AQLI Air Quality Life Index®

AIR QUALITY LIFE INDEX® | 2025

Annual Update

By Michael Greenstone, Tanushree Ganguly, Christa Hasenkopf, Nishka Sharma and Hrishikesh Chandra Gautam

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ACKNOWLEDGEMENTS

We would like to deeply thank Prof. Randall Martin, Dr. Aaron van Donkelaar, and the Atmospheric Composition Analysis Group at the University of Washington at St. Louis for their continued partnership in providing us with global satellite-derived annual ground-level $PM_{2.5}$ data. We would like to acknowledge Purushottam Gupta, Data Analyst at AQLI, for his support in generating visualisations for this manuscript.

Dear Friends and Colleagues,

We're pleased to bring you the latest data from the Air Quality Life Index (AQLI). This data shows that fine particulate air pollution remains the greatest external threat to public health—comparable to that of smoking, more than 4 times that of high alcohol use, 5 times that of transport injuries like car crashes, and more than 6 times that of HIV/AIDS. Perhaps surprisingly, the worst increases in pollution in 2023 occurred in Canada and the United States—two countries that, despite strict air quality rules, could not escape the smoke from climate-driven wildfires. Their pollution progress is being erased, reminding us of the multiple paths of destruction from fossil fuels.

As policies are needed globally to address the urgent climate challenge, there are steps countries impacted directly by fossil fuel pollution can take. Yet, air pollution continues to sit low on the national agenda of many countries. One clear sign of this is the lack of information about the air people breathe—half of all countries still lack government-operated air monitoring infrastructure. Some of these, including Cameroon and the Democratic Republic of Congo, are among the most polluted in the world, based on satellite-derived $PM_{2.5}$ estimates.

While a causal link between data availability and pollution reduction is yet to be firmly established, success stories from countries like the United States, China, and Poland suggest that when communities have access to data on the air they breathe—and understand its impact on their health—they are more likely to take protective action and push governments toward accountability. Guided by this theory of change, we launched the Air Quality Life Index in 2018 so people could understand that pollution in their community impacts their health. Since then, AQLI has been used to strengthen calls for action in India, Indonesia, Thailand, Pakistan, and beyond.

Recognizing that communities also need to have daily awareness about their air—and that effective policy and community responses require more timely data—we launched the EPIC Air Quality Fund in 2024. The Fund supports governments and other groups in some of the world's most under-monitored countries to establish local air quality monitoring networks to advance clean air policies. These efforts have already shaped policy, such as spurring a landmark environmental bill making its way through The Gambia's legislature.

EPIC is committed to making air pollution data more accessible around the world. Through the Air Quality Fund, we are expanding access to local air pollution data. Through AQLI, we are communicating the long-term health consequences of pollution in a way that resonates with people. Our efforts aim not only to expose the problem—which puts nearly 15 billion life years at stake—but also to help solve it by empowering communities as agents of change around the world.

Sincerely,

Michael Greenstone
Milton Friedman
Distinguished Service Professor
Director, EPIC

Christa Hasenkopf
Director, Clean Air Program
EPIC

Tanushree Ganguly
Director, AQLI
EPIC

At a Glance

Global pollution increased slightly in 2023 and remains the greatest external threat to human health.

- The AQLI's 2023 data reveals that global $PM_{2.5}$ concentrations in 2023 were 1.5 percent higher than in 2022 and nearly 5 times the World Health Organization (WHO) guideline of 5 µg/m³. If global particulate pollution were permanently reduced to meet this guideline, an average person around the world would gain 1.9 years of life, adding 15.1 billion total life years to the global population.
- Particulate pollution remained the greatest external threat to human life expectancy in 2023, with its impact comparable to smoking and surpassing other major health risks. Its toll on life expectancy is more than 4 times that of alcohol use, 5 times that of transport injuries or unsafe water, sanitation, and handwashing, and more than 6 times that of HIV/AIDS.

Wildfires caused particulate concentrations to rise to levels not seen since 2011 in the United States and since 1998 in Canada.

- **United States and Canada.** These countries experienced the highest increase in pollution globally. Record-breaking wildfires in Canada fueled the country's worst air quality since our data records began in 1998 and pushed pollution levels in the United States to their highest since 2011.[1] Wisconsin, Illinois, Ohio, Pennsylvania, Oklahoma, and Mississippi were most affected. Counties in these states replaced California counties as the top 20 most polluted for the first time since 2019. In Canada, more than 50 percent of Canadians breathed air that exceeded their national standard of 8.8 µg/m³ —up from less than 5 percent over the previous five years.[2]

Trends in air quality were mixed in the rest of the world.[3,4,5,6]

- **Latin America.** Particulate concentrations in Latin America reached the region's highest level since our data record began in 1998. Bolivia, the most polluted country in the region, ranked among the top ten most polluted countries in the world for the first time since 2010. The health threat posed by particulate pollution in many parts of Latin America is greater than that of self-harm and violence — nine times greater in Bolivia.
- **South Asia.** After a dip in 2022 compared to 2021, particulate pollution in South Asia increased by 2.8 percent in 2023—though it remained 7 percent lower than in 2021. Despite these fluctuations, South Asia remains the most polluted region in the world. In the region's most polluted countries, particulate pollution's impact on life expectancy is nearly twice that of childhood and maternal malnutrition and more than five times that of unsafe water, sanitation and handwashing.
- **China.** After a decade of consistent decline following the start of its "War on Pollution" in 2014, China saw a slight increase of 2.8 percent in particulate pollution in 2023 relative to 2022. Though Chinese citizens are breathing air that is 40.8 percent cleaner than at its worst levels in 2014, they would live 2.2 years longer if China's particulate pollution levels met the WHO guideline.
- **Africa.** While pollution declined slightly in Central and West Africa, residents in the most polluted parts of the region are losing up to 5 years of life expectancy due to particulate pollution that exceeds the WHO guideline. In these highly-polluted regions—such as Cameroon and the Democratic Republic of the Congo—air pollution takes a greater toll on life expectancy than well-known killers like HIV/AIDS, malaria and unsafe water.

Air pollution monitoring remains poor for billions of people. Without reliable monitoring, it is extraordinarily difficult for societies and individuals to adequately protect themselves from air pollution.

- **Availability of air quality information has improved worldwide, but 5.5 billion people still lack access to information that can meaningfully aid public or policy action.** The share of global population living in countries with government-monitored air quality data has increased from less than 20 percent in 2011 to 85 percent in 2024.[7,8] However, 68 percent of the world's population lives in countries where the monitoring density remains below three monitors per million

1 Nature communications. 2024. "Drivers and Impacts of the Record-Breaking 2023 Wildfire Season in Canada" https://www.nature.com/articles/s41467-024-51154-7

2 AQLI's compilation of country-level national ambient $PM_{2.5}$ standards can be found here (https://docs.google.com/spreadsheets/d/1FUYLqAg8a4dYwVYC-G277kJrod1q-uzMVMIWNS3uqYHA/edit?usp=sharing). The information in this sheet is updated to the best of our knowledge. We encourage readers to reach out if information provided here is incorrect, missing, or has been updated.

3 The AQLI report classifies the world into the following regions: South Asia, Central and West Africa, Southeast Asia, Middle East and North Africa, Latin America, China, United States & Canada, Europe, Oceania. Definitions of these regions can be found here: AQLI AR 2025 regions

