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Particulate Matter and Air Quality Standards

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Air pollution consists of gas, liquid or solid particles that are present in the atmosphere. Pollutants present in the earth's atmosphere can be from both natural and human sources. **Primary pollutants** are released directly into the atmosphere and include such compounds as nitrogen oxides, sulfur dioxide and carbon monoxide. **Secondary pollutants** are formed in the environment by reactions involving primary, emitted chemicals.

Air pollution that exceeds certain levels for prolonged periods of time can lead to significant human health issues, such as chronic respiratory disease, cardiovascular disease and premature mortality, and negative effects to crops, natural and built ecosystems. Aerosols also scatter light in the atmosphere and contribute to visibility impairment.

How Is Particulate Matter Defined and Where Does It Originate?

Both the amount and size range of particulate matter (PM) particles are key considerations in measuring air quality. For instance, $PM_{2.5}$ refers to particulate matter that is 2.5 micrograms (µg) or smaller in diameter while PM_{10} refers to coarse particles less than 10 µm in diameter. Incidently, 2.5 µm is approximately 1/30th the diameter of human hair. $PM_{2.5}$ particles are much smaller than 10 µm and much more likely to be inhaled and deposited more deeply into human lungs, thus increasing the health risk from exposure in some instances, depending on the chemical constituents.

Primary human activity-related sources of PM_{10} include blowing dust from bare soil sites and incomplete combustion of wood and fossil fuels (Figure 1). The sources of $PM_{2.5}$ include fuel combustion (e.g., burning coal, wood and diesel), industrial processes, unpaved roads, agricultural operations and fires (wild, prescribed and field burning). Other fine particles are also formed in

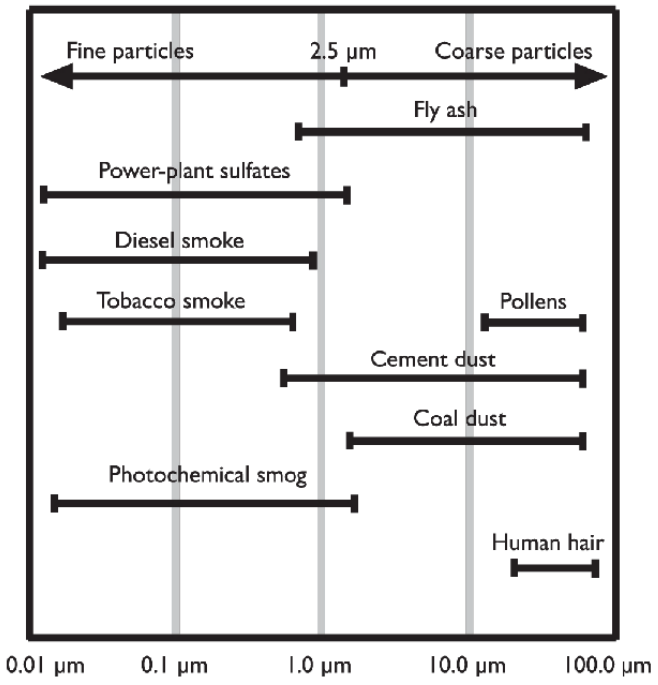


Figure 1. Size ranges of selected airborne particles in micrometer. *(Adapted from Heinsohn and Kabel, 1999)*

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the atmosphere when gases such as sulfur dioxide, nitrogen oxides and volatile organic compounds are transformed in the air by chemical reactions.

How Is Particulate Matter Regulated?

The National Ambient Air Quality Standards (NAAQS) regulates nitrogen oxides, sulfur dioxide, carbon monoxide, ozone, lead and particulates. Particle pollution is regulated under two categories of particles based on established information on differences in sources, properties and atmospheric behavior, to provide protection against potential health effects associated with short- and long-term exposure to particles. The **annual** $PM_{2.5}$ NAAQS is set to address human health effects from chronic exposure to the pollutants. The **24-hour** standard is set to address human health effect from short-term or seasonal exposure to the pollutants. Current allowable $PM_{2.5}$ daily concentrations are set at 35 micrograms per cubic meter ($\mu g/m^3$), and annual concentrations are set at 12 $\mu g/m^3$ (Table 1). Air quality monitoring samples are collected at locations within the state, with the observed levels compared to standards to determine if desired standards are being attained.

Why Did EPA Revise Particulate Matter Standards?

