from EPA's Air Quality System (AQS) in 2010. AQS data are direct measurements of pollutant concentrations at monitoring stations operated by tribes and state and local governments throughout the nation. EPA and other federal agencies also operate some air quality monitoring sites. For more information about the AQS, see http://www.epa.gov/ttn/airs/airsaqs/.

This indicator reflects only those sites that met specific criteria for data completeness over the period of record (1994–2009). In all, 22 sites met the criteria for this analysis. Spatially, these sites are distributed across the nation, although they tend to be more heavily representative of larger urban areas, where monitoring is generally more extensive.

The data used to derive this indicator represent the best, most readily available data on ambient air toxics concentrations. Benzene is one of the most widely monitored air toxics, and thus trends in benzene serve as a useful indicator of the state of the environment. The data for this indicator are collected under three national programs of ambient air quality surveillance, each with its own specialized focus. The UATMP characterizes the magnitude and composition of potentially toxic air pollution in, or near, urban locations. The NMOC Monitoring Program also focuses principally on urban areas, while the PAMS Program focuses on areas with significant ozone non-attainment problems (benzene and other volatile organic compounds [VOCs] are precursors to ground-level ozone).

This indicator is based on data from 22 monitoring locations that met specific criteria for temporal coverage. Although year-to-year trends can be influenced by meteorological conditions, annual averages can be expected to diminish the influence of meteorological variability. This record is sufficiently long (16 years) such that it can provide a good indication of general trends over time. Spatially, these monitors are distributed across the U.S., though mostly in urban areas. This spatial distribution yields useful information because (1) a large percentage of the population lives in urban/suburban areas, and (2) these areas are where sources of benzene (e.g., vehicles, gasoline stations) tend to be most concentrated.

In general, air toxics monitoring efforts focus on providing data for assessing public health consequences of air pollutants, and therefore, the monitors tend to be concentrated in urban areas with modest coverage in most rural areas. The ambient monitoring network is not designed to represent specific areas, specific sensitive populations, or ecosystems.

Sampling Procedures

Ambient concentrations of benzene are measured using a set of standard sampling and analytical methods. Typically, these methods are designed to determine ambient air concentrations over a 24-hour period. These methods are documented in EPA's Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (see http://www.epa.gov/ttn/amtic/files/ambient/airtox/tocomp99.pdf.). These Compendium Methods have

undergone extensive independent peer review and, when applied correctly, are widely viewed as providing scientifically valid measurements. Other information about ambient air monitoring can be found at http://www.epa.gov/ttn/amtic/.

Documentation

Standard documentation is available to support these data. The Ambient Monitoring Technology Information Center (AMTIC) provides links to numerous resources that describe sampling and analytical methods for air toxics (see: http://www.epa.gov/ttn/amtic/airtox.html), including the Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air, EPA-625/R-96-010b (http://www.epa.gov/ttn/amtic/files/ambient/airtox/tocomp99.pdf).

A description of the UATMP sampling design and monitoring plan is in the 2003 UATMP Final Report (July 2004; http://www.epa.gov/ttn/amtic/files/ambient/airtox/2003doc.pdf).The monitoring objectives for the PAMS network are found in 40 CFR 58, Appendix D 40 CFR 58 Subpart E. The monitoring objectives for the NMOC Monitoring Program are found in several EPA documents (EPA-454/4-92-010; EPA-454/4-91-008; EPA-454/4-90-011).

The monitoring networks and other aspects of survey design are documented in UATMP (2004) and PAMS monitoring objectives: 40 CFR 58, Appendix D; 40 CFR 58 Subpart E (both available at http://www.epa.gov/ttn/amtic/). Additional general information about PAMS is available at http://www.epa.gov/air/oaqps/pams/. UATMP and NMOC monitoring objectives are documented at http://www.epa.gov/ttn/amtic/uatm.html (for NMOC, see EPA-454/4-92-010; EPA-454/4-91-008; and EPA-454/4-90-011).

EPA's National Air Monitoring Strategy is documented at http://www.epa.gov/ttnamti1/monstratdoc.html.

Analytical methods used to collect the benzene concentration data for this indicator are documented in the references listed above for the individual monitoring programs. Generally, most sampling followed peer-reviewed methods documented in EPA's Compendium of Methods for the Determination of Toxic Organic Compounds in Ambient Air (see: http://www.epa.gov/ttn/amtic/files/ambient/airtox/tocomp99.pdf).

