Air Pollution Trends in Illinois

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Executive summary

This policy spotlight explains how Illinois' air pollution is monitored, describes trends in air pollution levels, and discusses the potential health consequences. In Illinois, the highest pollution levels are in the Chicago area, though these levels have notably decreased over the past two decades. If recent progress continues, Illinois can expect significant increases in life expectancy and quality of life. However, events such as the 2023 Canadian wildfires underscore that pollution levels in Illinois could be severely disrupted by climate change.

Background

Exposure to air pollution can lead to a variety of health problems, ranging from respiratory illness to premature death. In 2019 alone, the World Health Organization estimated that outdoor air pollution caused approximately 4.2 million deaths globally (World Health Organization 2024). Closer to home, researchers estimate that air pollution contributes to about five percent of premature deaths in Chicago, which houses a quarter of Illinois' population (City of Chicago 2020).

Illinois experiences varying levels of air pollution across its regions. Pollution concentrations typically peak in the Chicago metropolitan area, where factors such as industrial activities and heavy traffic contribute to elevated pollution levels. In 2023, Illinois' air pollution received significant attention when Canadian wildfires caused severe air quality conditions throughout the state. On June 27 of that year, Chicago recorded the highest air pollution levels among major cities worldwide (Smith et al. 2023).

Because of its detrimental effects on human health, air pollution has been heavily regulated by the Environmental Protection Agency (EPA) since the passage of the Clean Air Act of 1970. This landmark law established national air pollution standards and authorized the EPA to enforce them. These standards are periodically reviewed and updated to reflect new scientific findings regarding the effect of pollution on human health and well-being. For example, regulations regarding particulate matter initially targeted coarse particles that were 100 microns or less in diameter. However, subsequent research has found that smaller particles pose greater health risks, prompting updated regulations that now focus on particles smaller than 10 microns and even as small as 2.5 microns in diameter ("fine particulate matter"). The most recent update to these standards occurred in February 2024, when the EPA lowered the annual standard for fine particulate matter from 12 micrograms per cubic meter to 9 micrograms per cubic meter.

A county with outdoor air pollution levels that exceeds the EPA standards becomes designated as a "non-attainment" county. As of May 31, 2024, 10 counties in Illinois (including Cook county) are in violation of one EPA standard, and one county is in violation of two standards (EPA Green Book). States with counties that fail to comply with the air pollution standards established by the EPA are required to develop a State Implementation Plan (SIP) and submit it to the EPA for approval. An SIP is a detailed strategy outlining the steps that will be taken to bring down air pollution levels. If a state fails to submit an acceptable SIP, or if the EPA deems the submitted SIP inadequate to meet the national standards, the EPA can impose sanctions, such as withholding federal highway funds, or intervene directly by implementing a Federal Implementation Plan to ensure compliance.

To track air quality, the EPA regularly monitors six key pollutants: particulate matter, sulfur dioxide, nitrous dioxide, ozone, carbon monoxide, and lead. Particulate matter is made up of tiny airborne particles or droplets. Sulfur dioxide and nitrous dioxide are gases that are harmful when breathed in and can also react with other chemicals to form harmful particulate matter. Ozone, a major component of smog, can cause respiratory illnesses such as asthma. Because the production of ground-level ozone is driven by sunlight, ozone levels generally peak in the summer. Carbon monoxide is an odorless gas emitted by gasoline-powered vehicles that can lead to headaches, dizziness, or even death in cases of severe exposure. Airborne lead is a toxic pollutant originating primarily from industrial processes that can cause both mental and physical health problems over prolonged periods of time.

To help keep people informed about the air pollution levels in their area, the Illinois EPA publishes daily air quality information on the AirNow website. This information is summarized by an Air Quality Index

(AQI), which combines information on particulate matter, sulfur dioxide, nitrogen dioxide, ozone, and carbon monoxide into a single number, making it easier for the public to understand and compare air quality levels. Airborne lead, which does not fluctuate much day-to-day, is excluded from the index.

The conversion from individual pollutant measurements to AQI is detailed in Table 1, where each major AQI category is explained alongside corresponding pollutant value ranges. The EPA uses different averaging times due to the distinct ways these pollutants affect human health and the environment. For example, nitrogen dioxide is measured as the maximum observed 1-hour average, while fine particulate matter is measured as the daily mean.

