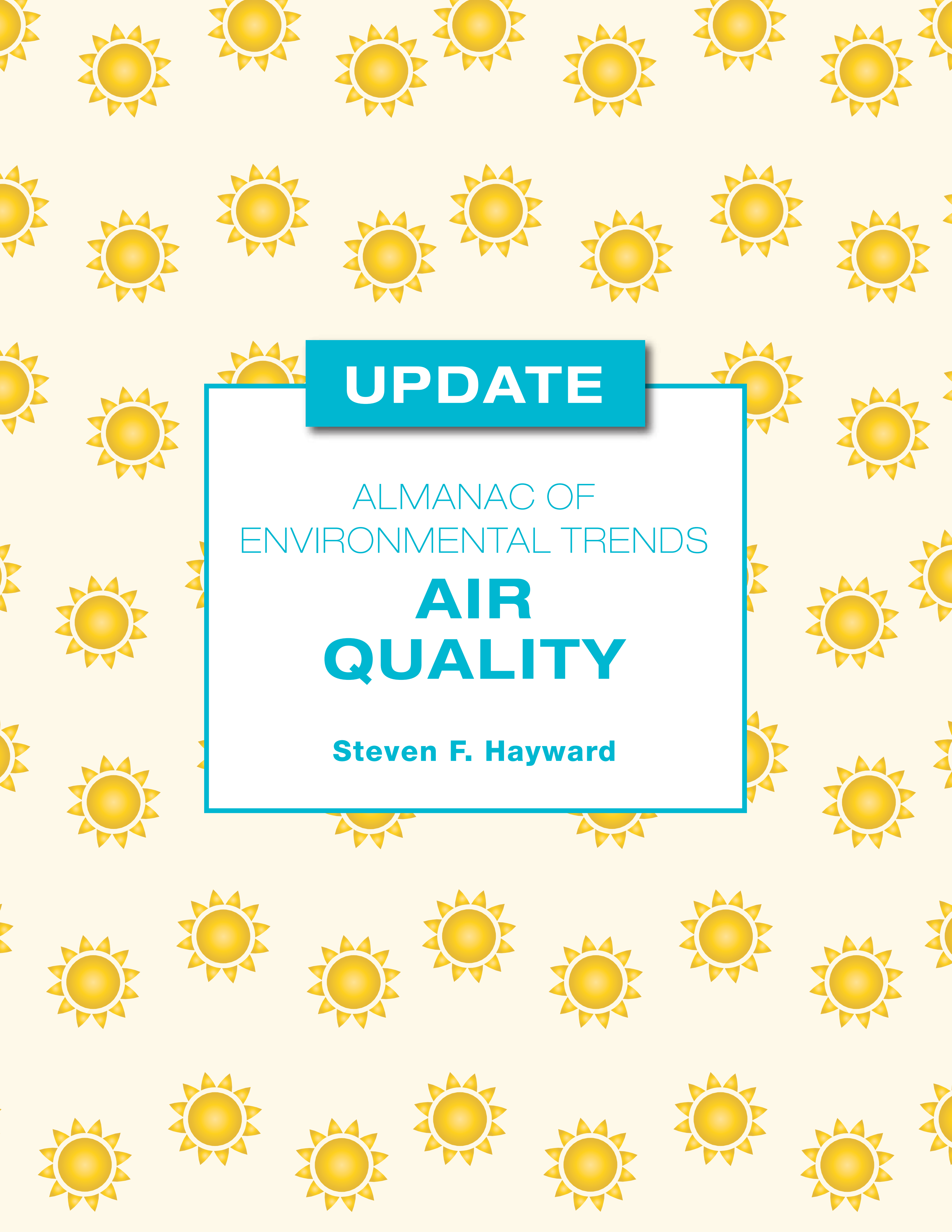

UPDATE

ALMANAC OF ENVIRONMENTAL TRENDS

AIR QUALITY

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2013 AIR QUALITY
ENVIRONMENTAL ALMANAC UPDATE
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AIR QUALITY

PRIMARY SOURCES

- Environmental Protection Agency
- U.S. Dept. of Energy, Energy Information Administration
- California Air Resources Board
- European Environmental Agency
- United Nations Environment Agency
- World Bank

SECONDARY SOURCES

- International Study of Asthma and Allergies in Childhood
- Centers for Disease Control

Emissions vs. Ambient Air Pollution

Air quality trends are measured in two ways: *emissions* and *ambient levels*. It is important to understand the distinction between these two measures. *Emissions* refers to the amount of pollutant that man-made activities generate—in other words, the amount of stuff that comes out of a smokestack or automobile tailpipe or other sources. Emissions are typically measured in pounds or tons. *Ambient level* refers to the actual concentration of a pollutant in the air and is typically measured in parts-per-million or parts-per-billion. A key point is that emissions are *estimated*, using sophisticated modeling techniques, while ambient air quality is monitored through several hundred sampling stations throughout the U.S.

Emissions are obviously important since they are the source of pollution, but the relevant measure to focus on is ambient levels, since the ambient levels measure the actual exposure to pollution. The same amount of pollutant emitted will produce very different ambient levels—and therefore human exposure levels—depending on variables such as geography, prevailing winds, temperature, humidity, and several other factors. Emissions are tracked chiefly to measure progress in control measures to reduce pollution input; ambient levels are tracked for their importance to human exposure and health risk.

Summary

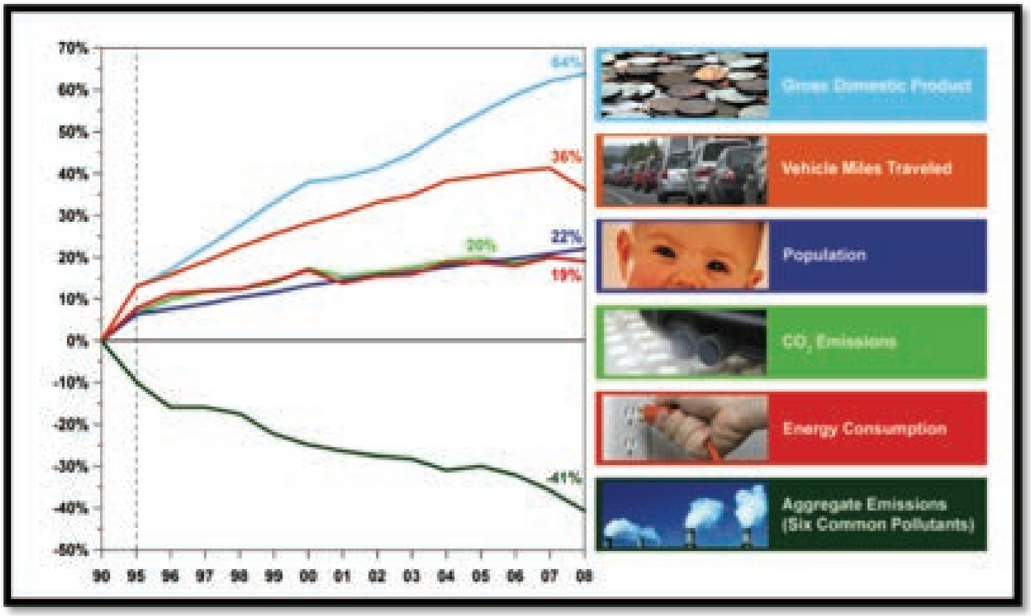
The reduction in air pollution continues to be the most successful domain of pollution reduction since the first Earth Day in 1970. Since the first edition of this *Almanac* two years ago, reductions in air pollution have been astonishing. The EPA recently updated its inventory of ambient air pollution levels monitored through 2010, and its model estimates of emissions through 2012. (See: http://www.epa.gov/airtrends/2011/ for the most recent EPA report; see sidebar for explanation of the difference between *ambient* air pollution and *emissions*.)

The new EPA data show some of the largest drops in ambient air pollution ever in 2009 and 2010, though some of this decline may have been related to the reduced economic activity of the long recession, while some of the reductions—especially in sulfur dioxide—are explained by the unforeseen rapid replacement of coal-fired electricity by natural gas. To take one important example, the Los Angeles basin, long the site of the nation's most severe smog, recorded just seven exceedences of the 1-hour national standard for ozone in 2010, compared to 195 exceedences in 1977, and 33 in the year 2000. And most of these exceedences in the LA basin are confined to outlying areas; much of the LA basin with the highest concentration of population saw no exceedences of the ozone standard. Meanwhile, the reduction in sulfur dioxide emissions is occurring more rapidly than the most optimistic projections of just a few years ago.

The EPA continues to tighten the standards for air pollution, which it is allowed to do administratively under the Clean Air Act. The EPA has introduced new lower standards for five of the six "criteria" pollutants (sulfur dioxide, lead, carbon monoxide, and particle pollution) over the last three years; a new lower standard for ozone is currently in limbo, pending additional review.[1] Sometimes new standards lead to misperceptions of progress, as tougher new standards often mean that an area that was in compliance with previous standards will be found out of compliance under the new standards, requiring new regulatory steps. To the casual citizen the news that their region has become a "non-attainment" area for one or more kinds of air pollution is taken to mean that pollution is getting worse, when in fact the progressive tightening of air quality standards is actually a measure of substantial *reductions* in air pollution, and reflects largely the drive for bureaucrats to maintain or extend their regulatory authority.

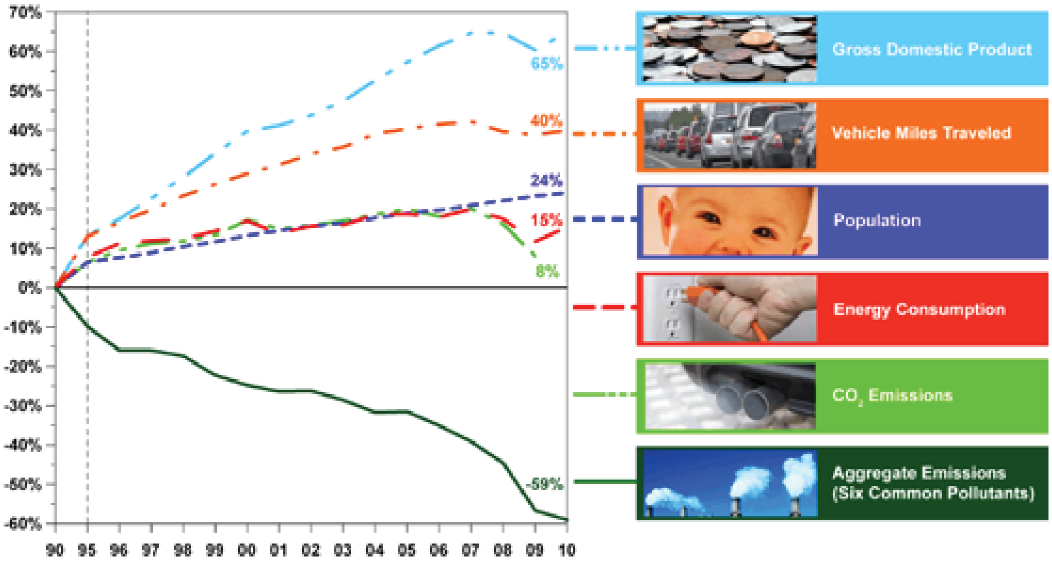
One way of grasping the divergence of the last few years, as well as placing air pollution reductions in a larger context, is to compare Figure 1a and Figure 1b on the next page. Figure 1a is drawn from the EPA's 2008 air quality trends report, while Figure 1b is drawn from the 2010 report. Notice that during the two-year interval between these figures, total emissions of the six criteria pollutants declined from -41 percent to -59 percent—almost a *one-third* reduction in total emissions in just two years compared to the entire preceding 20-year period.