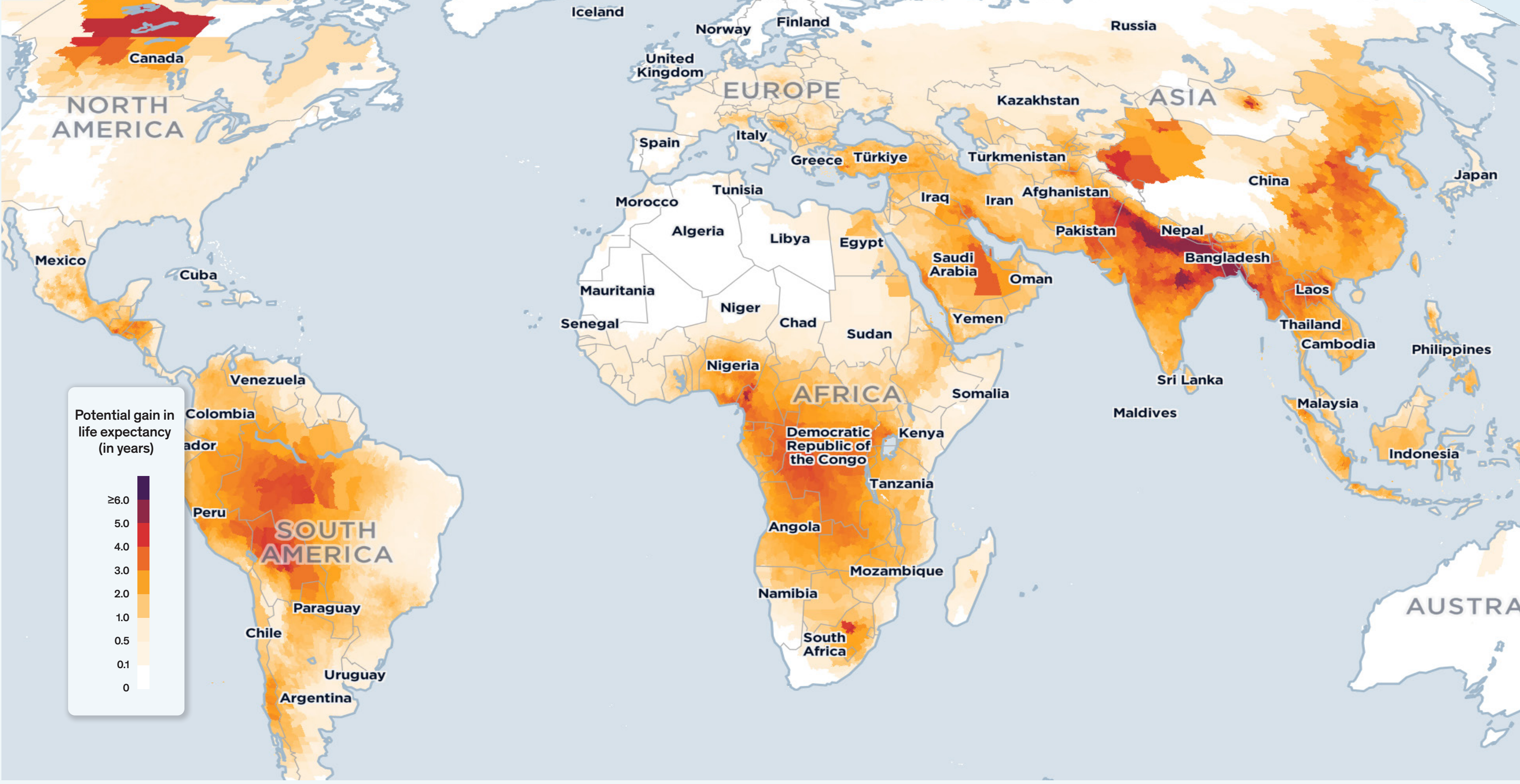
4 Refer Footnote 3 for definition of Europe

5 Refer Footnote 3 for definition of Central and West Africa

6 Refer Footnote 3 for definition of Latin America

7 Share of global population with access to air pollution information in 2011 has been calculated considering population of countries that reported data to the 2011 World Health Organisation Ambient Air Quality Database.

8 Share of global population with access to air quality information in 2024 has been calculated considering population of countries that have government-monitoring data as per the 2024 OpenAQ Global Air Quality Landscape report.



people — the minimum recommended by environmental protection agencies in the U.S. and Europe, leaving nearly 5 billion people without access to adequate information on the quality of the air they breathe.[9, 10]

- **Why is air pollution monitoring important?** Air pollution concentrations are not a law of nature—they reflect societal choices that are based on the trade-offs between economic growth and the benefits of clean air, regulatory capacity, values, politics and other factors. Without basic air pollution monitoring, there is little reason to believe that society's goals are being met or that people can protect themselves appropriately.

- **What has the introduction of air pollution information accomplished in the past?** In some important instances, including the United States and China, the availability of reliable data on pollution has been linked to policy changes and improvements in air quality.[11] The availability of air pollution data has additionally allowed people to make better decisions about protecting themselves through purchases of air purifiers, masks, and other changes in behavior.[12]

The Energy Policy Institute at the University of Chicago (EPIC) launched a major program to bring air quality monitoring to the parts of the world where air pollution data is currently unavailable. Through the program, more than 700 monitors are being installed across 19 countries.

- **EPIC Air Quality Fund.** Last year, EPIC launched the EPIC Air Quality Fund to support local groups and organizations in installing air quality monitors, sharing open data to some of the world's most polluted communities, and using that data to further national-level impact plans. The fund now supports 31 awardees in government, academia, and civil society who are installing more than 700 monitors across 19 countries.

- **Initial Impacts.** While still early, there are initial indications that these efforts are driving progress at the national level—for example, supporting the creation of the only air quality monitoring network in the Democratic Republic of Congo, and contributing to The Gambia's environmental protection legislation.

9 Code for Federal regulations. 2025. "Appendix D to Part 58, Title 40" https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-58/appendix-Appendix%20D%20to%20Part%2058

10 Official journal of the European Union. 2008. "Directive 2008/50/EC of the European parliament and the council" https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050

11 Mark T. Buntaine, Michael Greenstone, Guojun He, Mengdi Liu, Shaoda Wang, and Bing Zhang, "Does the Squeaky Wheel Get More Grease? The Direct and Indirect Effects of Citizen Participation on Environmental Governance in China". 2024. American Economic Review. https://doi.org/10.1257/aer.20221215

12 Zhenxuan Wang and Junjie Zhang. 2023.The Value of Information Disclosure: Evidence from Mask Consumption in China. Journal of Environmental Economics and Management. https://doi.org/10.1016/j.jeem.2023.102865

Section 1

Slight increase in global particulate levels in 2023

GLOBAL PARTICULATE CONCENTRATIONS TICKED UP MODESTLY IN 2023. POLLUTION REMAINS THE GREATEST EXTERNAL THREAT TO HUMAN LIFE EXPECTANCY: 2025 GLOBAL UPDATE

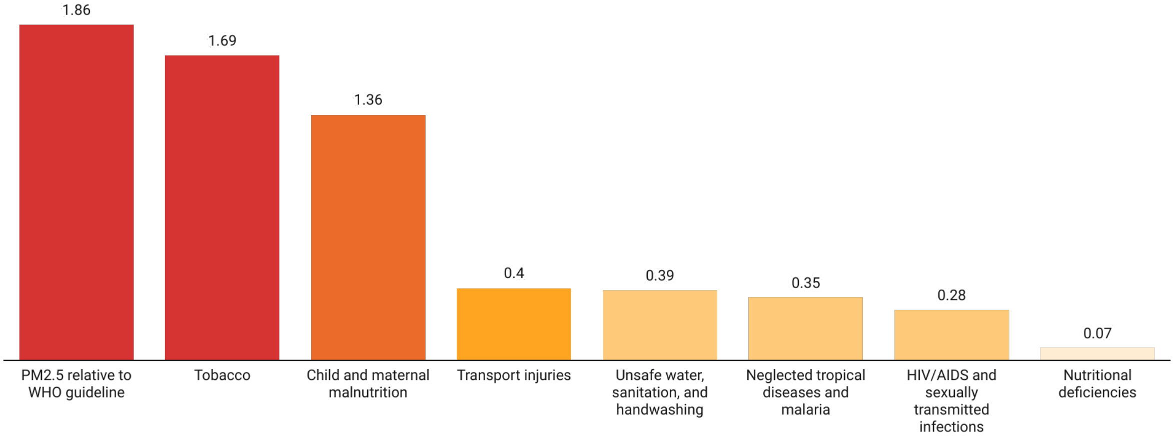
New and revised satellite-derived $PM_{2.5}$ data show a slight increase in global population-weighted $PM_{2.5}$ levels—increasing from 23.7 µg/m³ in 2022 to 24.1 µg/m³ in 2023. This is nearly 5 times the WHO guideline of 5 µg/m³ for annual $PM_{2.5}$ concentration. The AQLI shows that reducing global particulate concentration to meet the WHO guideline could add 1.9 years to average global life expectancy.

The impact of particulate pollution on human life expectancy makes it the greatest external threat to human health, with its impact similar to that of tobacco use, 1.4 times that of childhood and maternal malnutrition, 4.4 times that of high alcohol use, 4.6 times that of transport injuries or unsafe water, handwashing and sanitation, 6.7 times that of HIV/AIDS, and 26.7 times that of nutritional deficiencies (Figure 1.1).