Under the Clean Air Act (CAA), Environmental Protection Agency (EPA) is required to review the latest scientific studies and either reaffirm or modify previously established NAAQS every five years utilizing inputs made by an independent Clean Air Scientific Advisory Committee. In 2006, EPA strengthened the $PM_{2.5}$ by lowering the allowable **daily** concentration in the air, from the 1997 standard. The daily standard averaged over 24-hour periods was reduced from 65 $\mu g/m^3$ to 35 $\mu g/m^3$. In January 2013, EPA changed the 2006 **annual** primary standard for $PM_{2.5}$, lowering the allowable averaged concentration from 15 $\mu g/m^3$ to 12 $\mu g/m^3$. Based on its review of scientific studies, EPA determined that evidence continued to show associations between particles in ambient air and numerous significant health problems, including aggravated asthma, chronic bronchitis, nonfatal heart attacks and premature death. These standards may continue to be revised as more data are available and risk assessments deem it necessary to alter the standards to improve human health.

What Happens After a New Standard Is Established?

When a new standard becomes effective, EPA publishes a statutory schedule to promulgate the new standard. In general, states and tribal environmental protection agencies use multi-year air quality monitoring data and other criteria to identify geographical areas (usually counties) that exceed the standards as nonattainment areas. Once designated, states have three years from the final designation to submit nonattainment area State Implementation Plans. After that, states will have from two to seven years to meet the standards, depending on the severity of the problem and the availability of control measure options.

State Implementation Plans consist of specific regulations and emission control requirements to reduce pollutant concentrations and bring nonattainment areas into compliance. Areas designated as nonattainment for the NAAQS are also subject to New Source Review requirements. New Source Review is designed to ensure that newly constructed facilities, or substantially modified existing facilities, do not result in violation of applicable air quality standards. This means that the expansion of industrial sectors with companies that emit specific pollutants will be limited in nonattainment areas until a compliance level is reached.

In addition to the CAA requirement for states to develop implementation plans, EPA acts through national regulatory programs with the expectation that such actions will help states meet the revised NAAQS. These may be in the form of regulations of products and activities (e.g., automobiles and trucks) that might emit the pollutants or in the form of emission standards for new stationary sources (e.g., utilities, refineries).

Table 1. Historical Primary (Health) National Ambient Air Quality Standards (NAAQS) for Particles

	$PM_{2.5}$		PM_{10}	
	24-Hour Primary	Annual Primary	24-Hour Primary	Annual Primary
NAAQS	- - - - - - micrograms per cubic meter = $\mu g/m^3$ - - - - - -			
1997	65	15	150	50
2006	35	15	150	None
2012	35	12	150	None

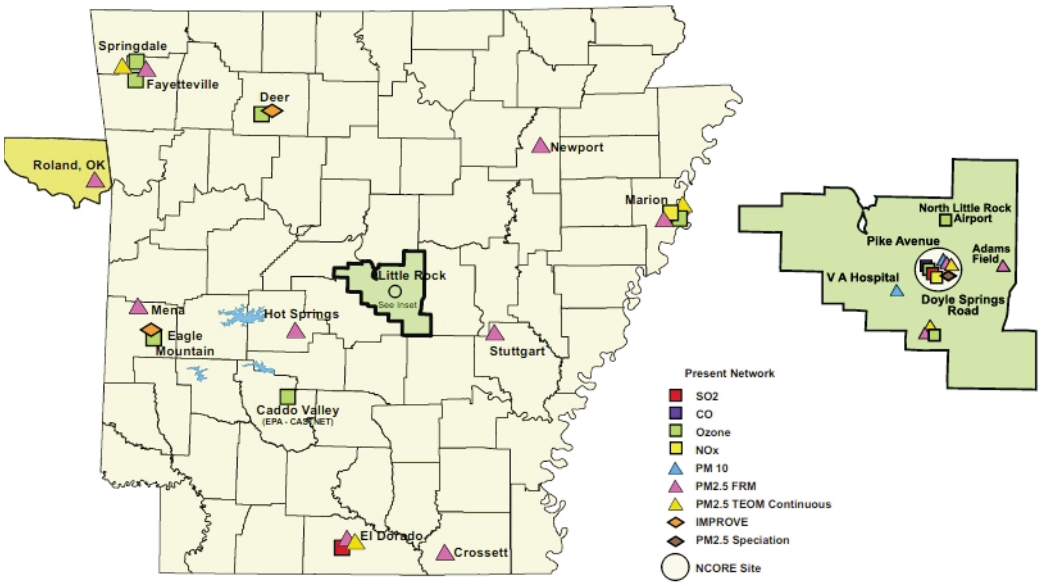


Figure 2. Air quality monitoring stations in the state of Arkansas. *(Source: Courtesy of Arkansas Department of Environmental Quality)*

The revision to the PM NAAQS does not directly regulate emissions from specific sources or compel installation of any pollution control equipment or measures but may indirectly affect agricultural activities, operations at industrial facilities and other sources, including on-road and off-road vehicles, wild and prescribed fires, etc.