The first column of Table 1 reports the values corresponding to the major AQI categories. These categories, which are described in the second column, range from "Good" to "Hazardous." The remaining columns report the corresponding value ranges for different pollutants. For instance, fine particulate matter with a measured range of 0.0—12.0 micrograms per cubic meter corresponds to an AQI range of 0—50 ("Good"). Within each category, the relationship between the pollution measure and AQI is linear. Thus, a value of 6.0, being in the middle of the 0.0—12.0 range for fine particulate matter, translates to an AQI of 25, which is in the middle of the 0—50 range for AQI. For a slightly more complex example, a sulfur dioxide value of 100 parts per billion translates to an AQI of 112.[1] When calculating the AQI for multiple pollutants, it is customary to report the maximum value across all pollutants. For instance, if the AQI for fine particulate matter is 25 and for sulfur dioxide is 112, an AQI of 112 would be reported, with sulfur dioxide identified as the responsible pollutant.

Trends in Illinois air pollution levels

Figure 1 illustrates annual trends in the Air Quality Index (AQI) since 2000 across six distinct regions in Illinois: Champaign-Urbana, Chicago-Naperville-Elgin (the "Chicago region"), Decatur, Peoria, Rockford, and Springfield. The Chicago region has seen a significant reduction of approximately 25 percent in air pollution levels over the past two decades, dropping from around 80 (classified as "Moderate") in 2000 to about 60 (still classified as "Moderate") by 2022. However, its AQI remains notably higher compared to the other five regions, which have maintained relatively stable AQI levels around 40 ("Good").

As explained earlier, the AQI for a particular area is determined by the highest AQI value among all measured pollutants. Figure 2 presents the frequency with which each measured pollutant records the

[1] The value 112 is computed as $101 + \frac{100-76}{185-76} \times (150 - 101)$.

highest AQI in each of the six Illinois regions. For the non-Chicago regions, ozone emerges as the primary culprit, accounting for the highest AQI in over 50 percent of instances, followed by particulate matter. Carbon monoxide is the third most common, although that is rare, accounting for less than 5 percent of instances. Conversely, particulate matter is the dominant pollutant in the Chicago region, with ozone ranking second, closely trailed by nitrogen dioxide.

Chicago's high air pollution levels compared to other parts of Illinois can be attributed to several factors. As a major transportation hub, Chicago experiences significant emissions from planes, trains, and automobiles, compounded by its dense population of nearly 10 million residents. The large number of diesel transport and passenger vehicles contributes to emissions of particulate matter and nitrogen dioxide, as well as ozone formation. Finally, Chicago's geographic location on Lake Michigan exacerbates pollution through temperature inversions, where cool air becomes trapped by warmer layers, particularly in winter and summer months. These factors combine to create persistently high levels of air pollution in the city.

Daily air pollution levels fluctuate significantly throughout the year, as illustrated in Figure 3. The large spike in air pollution from the June 2023 Canadian wildfires is clearly visible in all six regions. This unusual event produced unprecedented increases in AQI. As shown in Figure 3, June 2023 pollution levels exceeded the maximum daily level recorded in the preceding 5 years in all six Illinois regions. This event underscores that, while local characteristics such as traffic and population density do matter for air pollution, global events outside of Illinois' control such as distant wildfires can significantly affect air pollution levels throughout the entire state. Indeed, recent research indicates that the decline in U.S. air pollution achieved over the past several decades has begun to stagnate, primarily due to the increasing frequency and intensity of wildfires (Burke et al. 2023).

Health consequences of changes in air pollution

Many studies have explored the connection between air pollution and human health. Identifying this effect is challenging because other important factors that matter for health, such as income and access to healthcare, are also linked to pollution levels. For example, areas with lower levels of income tend to also have higher levels of air pollution (Jbaily et al. 2022). To address this challenge, researchers frequently focus on short-run changes in air pollution, which can sometimes be isolated from these other factors. For example, researchers have studied how daily fluctuations in air pollution caused by changes in wind direction affect mortality and medical spending (Deryugina et al. 2019). Wind direction greatly influences a region's air pollution levels while having minimal impact on anything else, making it an effective method for investigating the health effects of air pollution. By using these kinds of methods, researchers have found that short-term exposure to air pollution can lead to increased healthcare spending, more hospitalizations, and higher mortality rates (Chay and Greenstone 2003; Schlenker and Walker 2016). Older individuals, smokers, and those with comorbidities are especially vulnerable to the adverse health effects of air pollution exposure (Deryugina et al. 2021).