THE HIGHEST INCREASE WAS OBSERVED IN THE US AND CANADA, LARGELY DUE TO LARGE-SCALE CANADIAN WILDFIRES

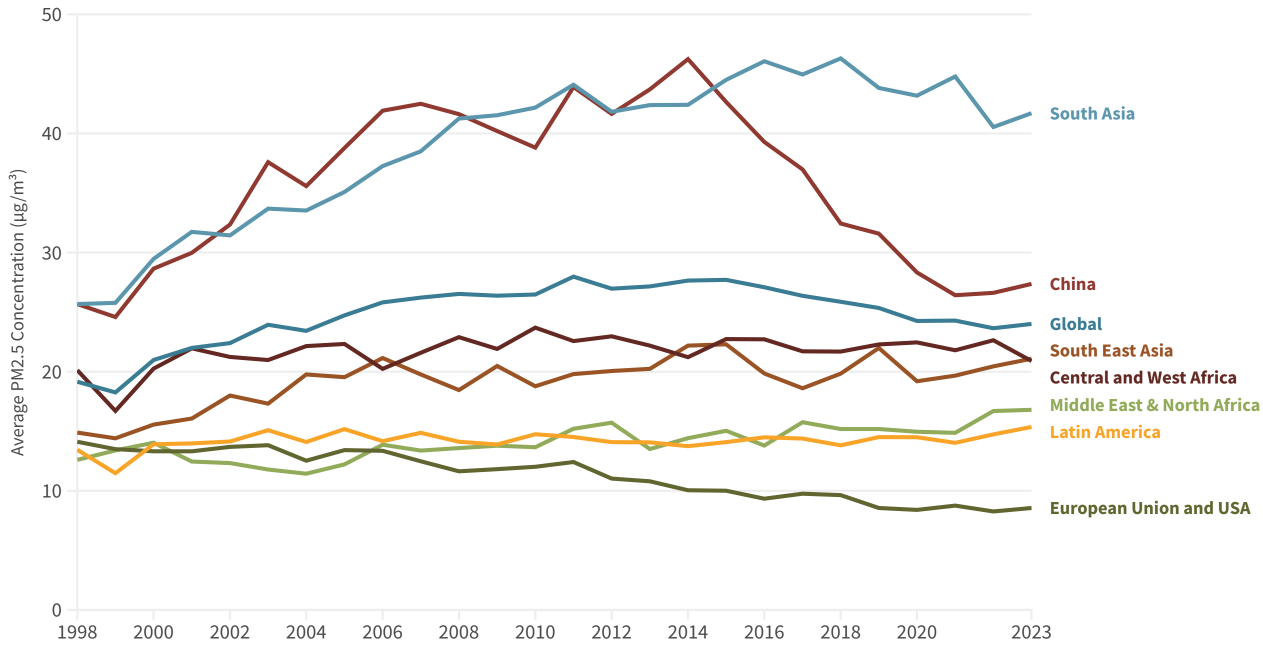
United States and Canada: Wildfires caused air pollution concentrations to rise to levels not seen since 2011 in the United States and since 1998 in Canada. As a result, Canada recorded its highest particulate pollution levels since 1998. In the country's most polluted regions, particulate pollution levels were comparable to Latin America's most polluted countries, such as Bolivia and Honduras. Over 50 percent of Canadians were exposed to air exceeding the national standard of 8.8 µg/m³—a stark jump from

Figure 1.1 · Comparison of years of life lost to selected major threats to life expectancy



Sources: Global Burden of Disease (https://vizhub.healthdata.org/gbd-results/) level-2 causes and risks data and WHO Life Tables (https://apps.who.int/gho/data/node. main.LIFECOUNTRY?lang=en) were combined with the Life table method to arrive at these results. "$PM_{2.5}$ relative to WHO Guideline" bar displays the reduction in life expectancy relative to the WHO guideline as calculated by latest AQLI (2023) data

Figure 1.2 · Particulate concentrations around the world between 1998-2023



less than 5 percent in the previous five years.

The United States was also adversely impacted by the wildfires. Particulate concentrations in the country witnessed their highest year-on-year increase since our records started in 1998, reaching their highest levels since 2011. Counties in Wisconsin, Illinois, Ohio, and even as far as Pennsylvania, Oklahoma, and Mississippi replaced counties in California as the most polluted regions in the country.

THE POLLUTION TRENDS WERE MIXED IN THE REST OF THE WORLD (FIGURE 1.2)

Latin America: In Latin America $PM_{2.5}$ concentrations reached the region's highest level since 1998. Bolivia, the most polluted country in the region—where an average resident stands to lose 2.7 years of life due to air pollution—ranked among the top ten most polluted countries in the world for the first time since 2010.

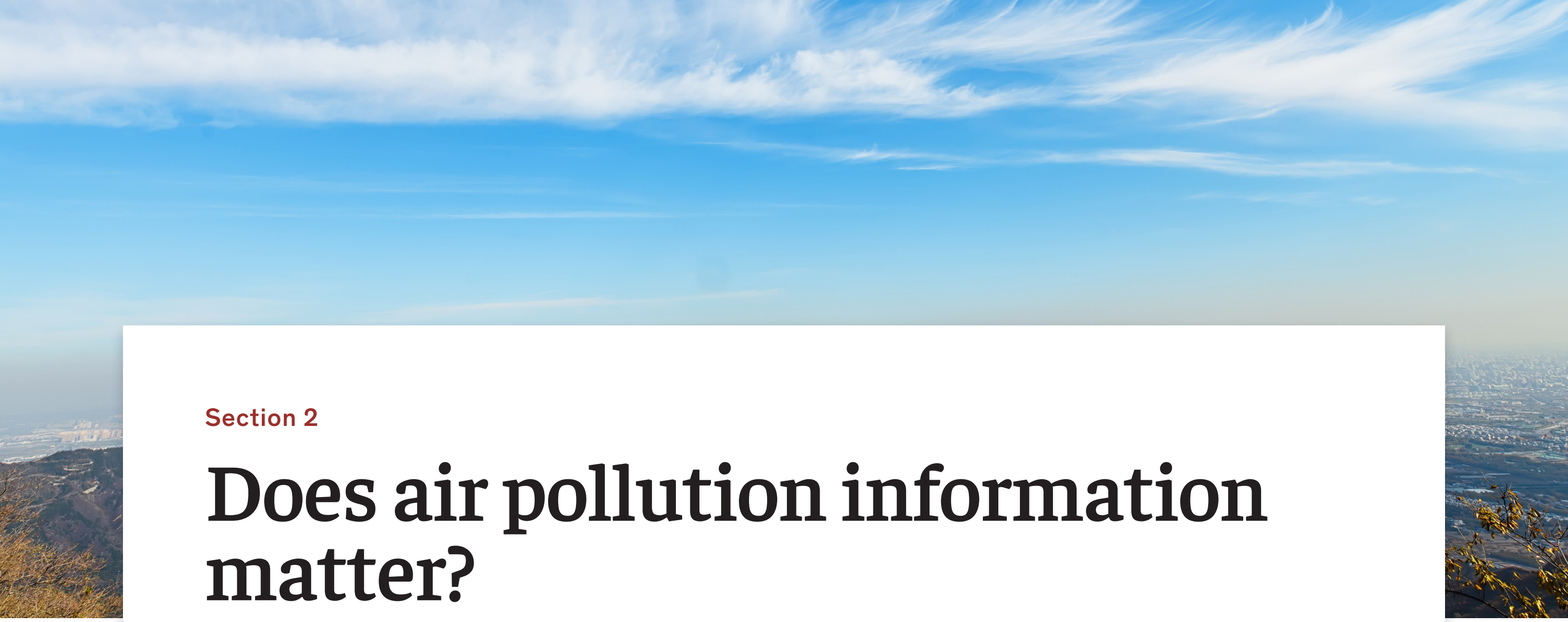
South Asia: In South Asia—the world's pollution hotspot—pollution increased by 2.8 percent from 2022 to 2023. This followed a 9.4 percent decline in the two years prior, from 2021 to 2022. Overall, pollution declined by 7 percent from 2021 to 2023. Nepal and Bhutan recorded the highest absolute declines during this period, with reductions of nearly 5 µg/m³ each.

China: After a decade of consistent decline, China's particulate concentrations increased by 2.8 percent from 2022 to 2023. This small increase was likely due to unfavourable weather conditions and higher emissions.[13] As a measure of the potential progress that remains, 7 out of the 33 provincial capitals did not meet the national standard for $PM_{2.5}$ in 2023.

Europe: Across the European Union, particulate concentrations were nearly 6 percent lower (~0.6 µg/m³) than they were in 2022. While particulate concentrations in the region's most polluted countries—Bulgaria, Poland, and Cyprus—have declined over time, an average individual in these countries could still gain 0.9, 0.8, and 0.7 years of life expectancy, respectively, if particulate levels were permanently reduced to meet the WHO guideline.

Central and West Africa: In the Central and West African region, particulate concentrations were nearly 8 percent lower (~1.7 µg/m³) than they were in 2022. While on average, residents of Central and West African countries could gain 1.6 years of life expectancy by breathing air that meets the WHO guideline, in the region's most polluted countries—Cameroon and the Democratic Republic of Congo, the toll on life expectancy is 2.7 years. These countries are also among the ten most polluted countries around the world.