Figure 1a: Comparison of Growth Measures and Emissions, 1990 - 2008



Source: EPA

Figure 1b: Comparison of Growth Measures and Emissions, 1990 - 2010



Source: EPA

Highlights

A review of the data reveals four main findings about air pollution trends:

- ***Virtually the entire nation has achieved clean air standards for four of the six main pollutants regulated under the Clean Air Act*** (carbon monoxide, sulfur dioxide, nitrogen oxides, and lead). The only pollutant where the clean air standard is still widely exceeded is ozone.

- In the case of ozone and particulates, ***the areas of the nation with the highest pollution levels have shown the greatest magnitude of improvement***. The average ambient declines in pollution on the national scale that are reported here *understate* the magnitude of improvement in the worst areas. On the flip side, the EPA's regulatory structure systematically overstates the number of Americans exposed to unhealthy air.

- The chief factor in the reduction in air pollution has been ***technological improvement***, mostly in "process efficiency" such as more complete fuel combustion, but also in control technologies that capture emissions, such as power plant "scrubbers" and catalytic converters on automobiles. Regulatory mandates played a prominent role in prompting some of these technological changes, but many were the result of market forces and economic growth, as can be seen by the fact that air pollution began dropping in the U.S. in the mid-1960s—*before* the passage of the first Clean Air Act.

- ***The long-term trend of improving air quality is certain to continue.*** Government air quality models project significant decreases in emissions over the next 20 years as technology improvement and equipment turnover continue. At the present time, however, reductions in air pollution are occurring more rapidly than the EPA's models have forecast.

Table 1 displays the EPA's calculation of the improvement in average ambient air quality, and emissions for the nation as a whole from 1980 through 2008 for the six main air pollutants targeted under the Clean Air Act. These reductions are all the more impressive when viewed in comparison with the increase in economic output, population, energy use, and driving since 1990, which the EPA displays in Figure 1. The six major types of air pollution are described in more detail in the next section.

Table 1. Change in National Average Ambient Levels, 1980 – 2010*

	Ambient
Carbon Monoxide (CO)	-82%
Ozone** (O_3)	-27%
Lead (Pb)	-89%
Nitrogen Dioxide (NO_2)	-52%
Particulates (PM_{10}), 1985–2010	-38%
Fine Particulates ($PM_{2.5}$), 1999–2010	-27%
Sulfur Dioxide (SO_2)	-83%

**Except for PM_{10} and $PM_{2.5}$, as noted. **Emissions measure here is VOCs, a principal ozone precursor*

Source: EPA

Table 2. Change in National Emissions, 1980 – 2012*

	Emissions
Carbon Monoxide (CO)	-65%
Ozone** (O_3)	-50%
Lead (Pb)	-96%
Nitrogen Dioxide (NO_2)	-58%
Particulates (PM_{10}), 1985–2012	-48%
Fine Particulates ($PM_{2.5}$), 1990–2012	-36%
Sulfur Dioxide (SO_2)	-78%

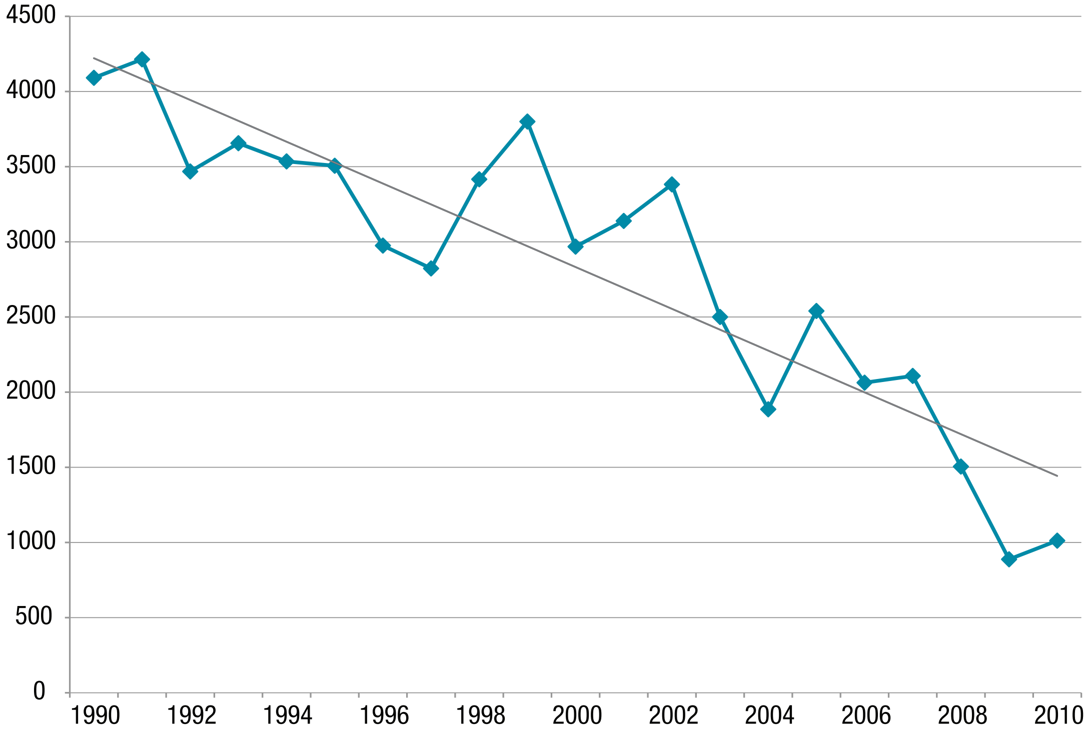
**Except for* PM_{10} *and* $PM_{2.5}$*, as noted. 2010 and 2012 emissions are estimates. **Emissions measure here is VOCs, a principal ozone precursor*
Source: EPA

The Air Quality Index

Another way of grasping the overall ongoing improvement in air quality is to look at the long-term trend of the EPA's Air Quality Index (AQI). The AQI is the metric used for declaring "unhealthy" air days for sensitive people (typically children, the elderly, and people with respiratory disease) in local metropolitan areas (the threshold is 100 on the AQI scale), and while this aggregate measure has some defects it is still useful as an indicator of general air quality trends. For the 88 metro areas that calculate the AQI, the EPA notes significant declines in the number of days each year the 100 threshold has been reached over the last 20 years. The AQI trend comes in three versions—for all air pollutants, for ozone only, and for $PM_{2.5}$ (because of the switch in measuring particle pollution from PM_{10} to $PM_{2.5}$ starting in 1999). All three variations, shown in Figures 2, 3, and 4, show that lowest threshold "unhealthy" level of air pollution (i.e., for "sensitive" people, i.e., the elderly, people with respiratory diseases, and children) is experienced less than 10 percent of the time in American cities, and that the number of exceedences of the 100 level have declined substantially, especially in the last decade.[2]

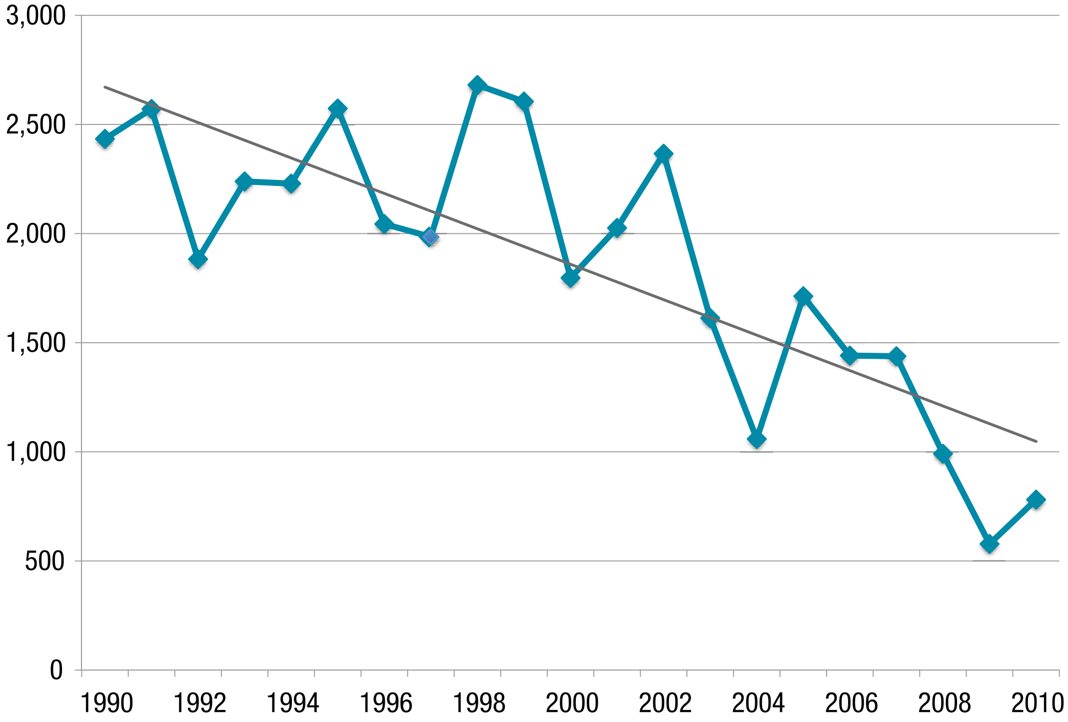
For all air pollutants, the cumulative number of exceedences has declined from a peak of just over 3,800 days in 1999 to 1,012 in 2010 (Figure 2). For ozone only, the number of AQI exceedences has gone from a peak of 2,700 in 1998 to 995 in 2010 (Figure 3), and for $PM_{2.5}$, the number of exceedences has fallen from a peak of 735 in 2001 to 173 in 2010 (Figure 3).