How Are $PM_{2.5}$ Values Monitored in Arkansas?

Measuring and analyzing air quality to determine where standards are not met is a key step in determining an area's designation. Designations are made primarily on the basis of three years of federally referenced monitoring data, which are generated from a network of monitors across the country. The air quality monitors in the state of Arkansas are shown in Figure 2. The locations for monitoring stations depend on the purpose of the monitoring. Most monitoring networks are designed with human health objectives in mind, and monitoring stations are therefore established in populous areas or near known pollutant sources.

Arkansas is one of a handful of states in the country that consistently meets all federal air quality standards for criteria pollutants. However, in recent years, the measured annual background levels of $PM_{2.5}$ are within 69 to 98 percent of the new $PM_{2.5}$ standard (Figure 3).

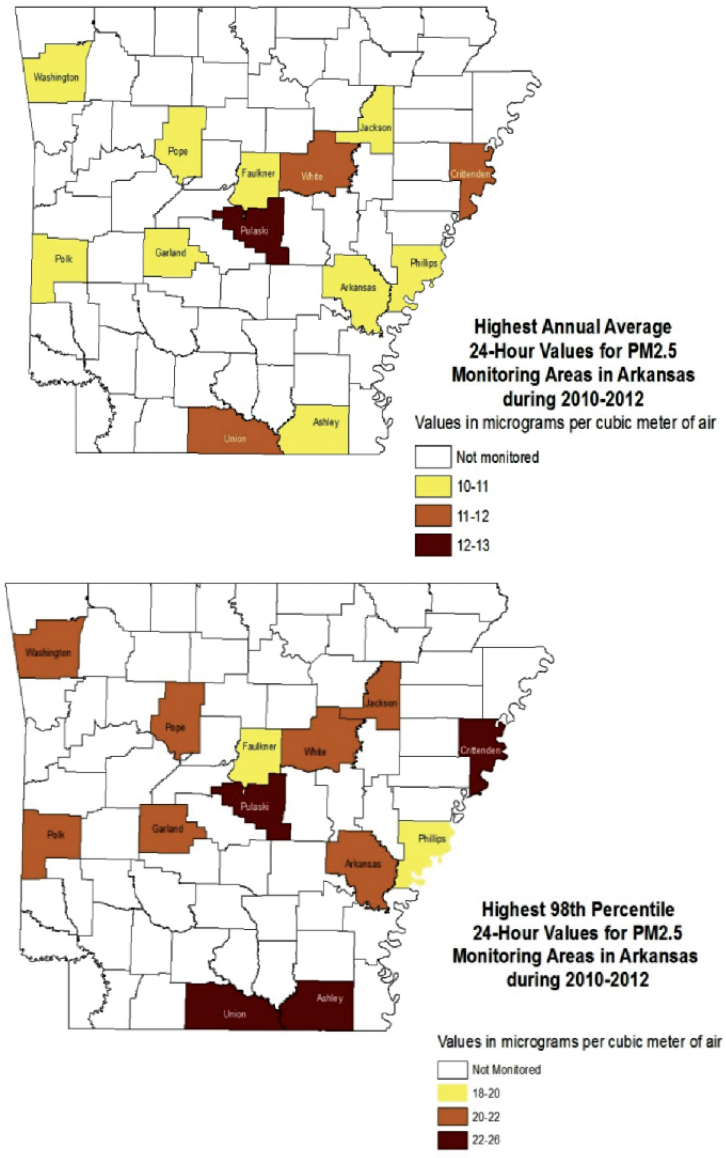


Figure 3. $PM_{2.5}$ concentrations from Arkansas air monitoring stations and relevant NAAQS $PM_{2.5}$ standards (top: *annual* average over three years; bottom: *daily* maximum values). (*Source: Compiled from data downloaded from United States Environmental Protection Agency AirData)*

Conclusion

Understanding the issue of air quality and its potential effect on public health and welfare is the first step in protecting our nation's air resources. Arkansas is one of a handful states that has consistently met the air quality standards. However, to continue meeting the current and future particulate matter standards will likely take a concerted effort from various public and private sectors, and ultimately the support and action by the citizens of the State of Arkansas.

For more information about $PM_{2.5}$, see the EPA website, which includes links to additional information on health effects, standards, implementation, etc. (http://www.epa.gov/air/airpollutants.html).

References and Selected Readings

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