13 Centre for Research on Energy and Clean Air (CREA). 2023. "$PM_{2.5}$ rebounds in China in 2023, after falling for 10 years straight" https://energyandcleanair.org/pm2-5-rebounds-in-china-in-2023-after-falling-for-10-years-straight/#:~:text=In%20the%20previous%2011%20months,action%20plan%20released%20in%202013.



Section 2

Does air pollution information matter?

There is increasing evidence that providing information on air pollution can cause people to breathe cleaner air. The launch of the AQLI in 2018 was based on this idea and our colleagues at the University of Chicago's Energy Policy Institute's Air Quality Fund are also taking this idea seriously. They have deployed USD 1.7 million to support local organisations across 19 of the most poorly monitored countries globally deploy nearly 700 air quality monitors.

The EPIC Air Quality Fund's hypothesis is that a modest investment of USD 50,000 to 100,000 can enable local actors (including governments themselves, in some cases) to establish and expand air quality monitoring efforts in their countries.[14] The provision of the information itself is valuable as people have a right to know how polluted their air is. More broadly, when people learn that the air they breathe is polluted, and that this polluted air can impact their health, there is potential for increasing their self-protection from air pollution and for encouraging and collaborating with their governments to act based on this information. Additionally, on-the-ground monitoring information has the potential to help governments create and adjust clean air policies and to build partnerships between governments and civil society.

CURRENT STATE OF GOVERNMENT-MONITORED $PM_{2.5}$ DATA AVAILABILITY AROUND THE WORLD

Air quality monitoring has improved worldwide. The share of the global population living in countries with government-monitored $PM_{2.5}$ networks has gone up from less than 25 percent in 2011 to 85 percent in 2024.[15, 16] The density of these monitoring networks, however, varies significantly from country to country (Figure 2.1). Environmental agencies in the United States and European Union recommend a minimum of three monitors per million population to monitor $PM_{2.5}$. As of 2023, only 32 percent of the world's population lived in countries with more than 3 monitors for every million people, leaving nearly 5.5 billion people with access to real-time data from monitoring networks with less than adequate number of monitors.[17, 18] (Figure 2.2).

WHY DOES AIR POLLUTION INFORMATION MATTER?

There is a growing body of research on the impacts of information on air quality. For example, Jha and La Nauze (2022) found that openly shared air quality data from U.S. diplomatic facilities led to an average improvement of 10 µg/m³ in $PM_{2.5}$ concentrations across the 50 cities with State Department monitors over five years.[19] Greenstone et al. (2024) showed that citizen engagement via social media—triggered by the release of real-time industrial emission data in China—made the government more likely to inspect polluting plants and led to a 12 percent decrease in air pollution.[20] More recently, Liu et al. (2025) demonstrated that publicly rating

14 Hasenkopf et al. 2023. "The Case for Closing Air Quality Gaps with Local Actors" Energy Policy Institute at the University of Chicago (EPIC). https://epic.uchicago.edu/wp-content/uploads/sites/5/2025/06/The-Case-for-Closing-Air-Quality-Gaps-with-Local-Actors.pdf.

15 WHO. 2011. "Air quality database: Update 2011" https://www.who.int/data/gho/data/themes/air-pollution/who-air-quality-database/2011

16 OpenAQ. 2024. "Open Air Quality Data: The Global Landscape" https://documents.openaq.org/reports/Open+Air+Quality+Data-The+Global+Landscape+2024.pdf

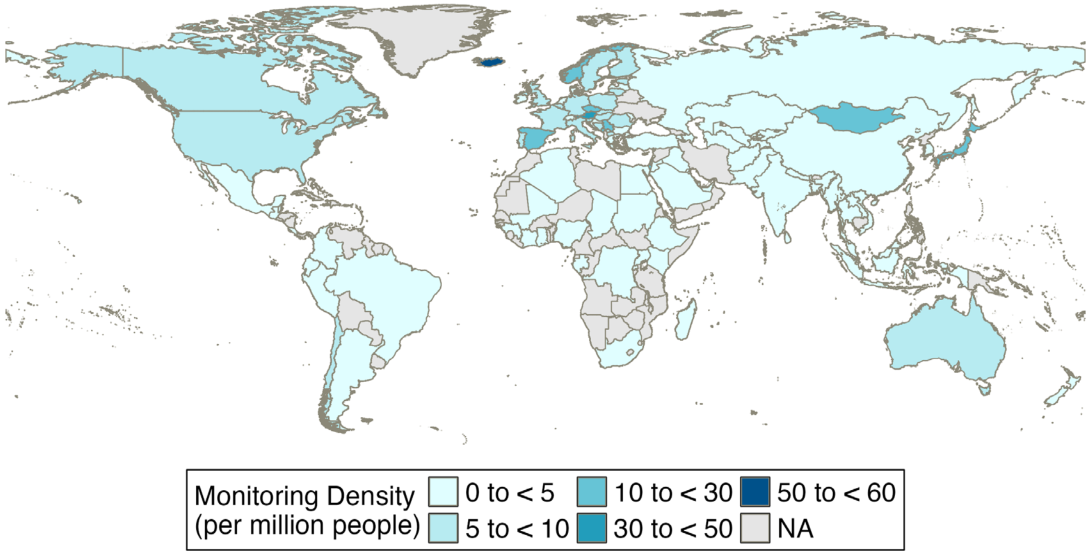
17 Code for Federal regulations. 2025. "Appendix D to Part 58, Title 40" https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-58/appendix-Appendix%20D%20to%20Part%2058

18 Official journal of the European Union. 2008. "Directive 2008/50/EC of the European parliament and the council" https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008L0050

19 Akshaya Jha and Andrea La Nauze. 2022. "US Embassy air-quality tweets led to global health benefits" Proc Natl Acad Sci U S A. 2022 Nov;119(44):e2201092119. doi: 10.1073/pnas.2201092119

20 Refer Footnote 11

Figure 2.1 · $PM_{2.5}$ Monitoring densities around the world



Note: Data on country-wise estimates on government-operated air quality monitoring stations was obtained from OpenAQ and last updated in 2023. The data can be found here.

selected Chinese municipal governments on their adherence to national environmental transparency rules increased transparency and government inspections and decreased air pollution by up to 10 percent.[21]

Further, several successful examples of clean air action from around the world seem related to local information on air pollution becoming available.

In the United States, the 1900s experienced several deadly smog episodes—most notably the 1948 Donora, Pennsylvania, event that killed 20 people. By 1970, Los Angeles had earned the title of the world's smog capital.[22] In 1962, Rachel Carson's Silent Spring highlighted the environmental harms of chemical pesticides, sparking nationwide concern.[23] These events fueled a growing environmental movement, culminating in the first Earth Day in 1970, when 20 million Americans marched across the country for a cleaner environment. Just months later, the Congress authorized creation of a new federal agency, the US Environmental Protection Agency (USEPA), tasked with enforcing the Clean Air Act in partnership with state, local and tribal authorities.[24]

Implementation of the Clean Air Act has reduced particulate concentrations by over 60 percent since 1970, adding 1.4 years to the life expectancy of American residents.[25] During this period, the regulations and standards established by the Clean Air Act have been updated several times to reflect technological advancements in emissions control.

In 2010, public pressure began to mount in Beijing because of worsening air pollution after real-time air quality data was made widely available through social media and mobile phone apps. After the city experienced an "airpocalypse" in 2013 and a study by Chen, Ebenstein, Greenstone and Li, published in the Proceedings of the National Academy of Sciences detailed the loss of life expectancy from high air pollution concentrations, the Chinese government declared a "War on Pollution" and launched a nationwide pollution control campaign.[26] Since 2013, particulate pollution has declined by 37 percent in China—the fastest drop recorded in our global data since 1998.

More recently, in Poland, civil society groups like the Polish Smog Alert have helped make air quality data accessible through social

21 Mengdi Liu, Mark T. Buntaine, Sarah E. Anderson, and Bing Zhang, 2025. "Transparency by Chinese Cities Reduces Pollution Violations and Improves Air Quality". Proceedings of the National Academy of Sciences. https://doi.org/10.1073/pnas.2406761122.