Figure 2: Air Quality Index Trend Based on All Pollutants, 1990 – 2010 (Number of Days Each Year the AQI Exceeded 100, All Metropolitan Areas)



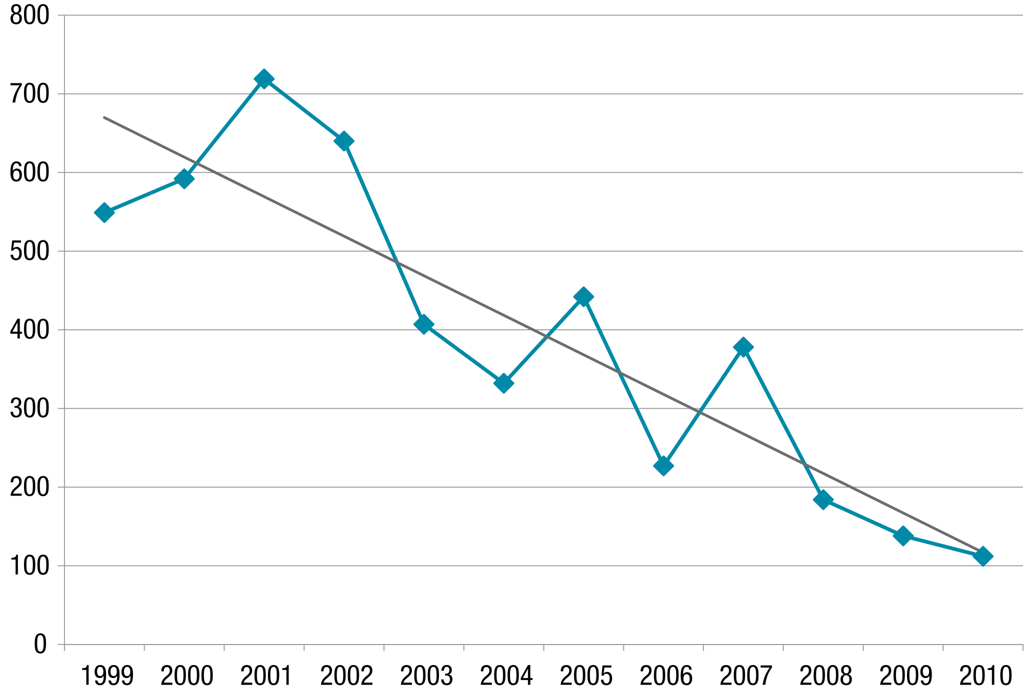
Source: EPA

Figure 3: Air Quality Index Trend, Ozone Only, 1990-2010



Source: EPA

Figure 4: **Air Quality Index Trend, $PM_{2.5}$ Only. 1999-2010**



(Source: EPA)

Main Types of Air Pollution and their Long-Term Trends

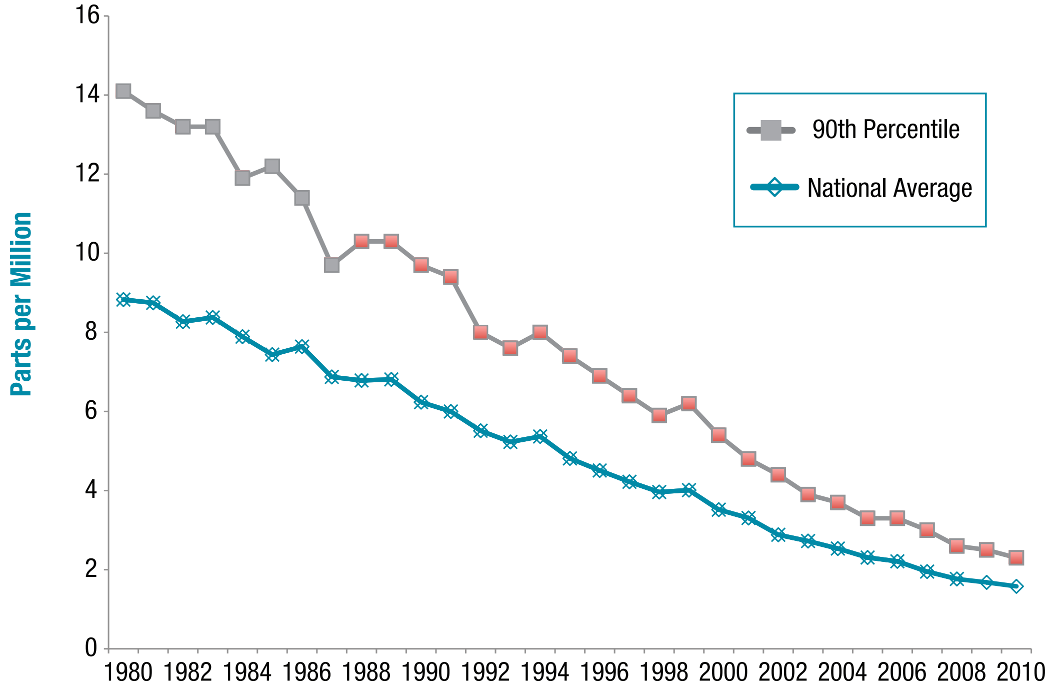
CARBON MONOXIDE

Carbon monoxide (CO) is a colorless, odorless, and at high levels, poisonous gas. Although trace amounts of CO occur naturally in the atmosphere, it is mainly the product of incomplete combustion of fossil fuels. Transportation sources (cars and trucks mostly) account for over 80 percent of the nation's total emissions.

Average national ambient carbon monoxide (CO) levels have fallen by 79 percent since 1980, and 83 percent since 1970, as shown in Figure 5. Figure 5 also displays the trend for the 90th percentile—that is, the locations with the highest levels of CO—have shown a similar decline.

The EPA's target level for CO is 9 parts per million (ppm). At an average national level of less than 2 ppm, ambient CO levels have met the EPA's target "good" range for the entire nation since 1993. It is noteworthy that these reductions occurred despite a 180 percent increase in vehicle miles traveled (VMT) and that they occurred at sites across all monitoring environments—urban, suburban, and rural.

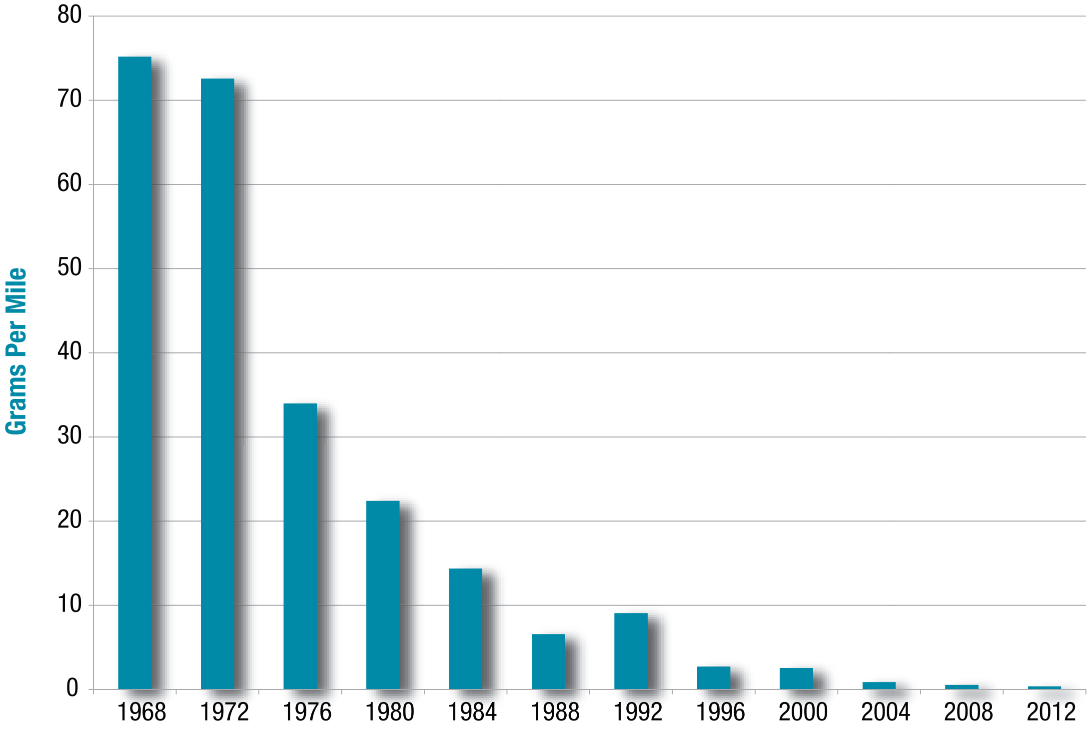
Figure 5: National Ambient Carbon Monoxide Trend, 1980-2010



Source: EPA

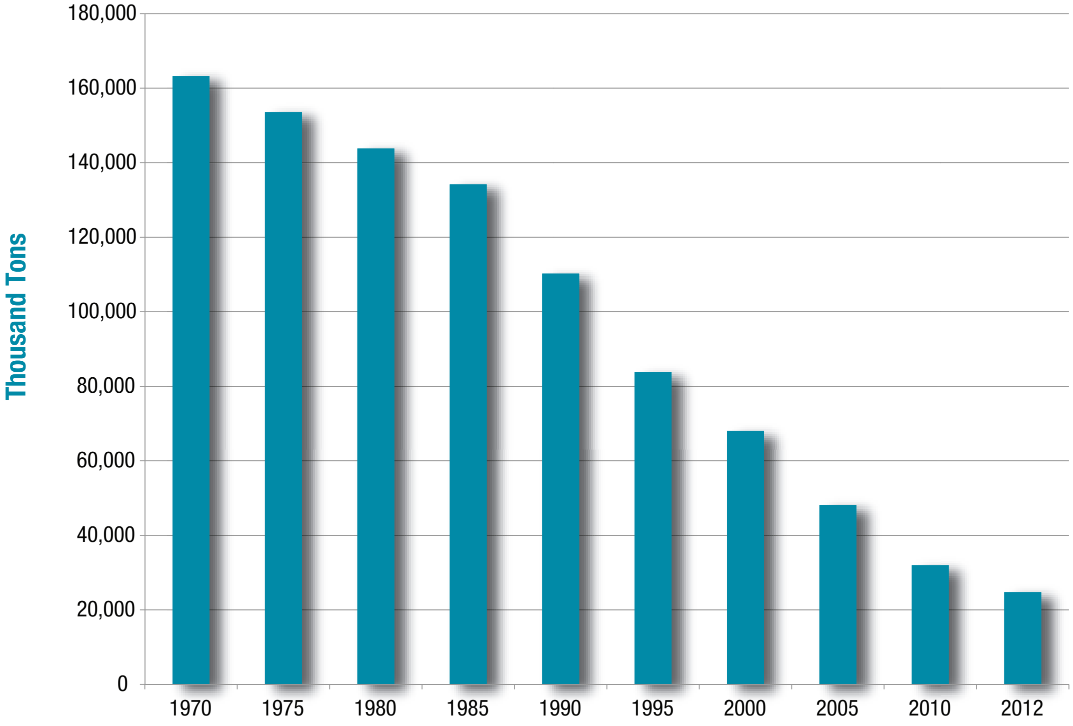
The decline in CO emissions is a good case study in the effects of better technology. Autos in the late 1960s emitted over 75 grams of CO per mile; new autos today emit less than .4 grams per mile—a 99.5 percent reduction in emissions.[3] Figure 6 displays the declining trend in average auto CO emissions, and Figure 7 displays the 85 percent decline in CO emissions from cars and trucks. Further reductions in CO emissions can be expected with turnover of the auto and truck fleet, as older models are retired and taken off the road. (A model year 2000 auto emits 2.5 grams of CO per mile—seven times as much as a 2012 model. With Americans holding on to their cars more than 10 years on average, there are still large emissions reductions to come from fleet turnover.)