The health effects of long-term exposure to air pollution are harder to measure directly, so researchers often look at associations rather than causal links. Many medical studies have found significant connections between air pollution and heart disease (Rajagopalan and Landrigan 2021). Air pollution has also been linked to various stages of lung cancer development (Turner 2020; Hill 2023). These findings suggest that reducing air pollution can have substantial long-term health benefits that may take decades to materialize.

Assessing the overall impact of the recent reductions in Illinois air pollution is complex. It requires considering the specific mix of pollutants, the expected duration of reduced exposure, and the uncertainties inherent in predicting the long-term health consequences of environmental changes. As one point of comparison, Deryugina and Reif (2023) estimated that a permanent, 10 percent reduction in air pollution could increase life expectancy by about one year, with most of these benefits concentrated in older adults. Overall, the evidence indicates that the decrease in air pollution over the past twenty years has already improved public health and that future health benefits are likely to be even greater.

Conclusion

The reduction in air pollution levels in the Chicago area over the past two decades is a significant achievement with substantial ongoing health benefits. However, while Chicago has seen notable improvements in air quality, other parts of the state have not experienced similar progress, with air quality levels remaining stagnant. Additionally, events like the 2023 wildfires remind us that these positive trends can be disrupted and potentially reversed. As global warming raises temperatures, certain pollutants, such as ozone, are expected to become more prevalent due to the increased frequency of conditions conducive to their formation (Hogrefe et al. 2004). A reversal in the decline of air pollution levels would have severe adverse effects on human health.

Tables

Table 1. Relationship between daily pollution levels and air quality index (AQI)

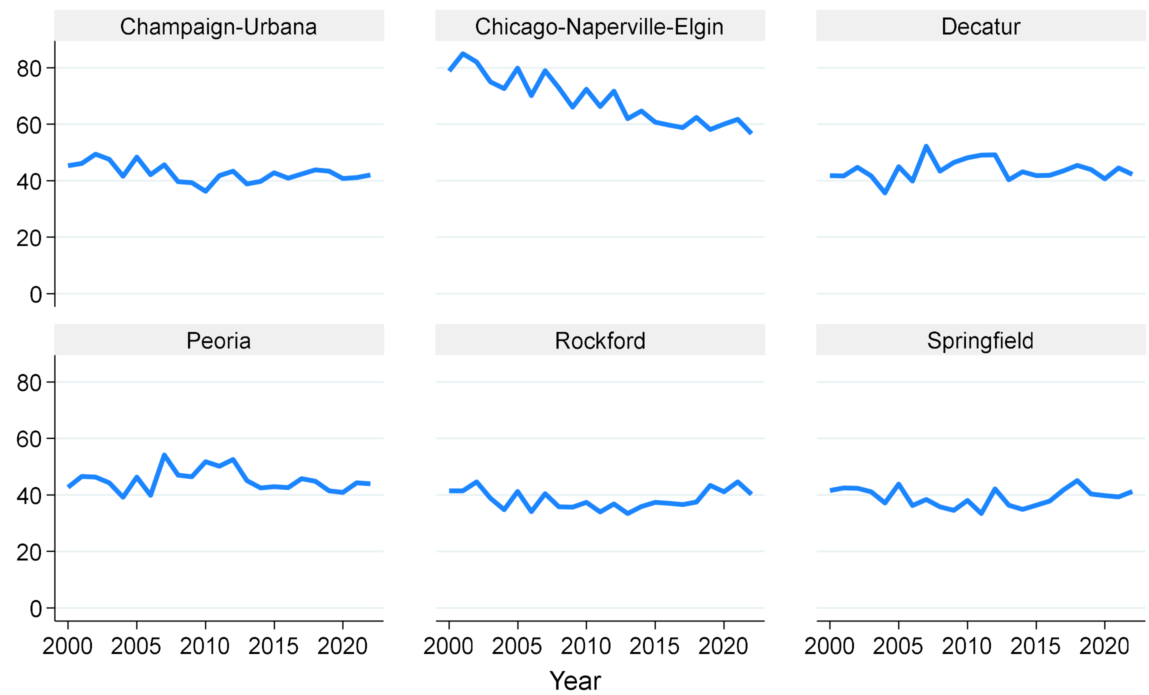
AQI	Category	Ozone	Fine particulate matter	Carbon monoxide	Sulfur dioxide	Nitrogen dioxide
0 – 50	Good	0 – 0.054	0.0 – 12.0	0.0 – 4.4	0 – 35	0 – 53
51 – 100	Moderate	0.055 – 0.070	12.1 – 35.4	4.5 – 9.4	36 – 75	54 – 100
101 – 150	Unhealthy for sensitive groups	0.071 – 0.085	35.5 – 55.4	9.5 – 12.4	76 – 185	101 – 360
151 – 200	Unhealthy	0.086 – 0.105	55.5 – 150.4	12.5 – 15.4	186 – 304	361 – 649
201 – 300	Very unhealthy	0.106 – 0.100	150.5 – 250.4	15.5 – 30.4	305 – 604*	650 – 1249
301 – 500	Hazardous	N/A	250.5 – 500.4	30.5 – 50.4	605 – 1004*	1250 – 2049