22 Sean D. Hamill, "Unveiling a Museum, a Pennsylvania Town Remembers the Smog That Killed 20," New York Times, November 1, 2008. https://www.nytimes.com/2008/11/02/us/02smog.html

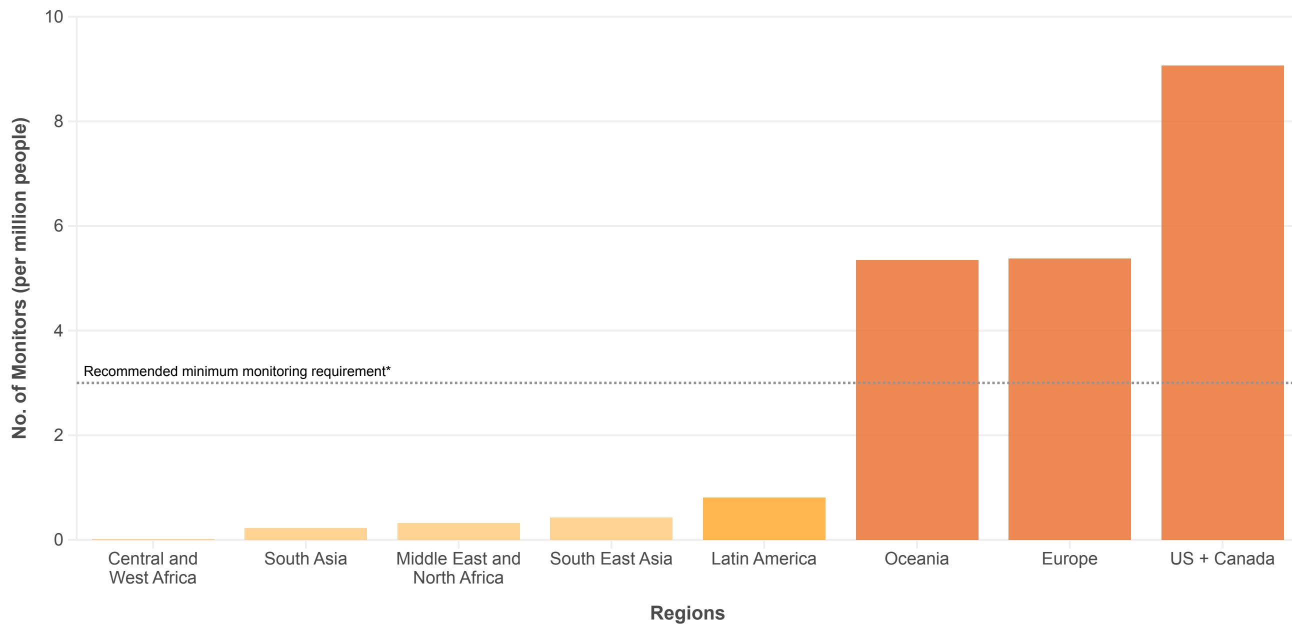
23 Green business benchmark. 2024. Earth Day History, Part 1," Green Business Benchmark, accessed July 8, 2025, https://www.greenbusinessbenchmark.com/archive/earth-day-history-part-1

24 USEPA. EPA History: Earth Day," U.S. Environmental Protection Agency, accessed July 8, 2025, https://www.epa.gov/history/epa-history-earth-day

25 AQLI.,"Policy impacts of United States Clean Air Act". https://aqli.epic.uchicago.edu/policy-impacts/united-states-clean-air-act/

26 Chen, Y., Ebenstein, A., Greenstone, M., & Li, H. 2013. "Evidence on the impact of sustained exposure to air pollution on life expectancy from China's Huai River policy." Proceedings of the National Academy of Sciences 110(32): 12936-12941. DOI: https://doi. org/10.1073/pnas.1300018110.

Figure 2.2 · **68 percent of the world's population lives in countries with less than 3 government-operated monitoring stations per million people**



Note: Data on country-wise estimates on government-operated air quality monitoring stations was obtained from OpenAQ and last updated in 2023. The data can be found here.

media and public campaigns, sparking action in polluted cities such as Kraków and elevating air pollution as a national issue.[27, 28] In 2016, Kraków became the first Polish city to ban solid fuels for household heating. Between 2016 and 2023, particulate pollution in the city fell by 27.6 percent, potentially adding 2.8 months to residents' life expectancy. This momentum spurred national reforms in 2017 and 2018, the Polish government introduced emissions standards for solid fuel boilers and coal, respectively.[29]

UNIVERSITY OF CHICAGO'S EFFORTS TOWARDS ENHANCING AVAILABILITY OF AIR QUALITY INFORMATION

As mentioned previously, despite the critical role air quality information plays in catalyzing action, nearly five billion people around the world still lack access to air quality information that can meaningfully help civic or policy action. Moreover, while the health impacts of air pollution are well established scientifically, they are not widely understood by the general public. For most people, awareness of air quality levels comes through Air Quality Index (AQI) scales, which use a color-coded system to provide a normative assessment of daily air quality. However, these colors fail to convey the actual health risks of exposure.

Recognizing the need to communicate these risks in a way that resonates with people, the Energy Policy Institute at the University of Chicago launched the Air Quality Life Index (AQLI) in 2018. Since then, AQLI has produced an annual report every year that provides a snapshot of pollution trends across world regions, and the impact of these trends on life expectancy around the world. AQLI has been used to educate school and university students, journalists, policy makers, and civil society organisations about impacts of air pollution through training sessions and workshops. AQLI has gained widespread media attention and public recognition in the last seven years. With hundreds of media mentions annually, the AQLI brings the message of air pollution's health impacts to more than 1 billion people globally, every year.

Because AQLI is designed to assess the effect of long-term exposure to particulate pollution on life expectancy, it uses annual-average pollution levels. These are derived from satellite-based estimates, which are global in coverage, consistent in methodology, and span multiple years—enabling robust trend analysis. However, timely health and policy responses also require continuous, real-time data, which in turn depends on regular ground-level monitoring.

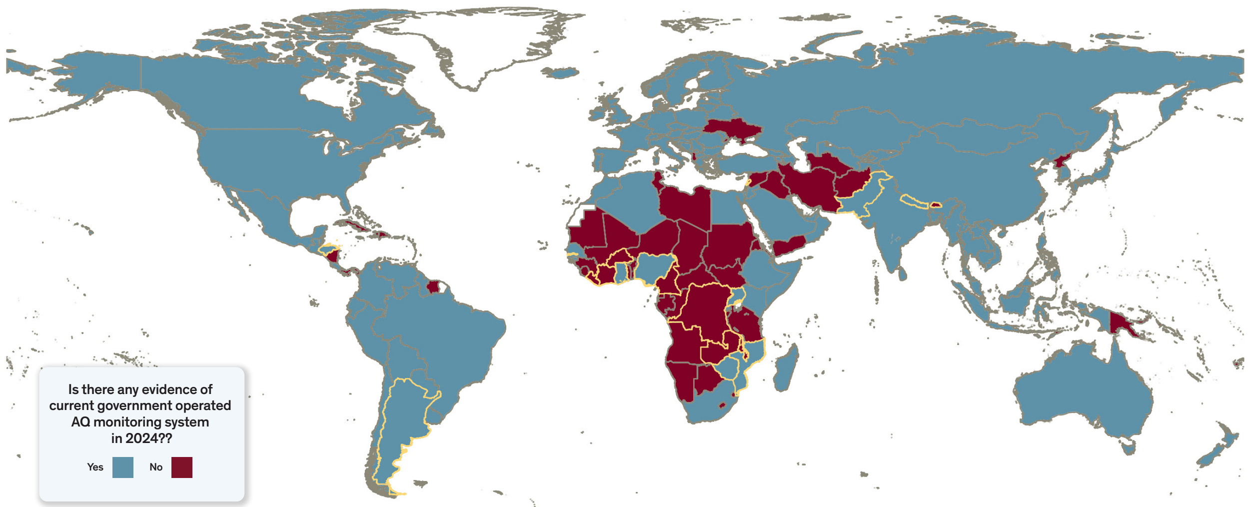
To address gaps in ground-level monitoring in many of the world's most polluted regions, the Energy Policy Institute at the University

27 Polish smog alert. 2025. https://www.polishsmogalert.org/

28 Maltby, T., Birch, S., Fagan, A., & Subašić, M. 2024. "What is the role of activism in air pollution politics? Understanding policy change in Poland." Environment and Planning C: Politics and Space, 42(8), 1332-1351. https://doi.org/10.1177/23996544241231677

29 Clean air fund. 2022. "Warsaw to ban coal burning from October 2023" https://www.cleanairfund.org/news-item/warsaw-to-ban-coal-burning-from-october-2023/

Figure 2.3 · EPIC Air Quality Fund Awardees are plugging data gaps in the world's most data poor regions



of Chicago launched the EPIC Air Quality Fund in 2024. The Fund supports local organizations in installing air quality monitors, providing open access to data, and using that data to drive national-level policy change in high-pollution communities. As of August 2025, 31 awardees across government, academia, and civil society are installing more than 700 monitors across 19 countries, where citizens are collectively losing 2 billion life years due to particulate pollution (Figure 2.3).

Within the first year of its launch, the EPIC Air Quality Fund is already providing information that people in the recipient locations find valuable.