Figure 6: Automobile Carbon Monoxide Emission Rate Per Mile, 1968-2012



Source: California Air Resources Board, EMFAC Emissions Database

Figure 7: Total Carbon Monoxide Emissions from Cars and Trucks, 1970-2010



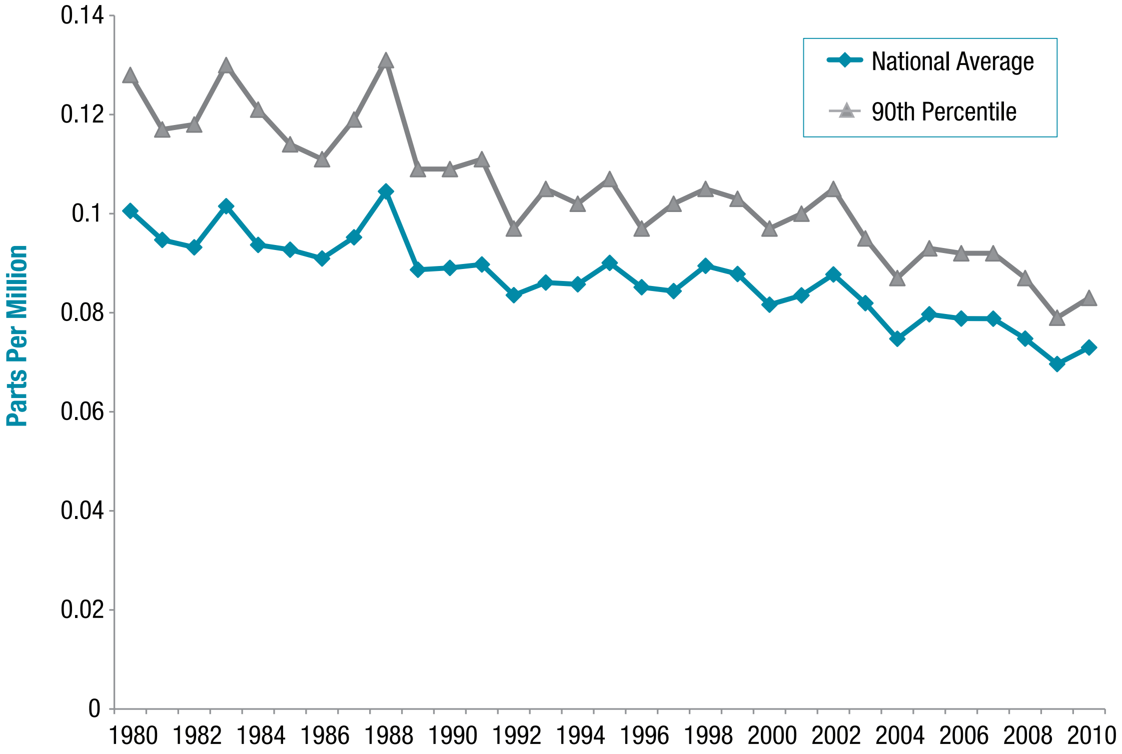
Source: EPA

OZONE

Ground-level ozone is the primary contributor to urban smog, although sulfur, nitrogen, carbon, and fine particulate matter contribute to smog's formation as well. Ozone is not emitted directly into the air, but rather, it forms when volatile organic compounds (VOCs—chiefly hydrocarbons from fossil fuels and chemical solvents, though there are many naturally occurring photosynthetic sources as well) combine in sunlight with nitrogen oxides (NO_x), depending upon weather-related factors. Because of this, it is difficult to accurately predict changes in ozone levels due to reductions in VOCs and NO_x, and ozone is proving to be one of the tougher air pollution problems. Trends in ambient ozone concentrations are influenced by various factors: changes in meteorological conditions from year to year, population growth, VOC to NO_x ratios, and by fluctuations in emissions from ongoing control measures. Ozone problems occur most often on warm, clear, windless afternoons.

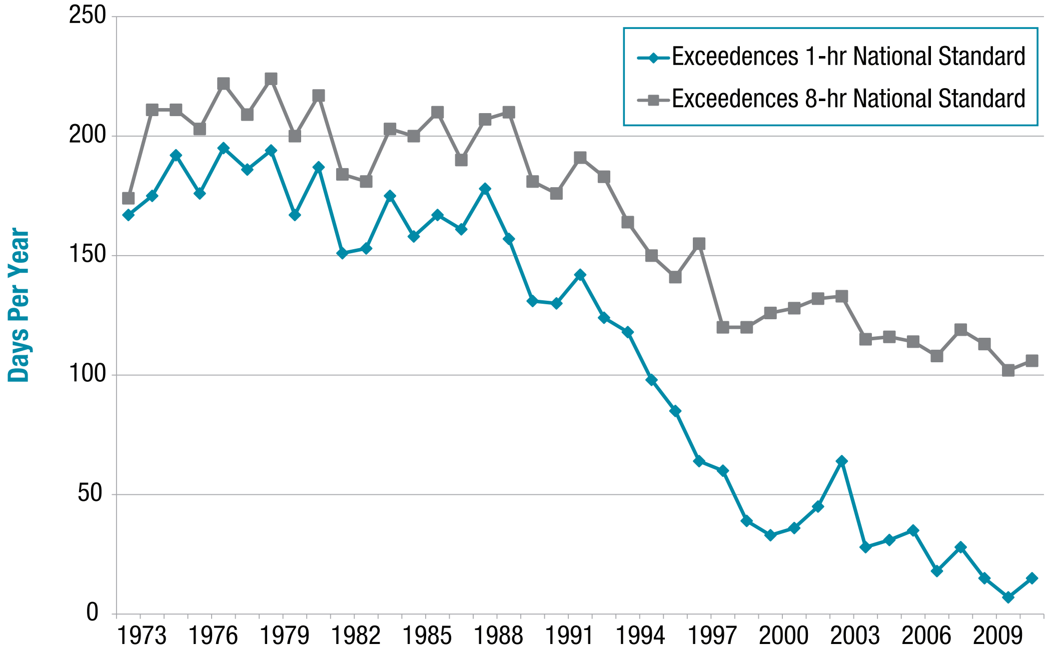
Ambient national average ozone levels have declined 27 percent since 1980, as shown in Figure 8, which displays the average level and level at the 90th percentile. This average national figure understates the magnitude of improvement, however, as ozone levels in the worst locations, such as Los Angeles, have fallen much more than the national average. The 8-hour peak ambient ozone level has fallen 67 percent since 1980 (Figure 9), and the number of days Los Angeles exceeded the older 1-hour ozone standard fell from 167 days in 1980 (nearly half the year) to just 15 days in 2011, while exceedences of the new stricter 8-hour standard fell from 200 days in 1980 to 106 days in 2011 (Figure 10). Overall the EPA classified 113 metropolitan areas as "nonattainment" zones for the new ozone standard in 1997; today the number of nonattainment areas has fallen to 41.

Figure 8: **Ambient National Ozone Trend (8-hr standard), 1980-2010**



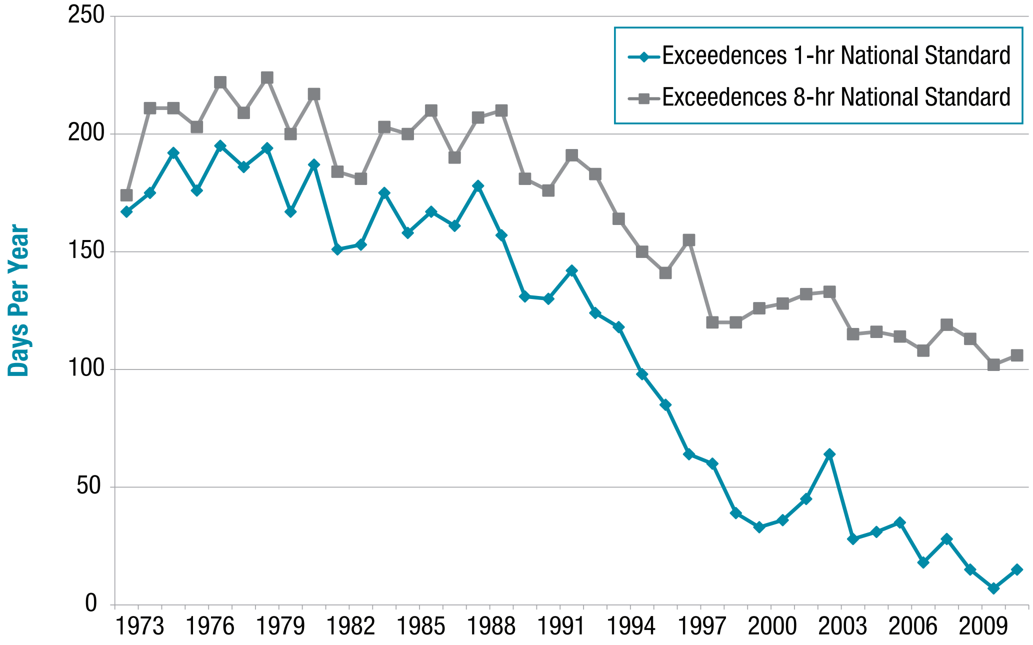
Source: EPA

Figure 9: Peak Ozone Levels in Los Angeles, 1973-2011



Source: California Air Resources Board

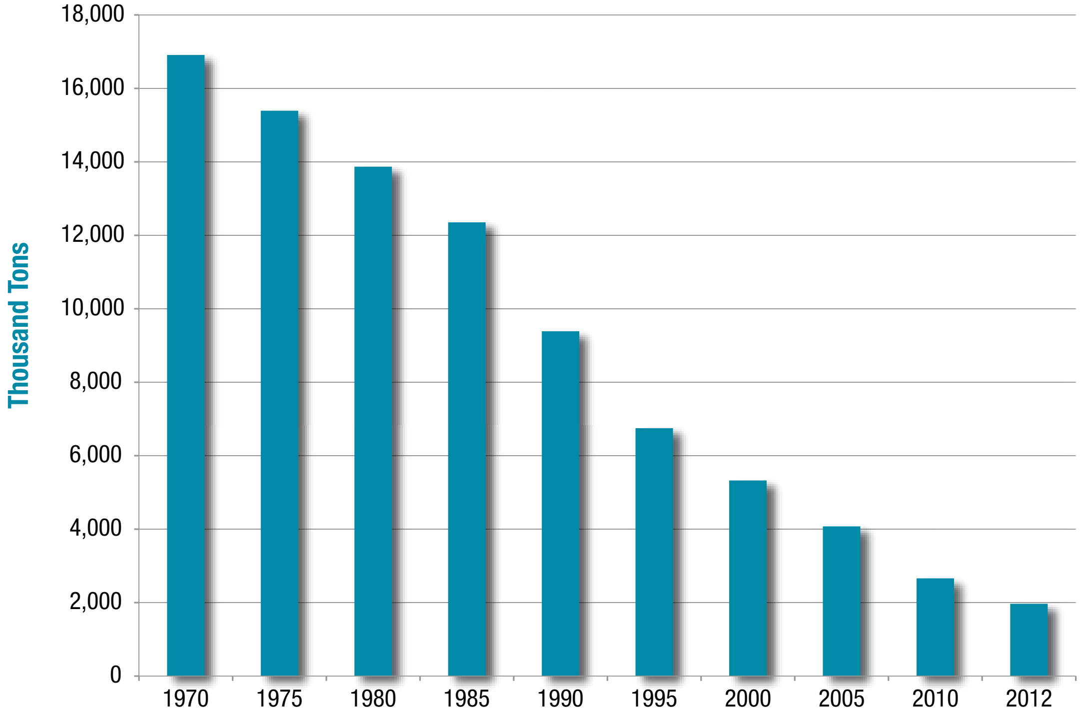
Figure 10: Number of Days Los Angeles Exceeded Ozone Standard 1973-2011