8. Indicator Derivation

The conceptual model used to derive this indicator has been used and thoroughly reviewed as part of the Agency's national report on air quality trends. For this indicator, monitoring sites were included in the trend analysis if they had at least 12 valid years of data during the 16-year period of 1994-2009. A year was considered "valid" when there were at least 15 days of data during the winter (calendar quarters 1 and 4) and 15 days during the summer (calendar quarters 2 and 3). This is equivalent to 50 percent completeness based on a 1-in-3 day sampling schedule. For this indicator, 22 sites met the data completeness criteria. From each of these sites, a winter mean and a summer mean were calculated for each year based on the measured 24-hour concentrations. Annual averages were calculated by averaging the complete winter and summer means. These conceptual methods are all consistent with methods used in EPA trends reports.

There are standard procedures for handling missing data. Monitoring sites with a substantial amount of missing data were excluded from the analysis. For those sites meeting the data quality criteria, missing annual summary statistics were estimated by linear interpolation from the surrounding years. Missing end

points were replaced with the nearest valid year of data. Descriptive statistics were then calculated from the annual averages (i.e., the mean, median, and 10th and 90th percentile values from the distribution of results for each year). All sites were weighted equally in calculating the composite average trend statistics. No attempt was made to portray data beyond the temporal bounds of the data set. The statistical procedures used for this indicator comply with the recommendations of the Intra-Agency Task Force on Air Quality Indicators (U.S. EPA, 1981).

9. Quality Assurance and Quality Control

The quality assurance/quality control (QA/QC) of the national air monitoring program has several major components: (1) the data quality objective (DQO) process; (2) reference and equivalent methods program; (3) EPA's National Performance Audit Program (NPAP); (4) system audits; and (5) network reviews (http://www.epa.gov/ttn/amtic/netamap.html).Further information on QA/QC procedures is available through EPA's Quality Assurance Handbook (EPA-454/R-98-004, Section 15).

In addition, each state or local agency operating an ambient air monitor for EPA's monitoring networks has a Quality Assurance Project Plan (QAPP). These QAPPs must meet EPA's Requirements for Quality Assurance Project Plans, EPA QA/R-5. The QA plans for specific sites are publicly available by request to the reporting agency or the corresponding EPA Regional Office. Some QA plans may be accessed online (see: http://www.epa.gov/ttn/amtic/plans.html). For example, the California Air Resources Board QA manual is available at http://www.arb.ca.gov/aaqm/qmosqual/qamanual/qamanual.htm . QA plans are audited at least once every 3 years as required in 40 CFR 58, Appendix A, Section 2.5. In addition, the data repository (i.e., AQS) provides direct access to information about precision and accuracy, which are two of the more prominent quality assurance indicators (http://www.epa.gov/ttn/airs/airsaqs/padata/).

Analysis

10. Reference Points

Because there are no national ambient air quality standards for air toxics (as there are for criteria air pollutants), there is no consensus metric to use to reflect the state of the environment for pollutants such as benzene. However, several agencies and organizations publish reference values for risk assessment. The 1999 National-Scale Air Toxics Assessment (NATA), which describes a distribution of relative cancer risk across the U.S., identifies benzene as a "national cancer risk driver" (see: http://www.epa.gov/ttn/atw/nata1999/risksum.html). In fact, benzene is the only air toxic that received this designation in the 1999 NATA.

11. Comparability Over Time and Space

The data presented in this indicator are viewed as highly comparable over both time and space because all data summarized in this indicator were collected using robust sampling and analytical methods (over the entire period of record) and because extensive quality assurance protocols were followed at the individual monitoring stations.

12. Sources of Uncertainty

Content under review.

13. Sources of Variability

Year-to-year variability may be influenced by meteorological factors and changes in the local air emission sources. However, this indicator uses annual averages and it has a long (1994–2009) period of record, which makes it a useful indicator of long-term, general trends in ambient benzene concentrations across the U.S. that are not overly influenced by shorter term fluctuations in meteorological conditions or emission events.

14. Statistical/Trend Analysis

This indicator presents a time series of concentrations averaged across 22 monitoring stations. No special statistical techniques or analyses were used to characterize the long-term trends and their statistical significance.

Limitations

15. Data Limitations

Limitations to this indicator include the following:

1. Benzene data represent only 22 urban sites in the U.S.
2. Because of the limited number of sites that are primarily located in urban areas, Exhibit 2-43 does not necessarily represent an overall national trend in benzene concentrations.
3. Benzene, while an important air toxic, is only one of many toxics that can occur in air.

References

16. Data Reference

UATMP (Urban Air Toxics Monitoring Program). 2004. Final Report, July 2004. http://www.epa.gov/ttn/amtic/files/ambient/airtox/2003doc.pdf.

U.S. EPA (United States Environmental Protection Agency). 1981. Intra-Agency Task Force report on air quality indicators. EPA/450/4-81/015.