For instance, in The Gambia, the Permian Health Lung Institute, in partnership with the National Environment Agency of The Gambia, has installed the country's first reference-grade monitor and established a low-cost sensor network consisting of a dozen monitors.[30] Building on this initial monitoring effort, the Permian Lung Institute is now working with the Gambian government to develop new clean air policies for the nation, including the country's first $PM_{2.5}$ standards.

Another awardee in the Democratic Republic of the Congo, Water and Sanitation in Rural and Urban areas (WASARU), has launched the country's only air quality monitoring network, sharing data in real-time with the public. This is an important first step in Africa's second most polluted country, the sixth most polluted in the world.

In Pakistan, the awardee, Pakistan Air Quality Initiative (PAQI) is working towards establishing a network of 70 low-cost sensors in Pakistan and working in partnership with government agencies to support the implementation of Pakistan's National Clean Air Policy.[31]

This section highlights the relevance of air quality data in shaping both policy and citizen responses to air pollution. The remainder of this report applies the Air Quality Life Index to satellite-derived particulate pollution estimates to examine current levels and pollution trends across different world regions, and the resulting impacts on human life expectancy. It also briefly explores relevant policy measures implemented by various countries.

30 EPIC Air Quality Fund. 2025. "Permian Health Lung Institute" https://aqfund.epic.uchicago.edu/entities/permian-health-lung-institute/

31 EPIC Air Quality Fund. 2025. "Pakistan Air Quality Initiative (PAQI)" https://aqfund.epic.uchicago.edu/entities/pakistan-air-quality-initiative-paqi/; https://pakairquality.com/

Section 3

Wildfires caused particulate concentrations to reach decade-high levels in the United States and Canada

Wildfires in Canada significantly worsened air quality in 2023, with $PM_{2.5}$ levels rising by over 50 percent in Canada and 20 percent in the United States compared to 2022.

Fueled by the worst wildfire season in its history, Canada experienced its highest particulate pollution levels since 1998 while also contributing to worsening air quality in several states in the United States.[32] The US saw a 20 percent increase in particulate pollution over 2022 levels. Both countries recorded their largest year-on-year increases in $PM_{2.5}$ concentrations since 1998 (Figure 3.2).[33]

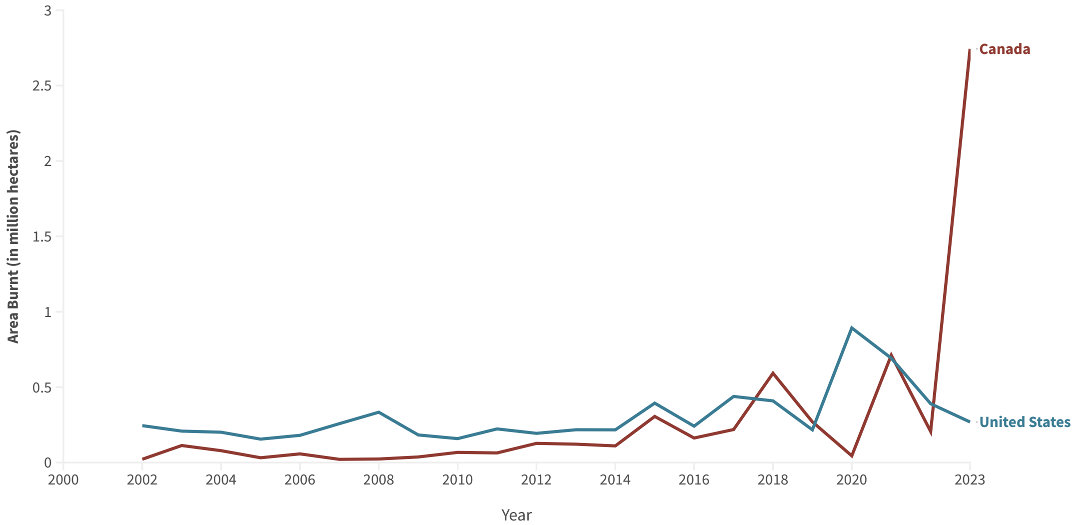
This was not an isolated episode. Evidence of a link between climate change, wildfire smoke, and rising particulate pollution has been increasing over the past two decades.[34] For example, a recent paper indicates that anthropogenic climate change has increased the likelihood of autumn wind-driven extreme wildfire events,

32 Refer Footnote 1

33 AQLI data records go back to 1998.

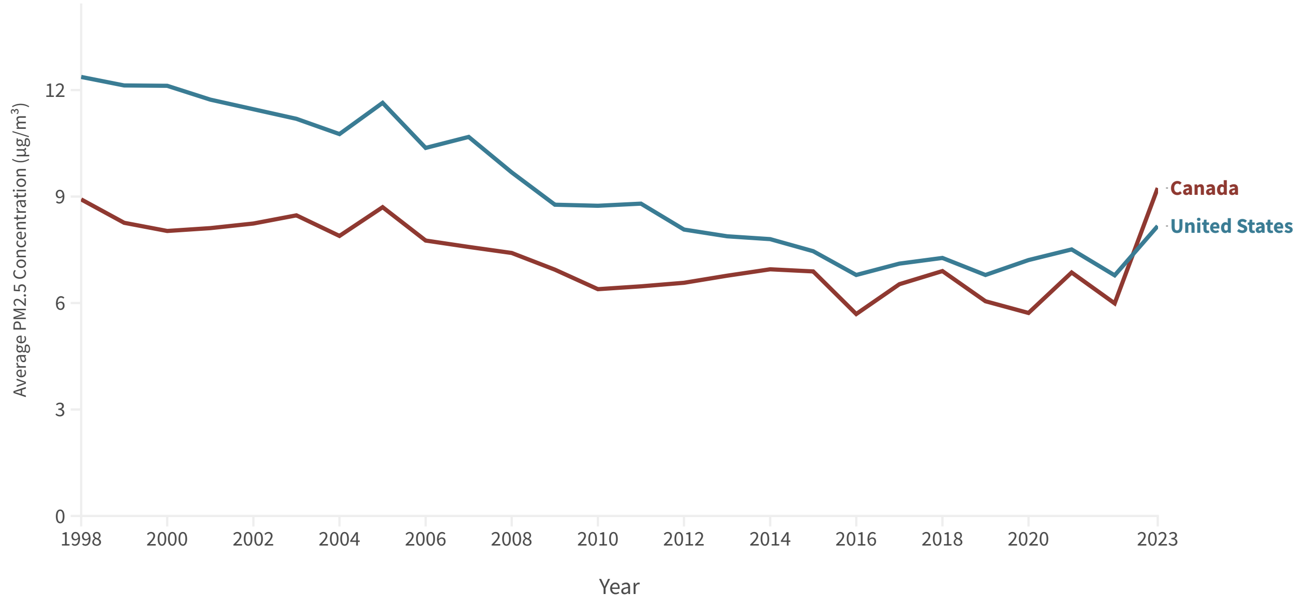
34 Liu, J.C., Mickley, L.J., Sulprizio, M.P. et al. 2016. "Particulate air pollution from wildfires in the Western US under climate change." Climatic Change 138, 655–666. https://doi.org/10.1007/s10584-016-1762-6

Figure 3.1 · Canada witnessed record breaking wildfires in 2023



Source: Global Wildfire Information System GWIS (https://gwis.jrc.ec.europa.eu/apps/country.profile/downloads).
GWIS derives wildfire events and burnt areas using the GlobFire methodology, based on the MODIS burnt area product (MCD64A1)

Figure 3.2 · Year-on-year change in $PM_{2.5}$ concentration in the United States and Canada between 1998 and 2023.



especially in the Western U.S.[35] Additionally, NASA scientists have found that since 2001, extreme wildfires have become both more frequent and intense, especially in temperate conifer forests of the Western U.S. and the boreal forests of northern North America, and that warmer nighttime temperatures are a major contributing factor.[36] Research has also warned that the increasing frequency of wildfire events is reversing decades of clean air progress made in the US.[37]

With a 20 percent increase over 2022 levels, in 2023, the particulate concentrations in the United States stood at 8.2 µg/m³, just below its revised national annual $PM_{2.5}$ standard of 9 µg/m³. At this level, residents could expect to gain roughly 3.7 months on average or 105.1 million total life years if the air they breathed permanently met the WHO guideline.

In addition to elevated pollution levels, 2023 also witnessed an altered geographical distribution of pollution in the US. The most polluted counties in the US were not concentrated in California, but were instead spread across the states of Wisconsin, Illinois, Indiana, and Ohio, and even extended to Pennsylvania, Oklahoma, and as far south as Mississippi (Figure 3.2). This is not to say that pollution levels in California have reduced—they have remained fairly constant over the past two years.