Source: CARB

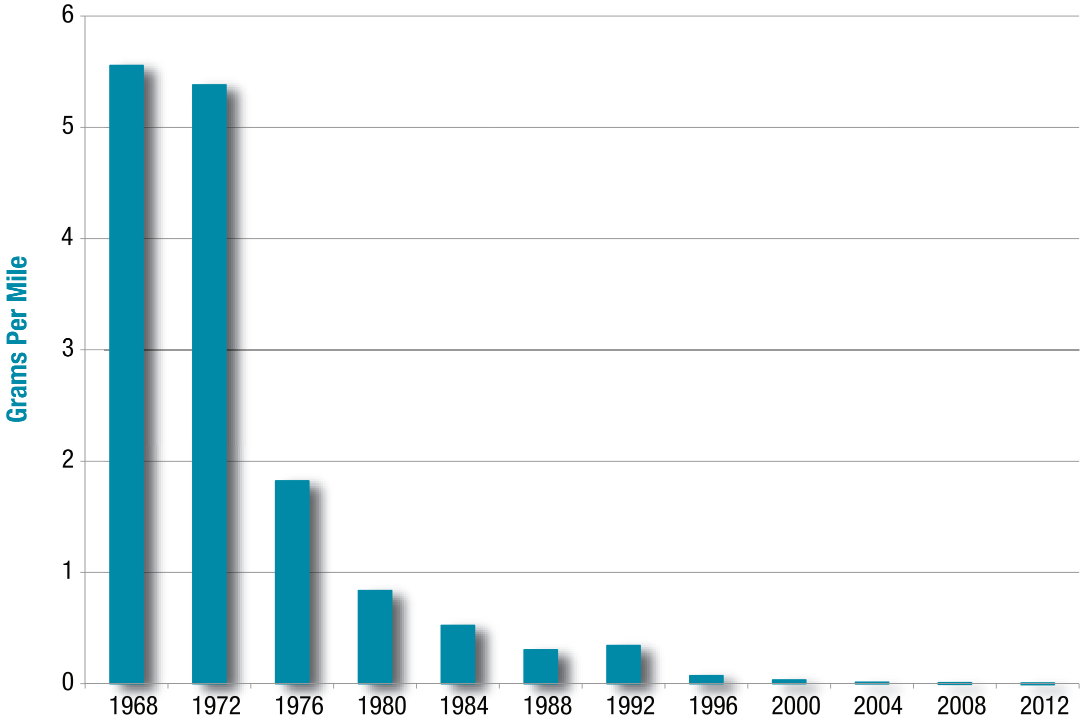
As was the case with carbon monoxide, reductions in emissions from automobiles have been the major factor in reducing ozone-forming emissions of both VOCs and nitrogen oxides (NO_x). Figure 11 displays the 88 percent reduction in VOC emissions from cars and trucks from 1970 to today, while Figure 12 displays the 99 percent reduction in tailpipe emissions of VOCs from individual cars and trucks since the late 1960s—from over 10 grams per mile in the late 1960s to 0.062 grams per mile today. As an example of the technological progress that has achieved these reductions, consider that *a 1970 model car sitting in a driveway will evaporate more VOCs from its carburetor than a 2010 model car driving at freeway speed.*

Figure 11: Total VOC Emissions from Cars and Trucks, 1970-2012



Source: EPA

Figure 12: Automobile Hydrocarbon Emissions Rate per Mile



Source: CARB

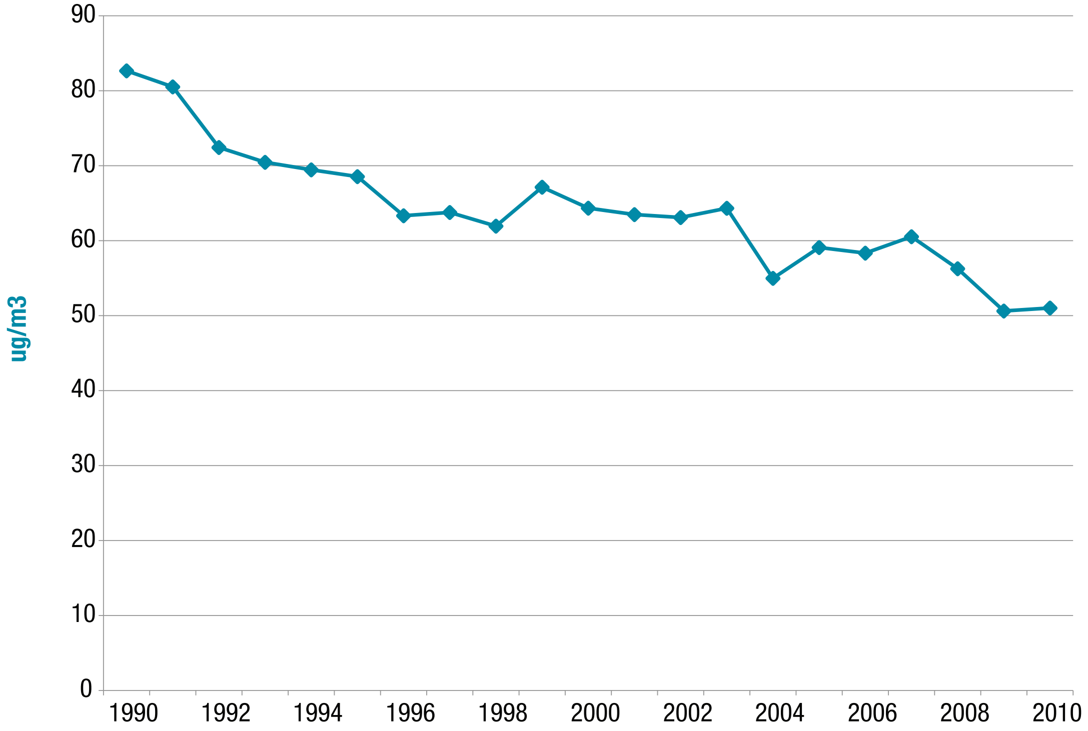
PARTICULATES (PARTICLE POLLUTION)

Particulate matter, or "particle pollution" as the EPA is now calling it, is the general term used for a mixture of solid particles, including pieces of dust, soot, dirt, ash, smoke, and liquid droplets or vapor directly emitted into the air, where they are suspended for long periods of time. Particulates can affect breathing and damage paints and reduce visibility. These particles derive from stationary, mobile, and natural sources. Such sources include forest fires and volcanic ash; emissions from power plants, motor vehicles, wood stoves, and waste incineration; and dust from mining, paved and unpaved roads, and wind erosion of natural dust sources. Indeed some of the highest particulate levels in the nation are found in Inyo County, California, from dry lake bed dust rather than human-made sources.

The classification of particulates has changed dramatically in recent years, with the threshold for monitoring and regulating particulates reduced from particles 10 microns in size—(PM_{10}) about one-fifth the thickness of a human hair—down to 2.5 microns in size—($PM_{2.5}$) or one-twentieth the thickness of a human hair, or 1/36th the size of a fine grain of beach sand. The EPA also moved from an annual peak average concentration to a 24-hour peak hour concentration, measured in micrograms per cubic meter rather than parts per million. Monitoring for the new $PM_{2.5}$ standard has been in place only since 1999, and monitoring for annual PM_{10} is being phased out.

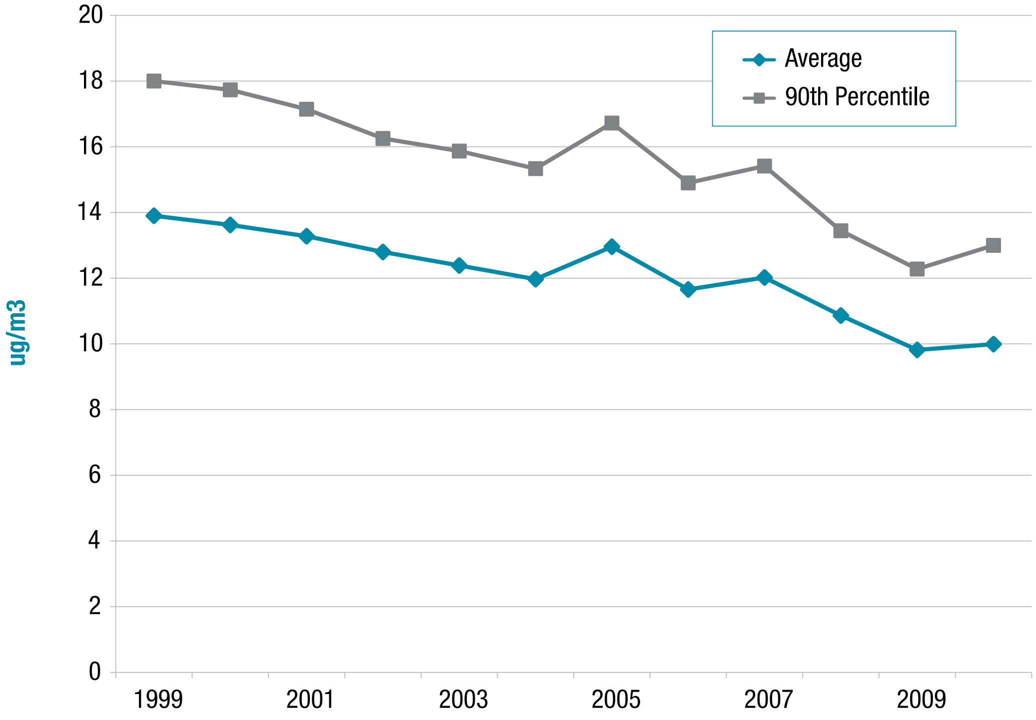
Figure 13 shows that average annual level of PM_{10} has fallen 38 percent since 1990, while Figure 14 shows the 24-hour average and 90th percentile $PM_{2.5}$ level has fallen 28 percent since 1999. Figure 14 also shows that the level at the 90^{th} percentile has fallen to below the average level of the whole nation in 1999.