Notes: Ozone levels are measured as the daily maximum of an 8-hour running average (parts per million). Fine particulate matter is measured as the daily mean (micrograms per cubic meter). Carbon monoxide is measured as an 8-hour running average (parts per million). Sulfur dioxide and nitrogen dioxide are measured as daily maximums of a 1-hour average (parts per billion). Sulfur dioxide values indicated with an asterisk (*) are calculated using a 24-hour mean instead of a 1-hour max. Table excludes information for 1-hour ozone and 24-hour coarse particulate matter readings. Source:

https://aqs.epa.gov/aqsweb/documents/codetables/pollutant_standards.html

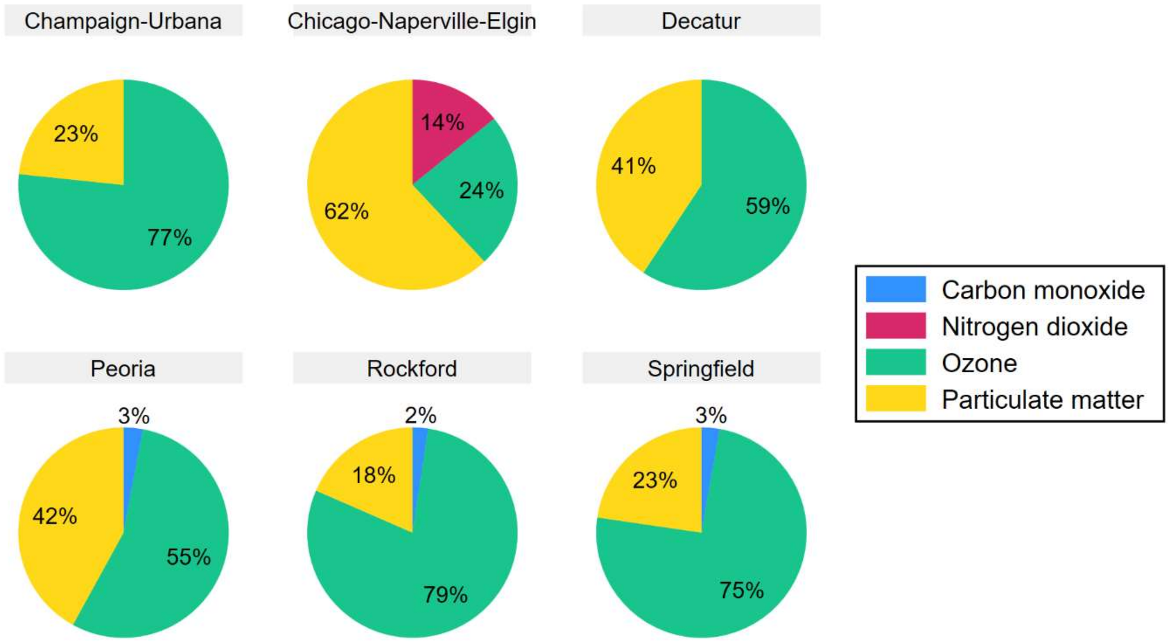
Figures

Figure 1. Annual air quality index (AQI) during the years 2000—2022, for selected regions of Illinois