In Canada, particulate pollution levels in 2023 exceeded the national annual $PM_{2.5}$ standard of 8.8 µg/m³ for the first time since 1998. At 9.2 µg/m³, more than 1.5 times the 2022 levels, the life expectancy could increase by 5 months on average, adding a total of 15.7 million total life years to Canada's population, if particulate pollution was permanently reduced to meet the WHO guideline.

More than 50 percent of Canadians breathed air that exceeded their national standard of 8.8 µg/m³—a sharp contrast to less than five percent over the previous five years.

The most polluted regions were in the provinces of Northwest Territories, British Columbia, and Alberta. Here, particulate pollution levels in 2023 were comparable to relatively polluted Latin American countries like Bolivia and Honduras, cutting people's lives short by more than 2 years (Figure 3.2).

The coincidence of higher temperatures, increased incidence of wildfires, and elevated air pollution concentrations in the US and Canada suggests that climate change and air pollution are deeply connected.[38, 39, 40] Both climate change and air pollution are driven by the same source—fossil fuel combustion from vehicles,

35 Hawkins et al. 2022, "Anthropogenic Influence on Recent Severe Autumn Fire Weather in the West Coast of the United States," Geophysical Research Letters 49, no. 3. https://doi.org/10.1029/2021GL095496.

36 NASA. 2025. "Wildfires and Climate Change." NASA Science – Earth Science. 2025. https://science.nasa.gov/earth/explore/wildfires-and-climate-change/.

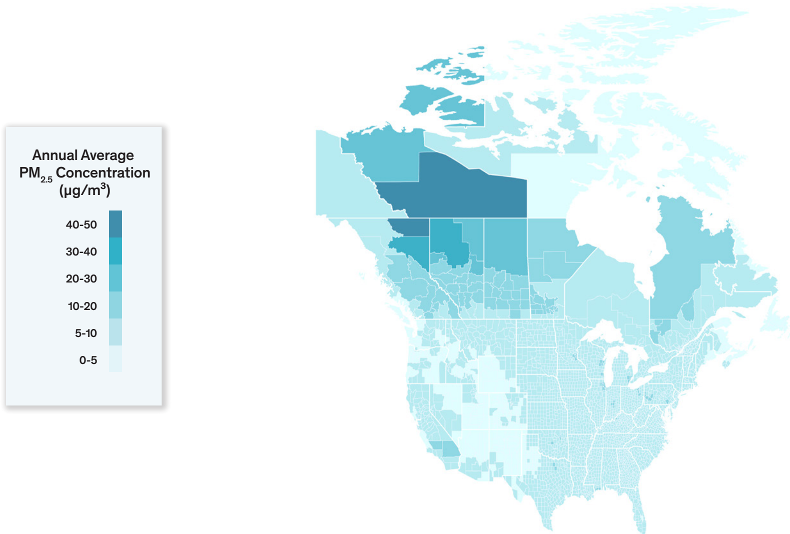
37 Burke, M., Childs, M.L., de la Cuesta, B. et al. 2023. "The contribution of wildfire to $PM_{2.5}$ trends in the USA". Nature 622, 761–766. https://doi.org/10.1038/s41586-023-06522-6

38 US EPA. 2025. "Climate Change Indicators: Heat Waves" https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves

39 Refer Footnote 34

40 Y. Zhuang, R. Fu, B.D. Santer,R.E. Dickinson, A. Hall. 2021. "Quantifying contributions of natural variability and anthropogenic forcings on increased fire weather risk over the western United States" Proc. Natl. Acad. Sci. U.S.A. 118 (45) e2111875118, https://doi.org/10.1073/pnas.2111875118

Figure 3.3 · Wildfires pushed particulate concentrations to more than 5 times the WHO guideline in some parts of Canada. [1]



1 The regions of Alaska and Hawaii (United States) are not shown due to space limitations, but all underlying calculations include these regions.

power plants, and industry. In this respect, reductions in fossil fuel consumption have the potential to decrease air pollution concentrations and the risks of disruptive climate change.

POLICY PROGRESS TOWARDS CLEAN AIR

In 2024, the United States Environmental Protection Agency implemented a stricter annual $PM_{2.5}$ standard of 9 μg/m³, replacing its standard of 12 μg/m³.[41] In 2023, 42 out of 50 states met the revised standard. The eight states that did not meet the revised standard were Illinois, Wisconsin, Ohio, Indiana, Pennsylvania, Michigan, Oklahoma and Minnesota. Due to the impact of the Canadian wildfires, the number of counties where pollution levels were higher than the new standard increased to 308 out of 3,137 from only 13 in 2022. Forty-eight of these counties are in the state of Ohio, followed by 41 in Wisconsin, 31 in Pennsylvania, 26 in Indiana, and 19 in Illinois. The remaining 143 counties are spread across the country, with five in California. If these counties were to meet the revised standards, an average resident in these parts of the US would gain an additional 5.7 months of life expectancy, adding 54 million life years nationally.

41 US EPA. 2024. "Final Rule to Strengthen the National Air Quality Health Standard for Particulate Matter" https://www.epa.gov/system/files/documents/2024-02/pm-naaqs-overview.pdf

Section 4

Europe sees continued health benefits as a result of decline in particulate concentrations

In Europe, particulate pollution levels were modestly lower (1.2 percent) than they were in 2022. Sustained implementation of clean air policies in the region have helped reduce particulate pollution levels by 31.5 percent compared to 1998 levels, adding 5.5 months to the average life expectancy in the region.[42] Barring some residents living in Italy and Spain, most European residents have seen air quality improvements that have extended their life expectancy since 1998 (Figure 4.1).

The average European resident in 2023 was exposed to a particulate concentration of 10.2 µg/m³. If particulate concentrations in Europe were further reduced to meet the WHO guideline, average life expectancy in the region could increase by 6.1 months adding 437 million life years to Europe's population.

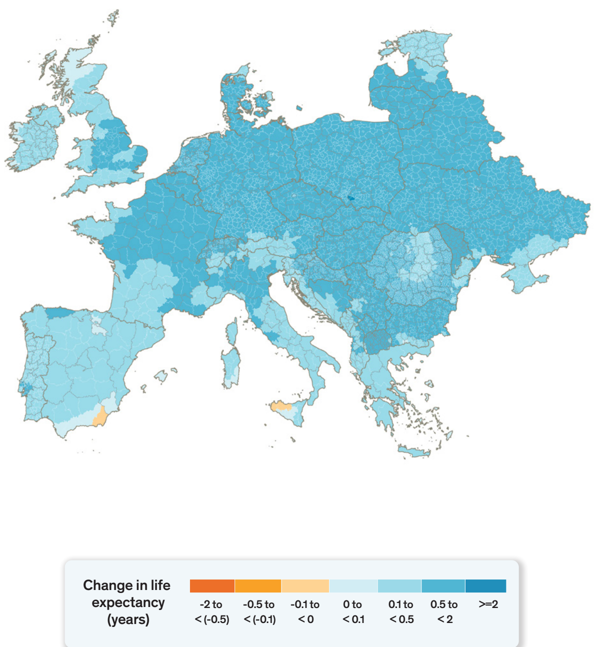
In Europe, the eastern portions of the continent report higher particulate concentrations relative to the western portions—with an average resident of eastern Europe likely to gain 7.9 months of life expectancy if pollution met the WHO guideline, 3.8 months more than residents of Western Europe (Figure 4.2).

While all of Eastern Europe except Estonia exceeds the WHO guideline, the Eastern European nation of Bosnia and Herzegovina is the most polluted country in Europe. An average resident of Bosnia and Herzegovina could gain 1.6 years of life expectancy if particulate concentrations here were reduced to meet the WHO guideline.