Figure 13: Average Annual Ambient PM_{10} Levels, 1990 - 2010



Source: EPA

Figure 14: Average 24-Hr $PM_{2.5}$ Level, 1999 - 2010

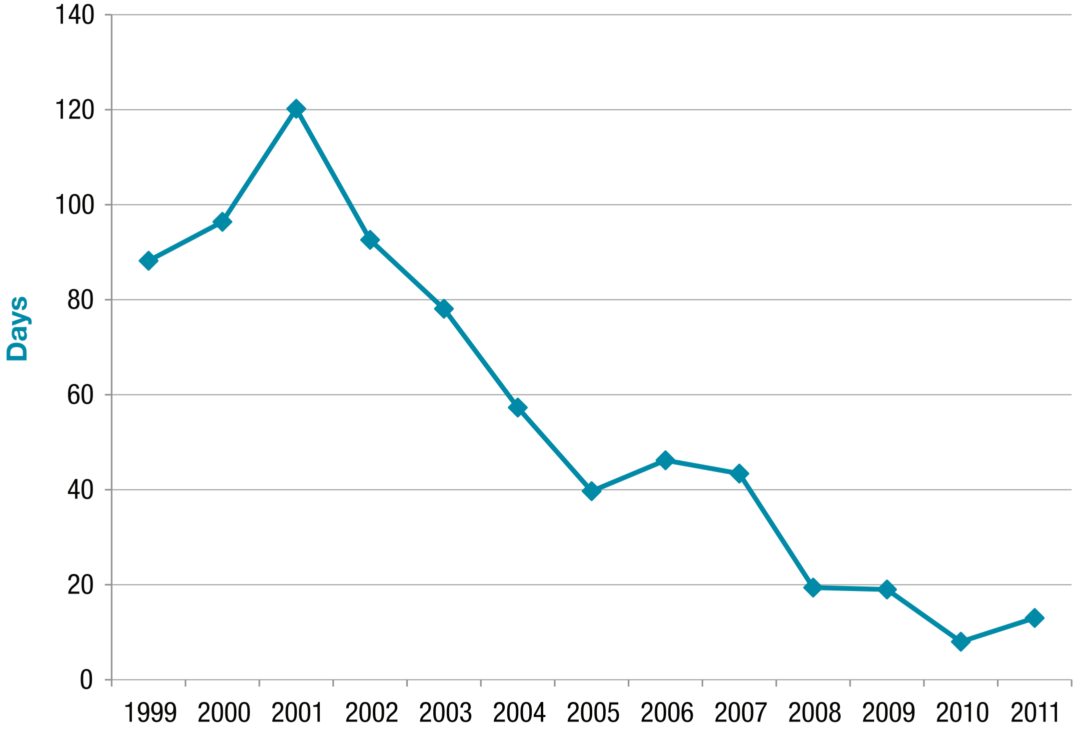


Source: EPA

The EPA threshold for an unhealthy level of $PM_{2.5}$ is a 24-hour average level above 35 micrograms per cubic meter (ug/m^3). As of 2008, 31 metropolitan areas recorded $PM_{2.5}$ levels above this standard.

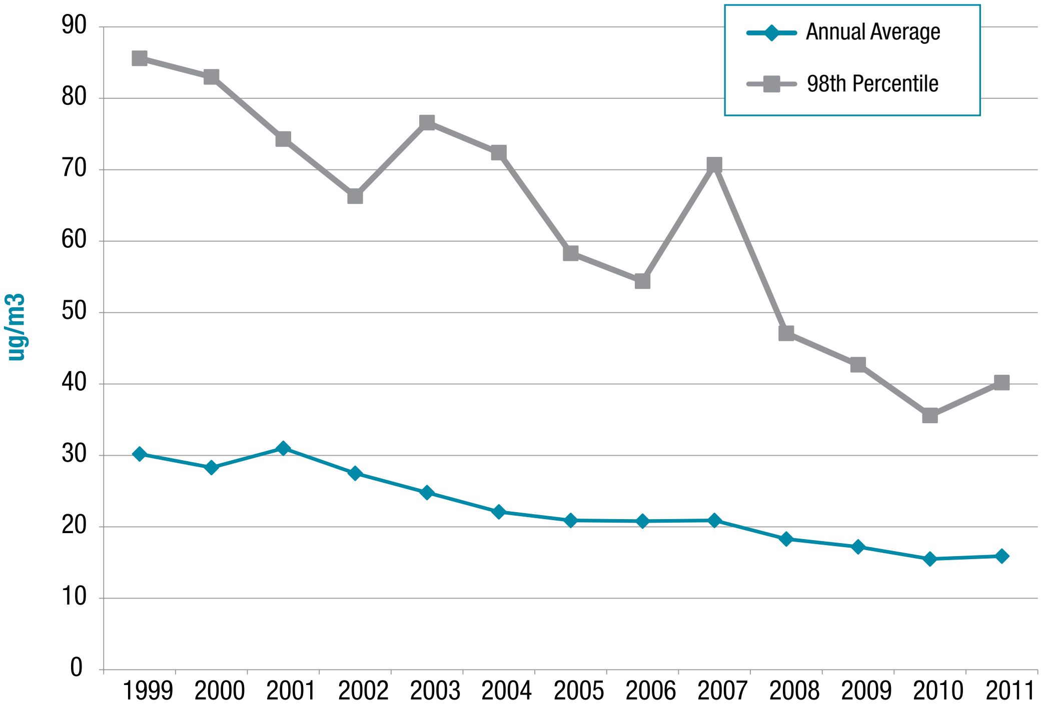
As is the case with ozone, areas with the highest levels of particulates have experienced larger than average declines in particulate pollution. Figure 15 shows that the number of days Los Angeles exceeded the $PM_{2.5}$ standard fell from 120 days in 2001 to just 13 days in 2011, while Figure 16 shows that levels of $PM_{2.5}$ fell by more than twice the national trend over the same time period (-47 percent on average, and -50 percent at the 98th percentile level).

Figure 15: Exceedences of $PM_{2.5}$ Standard in Los Angeles, 1999-2011



Source: CARB

Figure 16: Ambient Levels of $PM_{2.5}$ in Los Angeles, 1999-2011



Source: CARB

LEAD

Lead is a soft, dense, bluish-gray metal that is used in the production of piping, batteries, weights, gunshot, and crystal. Of the six criteria pollutants, lead is the most toxic; when it is ingested through food, water, soil, dust, or inhaled through the air, it accumulates in the body's tissues. Because it is not readily excreted, high concentrations and excessive exposure to lead can cause anemia, kidney disease, reproductive disorders, and neurological impairments such as seizures, mental retardation, and behavioral disorders—including perhaps crime. (See sidebar.) Today, the highest concentrations of lead are found in the surrounding area of nonferrous and ferrous smelters, battery manufacturers, and other stationary sources of lead emissions.

The decline in ambient lead concentration is the greatest success story in the efforts to reduce air pollution. In the United States, ambient lead concentrations decreased 89 percent between 1976-2010. Most of this reduction was achieved through the introduction of unleaded gasoline in the 1980s, and the elimination of lead compounds in paints, coatings, and point sources, such as smelters and battery plants.

Young children are the most vulnerable to blood lead and high blood lead levels in small children retard brain and IQ development. Children who live in older housing in the inner city that has lead-based paint are still at risk for high blood lead levels, but the pervasive threat of lead from poor urban air is a problem of the past. Lead in blood samples is a much better indicator of the public health impact of lead than outdoor air quality. Between the late 1970s and 1991, the proportions of people who had more than 10 micrograms of lead per deciliter of blood declined from 78 percent to 4.3 percent. (See the section on Toxic Chemicals for more data on lead levels in humans.)

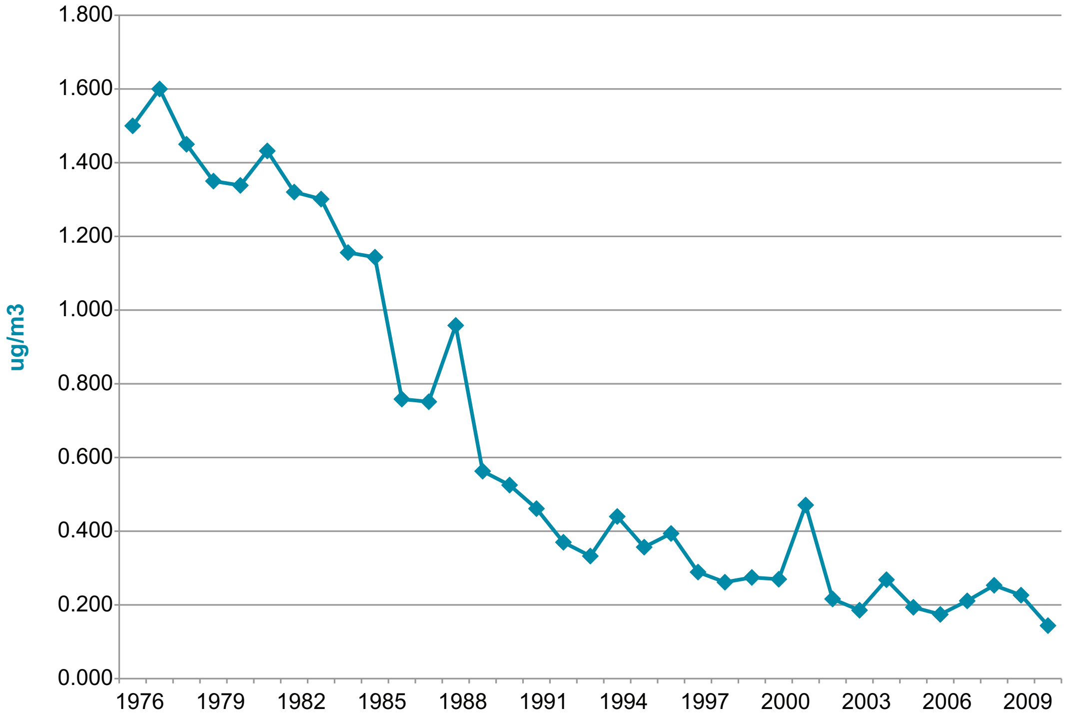
Particle Pollution in China: How Bad Is It?

The short answer to this headline is—really, really bad. Possibly worse than any level ever likely experienced in the United States. On January 13, 2013, Beijing recorded a peak level of PM$_{2.5}$ of 886 micrograms per cubic meter. This level is 22 times higher than the worst recorded level in Los Angeles, which has the highest metropolitan PM$_{2.5}$ levels in the country), 70 times higher than the highest levels recorded on a national basis in the U.S., and almost 90 times higher than the average U.S. level. Energy expert Vaclav Smil observes that if Beijing's particle pollution level were evaluated according to the Air Quality Index the U.S. uses to judge health risk from air pollution, it would break the top end of the scale.[4]

As Smil explains,

> The peak concentration of 886 μg/m^3 reached on January 12 translates to an AQI of 755, far beyond the defined scale. . . Perhaps the best way to indicate how extraordinarily high such levels are is to note that regular monitoring at nearly 650 sites in the United States showed a mean concentration of 10 μg/m^3 (AQI 32), with 10 percent of sites having levels below 7 and only 10 percent of places having concentrations above 13 μg/m^3 (AQI 42). Peak Beijing levels on January 12 were thus nearly 90 times the U.S. mean, and even the city's common winter levels of 250–350 μg/m^3 are 25–35 times the U.S. mean.

Figure 17: Ambient National Lead Trend, 1976-2010



Source: EPA

Lead and Crime: Is There a Causal Connection?