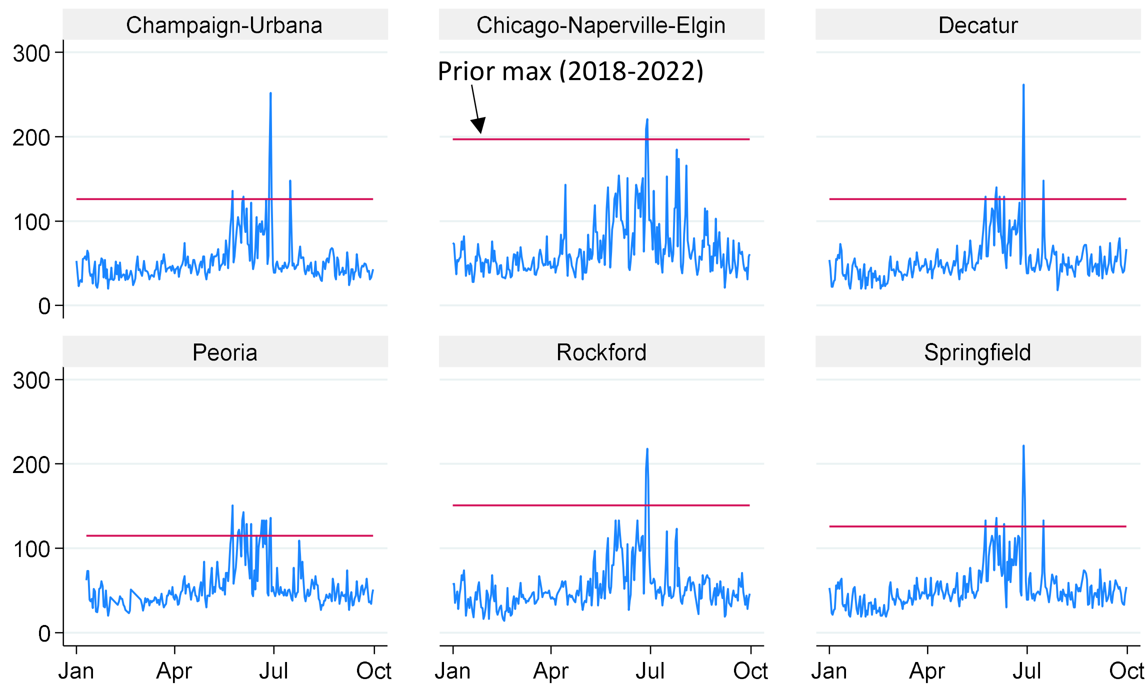
Notes: Figure reports the average annual AQI in each region for the years 2000—2022. Each region is a core-based statistical area (CBSA), which includes an urban center as well as its surrounding areas. Table 1 provides category labels for different levels of AQI. Source: aqs.epa.gov/aqsweb/airdata/download_files.html

Figure 2. Main pollutant during the years 2000—2022, for selected regions of Illinois



Notes: Figure shows the proportion of time that an air pollutant was the main daily pollutant for a region during the years 2000-2022. A main pollutant is defined as the air pollutant with the highest air quality index (AQI) on a particular day. Each region is a core-based statistical area (CBSA), which includes an urban center as well as its surrounding areas. Source: aqs.epa.gov/aqsweb/airdata/download_files.html

Figure 3. Daily air quality index (AQI), January 1, 2023 – September 30, 2023



Notes: Figure reports daily AQI levels for 2023 using the most recently available data. The horizontal lines report the maximum daily AQI recorded during the years 2018-2022 for the months January through September. Each region is a core-based statistical area (CBSA), which includes an urban center as well as its surrounding areas. Table 1 provides category labels for different levels of AQI. Source: aqs.epa.gov/aqsweb/airdata/download_files.html

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