The decline in airborne lead levels since the early 1970s has been connected with rising IQ scores, but might declining lead also be a major factor in the unexpected and sharp decline in the crime rate since the early 1990s? That is the intriguing theory of several researchers, ably summarized by Kevin Drum in *Mother Jones* magazine in January 2013.[5] Reviewing several studies widely scattered time, space, and methodology, Drum summarizes:

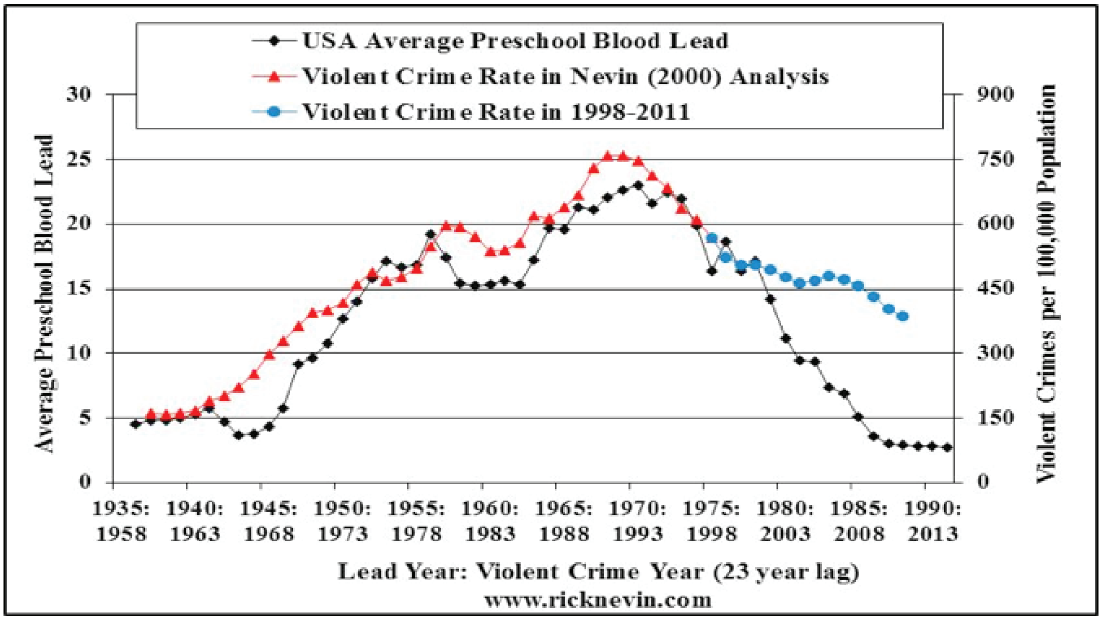
> It's the only hypothesis that persuasively explains both the rise of crime in the '60s and '70s and its fall beginning in the '90s. Two other theories—the baby boom demographic bulge and the drug explosion of the '60s—at least have the potential to explain both, but neither one fully fits the known data. Only gasoline lead, with its dramatic rise and fall following World War II, can explain the equally dramatic rise and fall in violent crime.

Drum draws our attention to several academic papers on the subject, starting with Rick Nevin's 1999 study published in *Environmental Research* that traced a close statistical correlation between changing lead levels and changing crime rates.[6] As Drumm summarizes Nevin's findings, "he concluded that if you add a lag time of 23 years, lead emissions from automobiles explain 90 percent of the variation in violent crime in America. Toddlers who ingested high levels of lead in the '40s and '50s really were more likely to become violent criminals in the '60s, '70s, and '80s." Nevin returned to the issue several times over the last decade and has extended his research in several similar journal articles, which he summarizes in a PDF file on his website (www.ricknevin.com), "The Answer is Lead Poisoning."[7] Mindful of the axiom that "correlation does not equal causation," in a new paper from January 2013 Nevin walks through nine factors that argue strongly for accepting a causative correlation in the case of lead and crime.[8] (See Figure A below.)

Separate research of state-by-state lead levels and crime statistics by Amherst College economist Jessica Wolpaw Reyes arrives at the same conclusion as Nevin.[9] Reyes reaches the specific conclusion that "changes in childhood lead exposure are responsible for a 56 percent drop in violent crime in the 1990s. . . children born in the 1980s, who experienced drastically lower lead exposure after the phase-out of lead from gasoline, may have been much less likely to commit crimes when they became adults in the late 1990s and early 2000s."

While compelling, the super-numerate Jim Manzi cautions that confounding variables in these assessments come "way short of making a convincing case for spending $400 billion of taxpayer money" to remediate old houses with lead paint, as Drum, Nevin, and other advocates recommend.[10] While agreeing that Nevins and Reyes are on to something significant, Manzi points out that with just a few changes of focus in what variables are included in the statistical analysis, much of Reyes's lead-crime correlation disappears.[11] This is one of those controversies of advanced methodology that is difficult for laypeople and policy makers to follow, but keep your eye on it—there's likely to be increasing attention to this and other environmental factors in behavioral change.

Figure A: Childhood Lead Levels and Crime Rate



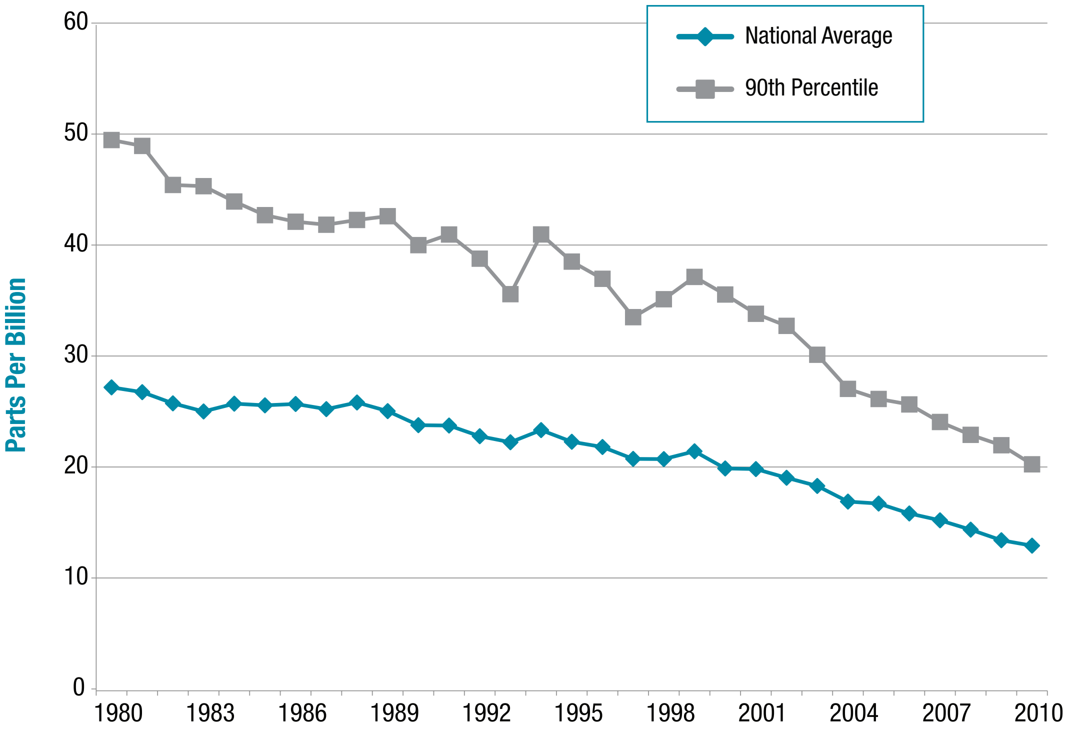
NITROGEN DIOXIDE

Nitrogen oxides (NO_x) form naturally when nitrogen and oxygen combine through bacterial action in soil, lightning, volcanic activity, and forest fires. Nitrogen oxides also result from human activities including high-temperature combustion of fossil fuels by automobiles, power plants, industry, and the use of home heaters and gas stoves.

Environmental agencies particularly track the light brown gas nitrogen dioxide (NO_2) because it is a precursor (along with VOCs) in the formation of ozone.

The national average for ambient levels of nitrogen dioxide decreased by 52 percent from 1980-2010 (59 percent for the 90th percentile), as shown in Figure 18. All monitoring locations across the country, including Los Angeles, currently met the national NO_2 air quality standard. Nonetheless, current regulatory efforts aim for large further reductions in NO_x emissions in order to combat ozone.

Figure 18: Ambient Nitrogen Oxide Trends, 1980-2010

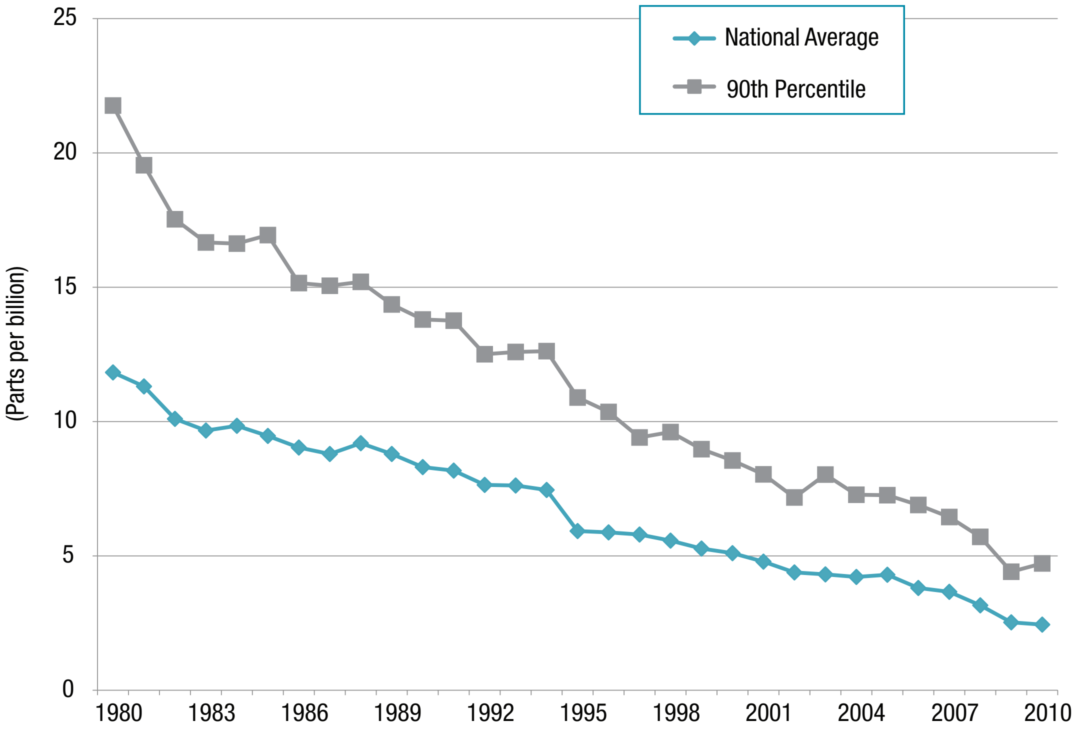


Source: EPA

SULFUR DIOXIDE

Sulfur dioxide (SO_2) is a colorless gas that forms from the burning of fuel containing sulfur (mainly coal and oil), as well as from industrial and manufacturing processes, particularly the generation of electrical power. Environmental factors such as temperature inversion, wind speed, and wind concentration also affect SO_2 levels. SO_2 can contribute to the formation of both ozone and fine particle ($PM_{2.5}$) pollution. The average ambient national level of sulfur dioxide decreased 79 percent between 1980 and 2010 (Figure 19), and the entire United States currently met the EPA's designated "good" category.

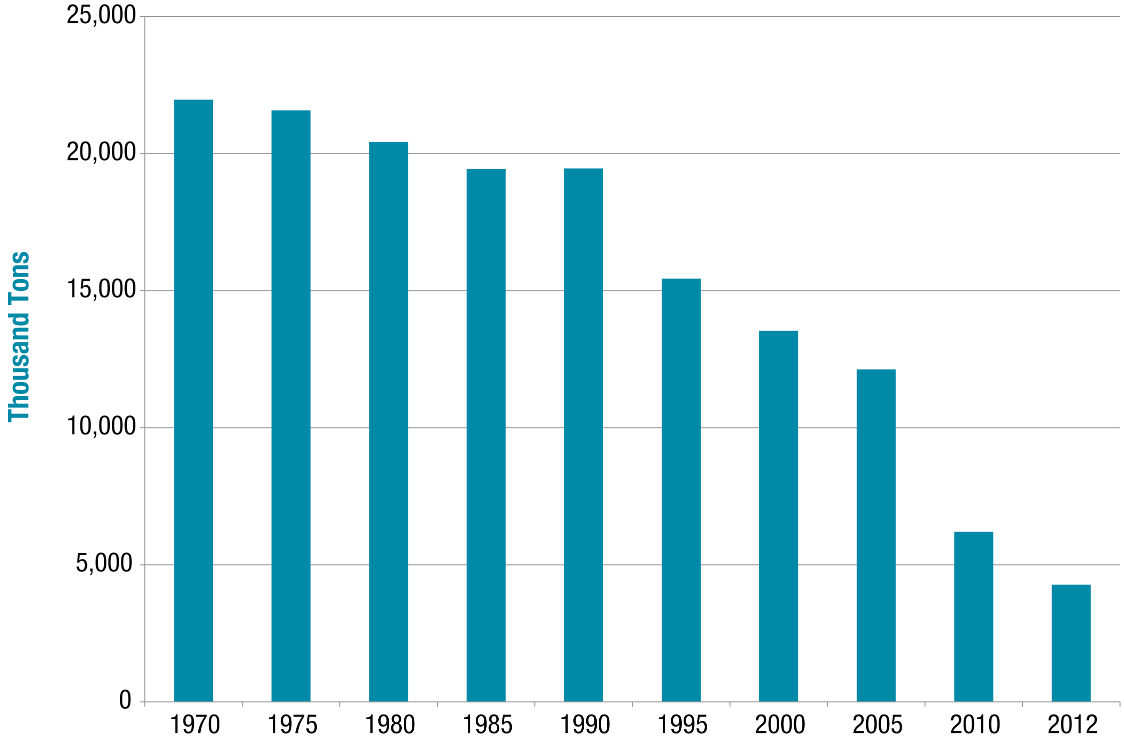
Figure 19: Ambient Sulfur Dioxide Trends, 1980-2010



Source: EPA

Fuel combustion from electric utilities and industrial production account for more than three-quarters of SO_2 emissions. As Figure 20 displays, SO_2 emissions from electric utilities and industrial combustion have fallen 80 percent since 1970, with most of that reduction occurring in the last five years. The acceleration of the replacement of coal-fired with natural gas-fired electricity generation over the last two years will likely deliver a further substantial reduction in ambient levels of SO_2 when the monitor date from 2011 and 2012 is collated and analyzed.

Figure 20: SO_2 Emissions from Electric Power Plants and Industrial Production, 1970 - 2012

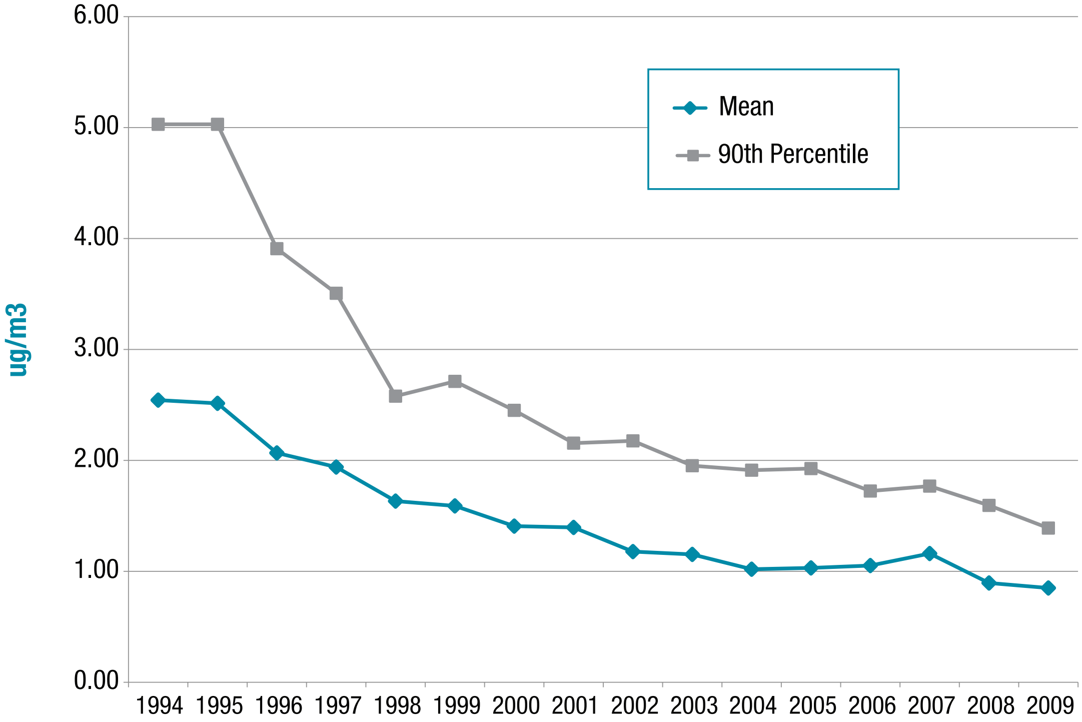


Source: EPA

HAZARDOUS AIR POLLUTANTS (HAPS)

The Clean Air Act requires the EPA to regulate 187 other hazardous air pollutants (HAPS) such as benzene and formaldehyde, but because these compounds are emitted in such small quantities they are hard to monitor. Starting in 2003 the EPA established 27 monitoring sites, but supplements its data with state and local monitoring efforts. While the small number of monitoring sites limits the reliability of the data, the EPA concludes that ambient levels of most of the 187 air toxics declined by as much as 5 percent per year between 2003 and 2010 (for methyl chloroform, for example). Benzene, the most prevalent HAP, has declined 66 percent (72 percent at the 90th percentile level), as shown in Figure 21. The only air toxic compounds that appear to have increased were dichloromethane and chloromethane.[12] California has monitored several air toxics since 1989; its data show an 89 percent reduction in ambient mean benzene levels from 1989 to 2011, and similar reductions in three other principal air toxics.[13] The California Air Resources Board estimates that this decline translates to a reduction in the lifetime cancer risk from benzene exposure from 275 in a million population to 30 per million.[14]

Figure 21: **Ambient Benzene Levels, 1994-2009**



Source: EPA

Detailed and widespread monitoring of the kind necessary for the reporting and tracking of air pollution trends is a relatively recent phenomenon even in the United States, dating back to the early 1970s. However, there are proxy sources of data that have emerged from climate research that can tell us about some air quality conditions decades ago, in addition to EPA emissions models that derive estimates of pollution levels from co-efficients of fuel combustion. One of the more interesting recent research results was a 2008 study in the Proceedings of the National Academy of Sciences about toxic metal levels detected in arctic ice core sample studies.[15] Working from Greenland ice core samples, researchers Joseph McConnell and Ross Edwards of the Desert Research Institute constructed estimates of monthly and annual levels of thallium, cadmium, and lead levels from 1772 – 2003. Their findings upended the long-held view that heavy metal pollution from fuel combustion (chiefly from coal) peaked in the 1960s or 1970s. To the contrary, the study found that levels of the three heavy metals were two to five times higher a century ago than in recent decades. Cadmium levels peaked in 1906, while lead and thallium peaked in 1915. The study warns, however, that heavy metal levels could increase again with rising coal use in Asia.

ENDNOTES

1 http://www.epa.gov/air/criteria.html.

2 The EPA website can generate individualized AQI data tables for local areas: http://www.epa.gov/air/data/reports.html.

3 Data from CARB's EMFAC Emissions Database, http://www.arb.ca.gov/emfac/.

4 Vaclav Smil, "Just How Polluted Is China Anyway?", http://www.american.com/archive/2013/january/just-how-polluted-is-china-anyway.

5 http://www.motherjones.com/environment/2013/01/lead-crime-link-gasoline.

6 Rick Nevin, "How Lead Exposure Relates to Temporal Changes in IQ, Violent Behavior, and Unwed pregnancy," *Environmental Research*, Vol. 83, no. 1, May 2000, pp. 1-22; http://www.sciencedirect.com/science/article/pii/S0013935199940458.

7 http://www.ricknevin.com/uploads/The_Answer_is_Lead_Poisoning.pdf.

8 http://www.ricknevin.com/uploads/Lead_and_Crime_-_Why_This_Correlation_Does_Mean_Causation.pdf. See also http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1257652/?tool=pmcentrez.

9 Jessica Wolpaw Reyes, "Environmental Policy as Social Policy? The Impact of Childhood Lead Exposure on Crime," NBER Working Paper No. 13097, May 2007, http://www.nber.org/papers/w13097.

10 http://www.nationalreview.com/corner/337398/lead-and-crime-jim-manzi.

11 Drum responded to Manzi (http://www.motherjones.com/kevin-drum/2013/01/lead-and-crime-response-jim-manzi), and Manzi offered further comment (http://www.nationalreview.com/corner/338317/more-lead-and-crime-really-how-make-decisions-jim-manzi). This issue clearly will play out further.

12 See *Our Nation's Air: Status and Trends Through 2010* Washington DC: EPA, 2012), pp. 19-21.

13 http://www.arb.ca.gov/adam/toxics/statepages/benzstate.html.

14 http://www.arb.ca.gov/adam/toxics/riskdesc.html.

15 Joseph R. McConnell and Ross Edwards, Coal Burning Leaves Toxic Heavy Metal Legacy in the Arctic, PNAS, vol. 105, no. 34 (August 26, 2008), www.pnas.org/cgi/doi/10.1073/pnas.0803564105.

About the Author

Dr. Steven Hayward is the author of PRI's *Almanac of Environmental Trends,* a major study on the state of the environment released each year on Earth Day. He is also nationally recognized for his books, The Real Jimmy Carter (Regnery Publishing, 2004), *The Age of Reagan: The Fall of the Old Liberal Order 1964-1980* (Prima Publishing, 2001), and *Churchill on Leadership: Executive Success in the Face of Adversity* (Prima Publishing, 1997).

Dr. Steven Hayward writes frequently on a wide range of issues, including environmentalism, law, economics, and public policy, and has published dozens of articles in scholarly and popular journals. His work has appeared in *National Review, New York Times, Wall Street Journal, Reason, The Weekly Standard, Policy Review,* and *Chicago Tribune.* He is a Weyerhaeuser Scholar at the American Enterprise Institute, an adjunct fellow of the John Ashbrook Center and a former Bradley Fellow at the Heritage Foundation, Weaver Fellow of the Intercollegiate Studies Institute, Earhart Fellow, and Olive Garvey Fellow of the Mont Pelerin Society. Dr. Hayward is also a regular blogger for Powerline.

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