Outside of Eastern Europe, pollution remains high in Italy. In Milan, the city with the highest pollution in Western Europe,

42 Europe is defined as the 53 countries in the following file: https://docs.google.com/spreadsheets/d/1FnrmLsWn9z9pQ7Af-mKOw-vCn7DQGcpAPKoAf2woY1Xc/edit?gid=1701994524#gid=1701994524

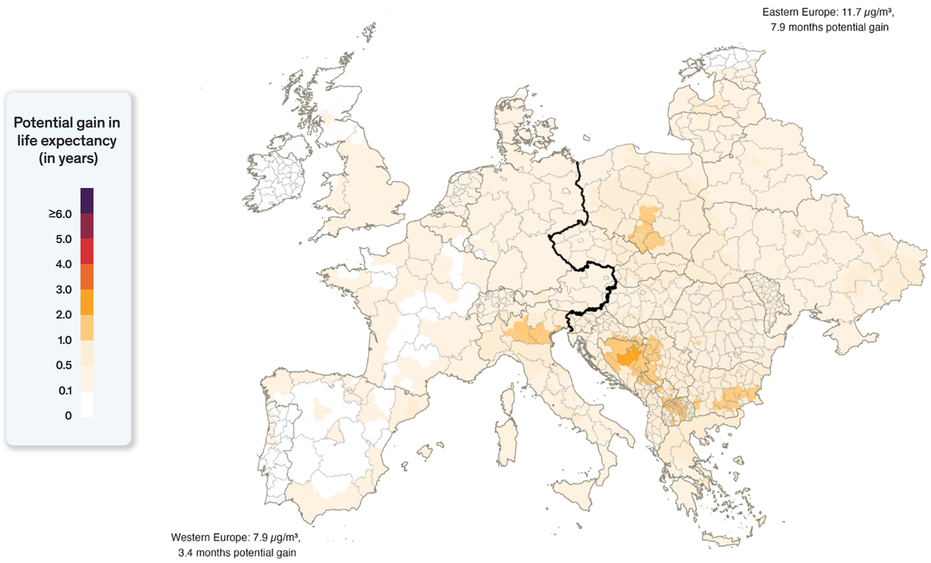
Figure 4.1 · Change in life expectancy due to change in $PM_{2.5}$ concentration in Europe between 1998 and 2023.[1,2]



1 This map excludes Armenia, Azerbaijan, Cyprus, Finland, Georgia, Iceland, Kazakhstan, Norway, Russia, Svalbard and Jan Mayen, Sweden and Turkey from the definition of Europe.

2 The regions of Islas Canarias (in Spain), and Azores and Madeira (in Portugal) are not shown due to space limitations, but all underlying calculations include these regions. Refer footnote 42 for the definition of Europe.

Figure 4.2 · Potential gain in life expectancy from permanently reducing PM2.5 from 2023 concentration to the WHO guideline, comparing Eastern Europe versus Western Europe (demarcated by heavy black line).[1, 2]



1 This map excludes Armenia, Azerbaijan, Cyprus, Finland, Georgia, Iceland, Kazakhstan, Norway, Russia, Svalbard and Jan Mayen, Sweden and Turkey from the definition of Europe.

2 The regions of Islas Canarias (in Spain), and Azores and Madeira (in Portugal) are not shown due to space limitations, but all underlying calculations include these regions. Refer footnote 42 for the definition of Europe.

residents could gain 1.4 years if particulate pollution levels were reduced to meet the WHO guideline.

POLICY PROGRESS TOWARDS CLEAN AIR

In 2024, the European Union introduced a stricter $PM_{2.5}$ limit of 10 μg/m³ for all EU nations to meet by 2030.[43] In 2023, the particulate concentration in 12 out of the 26 EU nations, accounting for 38 percent of the EU's population, was higher than this limit. If particulate concentrations in these countries were reduced to meet the EU-2030 limit, average life expectancy in the EU could go up by 2 months, adding 30 million life years to the EU's population.

43 Council of the Europen Union. 2024. "Air quality: Council and Parliament strike deal to strengthen standards in the EU" https://www.consilium.europa.eu/en/press/press-releases/2024/02/20/air-quality-council-and-parliament-strike-deal-to-strengthen-standards-in-the-eu/

Section 5

South Asia continues to experience the most polluted air in the world

After a trend reversal in 2022, particulate concentrations increased in South Asia in 2023. People living in the region continue to breathe the most polluted air globally and could potentially gain 3.6 years of life expectancy if particulate concentrations in the region were permanently reduced to meet the WHO guideline.

Particulate pollution remains among the greatest external threat to life expectancy across all South Asian countries (Figure 5.1).[44] In Bangladesh, India, Nepal, and Pakistan—the most polluted countries in the region—the impact of particulate pollution is over 1.5 times greater than that of childhood and maternal malnutrition, and more than eight times greater than that of unsafe water, sanitation, and handwashing.

In 2023, $PM_{2.5}$ concentrations in South Asia were 2.9 percent higher than in 2022, following the 9.6 percent decline between 2021 and 2022. Despite the increase in 2023, particulate concentrations were 7 percent lower in 2023 relative to 2021, with Nepal and Bhutan recording the highest absolute declines of nearly 5 µg/m^3, during this period.

Bangladesh has consistently emerged as the most polluted South Asian country. In 2023, Bangladesh's annual-average $PM_{2.5}$ level increased to 60.8 µg/m^3—1.7 times its own national standard of 35 µg/m^3 and more than 12 times the WHO guideline. If $PM_{2.5}$ concentrations in Bangladesh were reduced to meet the WHO guideline, an average resident in Bangladesh could live 5.5 years longer.

In Dhaka, the capital of Bangladesh, with an annual-average particulate pollution of 76.4 µg/m^3—an average resident could live 7 years longer if the pollution levels met the WHO guideline. In the most polluted part of the country—Gazipur district—residents could live 7.1 years longer if the WHO guideline were permanently met. Even in the least polluted part of the country—Lalmonirhat district in the Rangpur division—an average resident could live 3 years longer if pollution levels were brought down to permanently meet the WHO guideline.

In India, South Asia's and the world's most populated country, the particulate concentration in 2023 was 41 µg/m^3—more than eight times the WHO guideline, and slightly higher than the country's national ambient $PM_{2.5}$ standard of 40 µg/m^3. With a 1.2 percent increase in particulate levels in 2023 compared to 2022, an average resident in India could live 3.5 years longer if pollution levels were brought down to meet the WHO guideline. In India's capital, the National Capital Territory (NCT) of Delhi, an average resident could live 8.2 years longer if particulate concentrations were brought down to meet the WHO guideline. This is the highest potential gain in life expectancy across all regions globally.

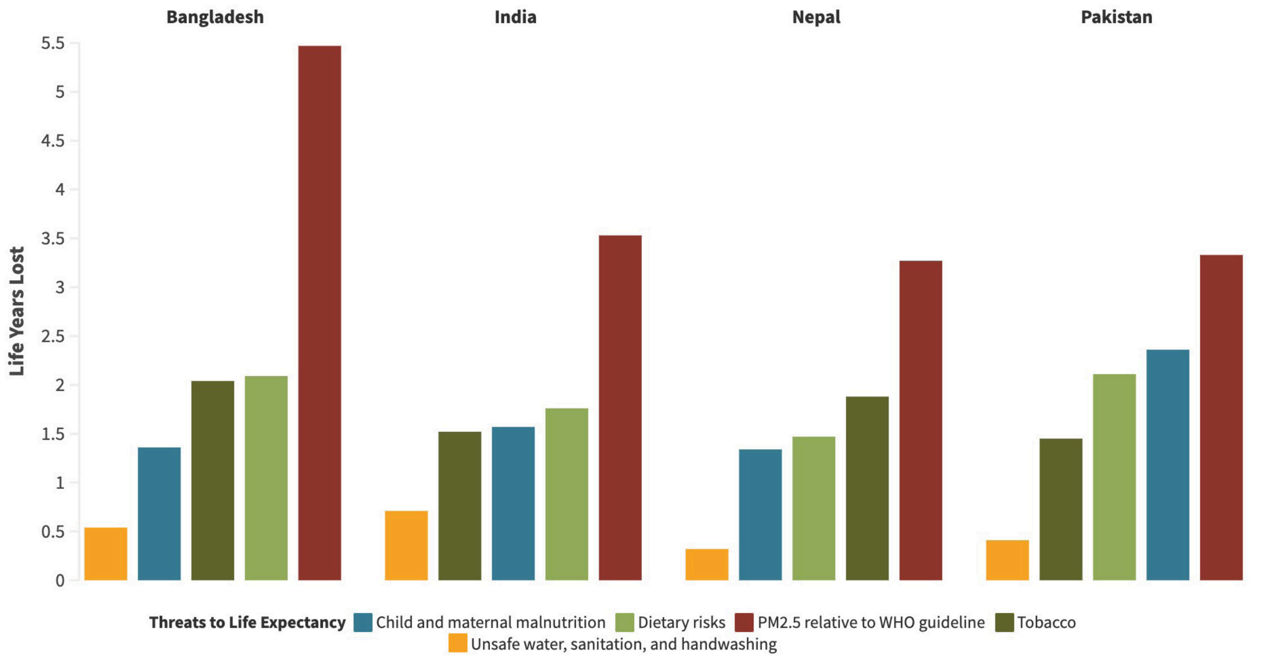
In the country's most polluted region, the Northern Plains, an average resident could live 5 years longer if particulate concentrations met the WHO guideline.[45] Beyond the Northern Plains, the states of Chhattisgarh, Tripura and Jharkhand are the most polluted in the country. On average, people living in these states could live 3.7 years longer if particulate concentrations were to meet the WHO guideline.

In Nepal, where the $PM_{2.5}$ concentration was 38.3 µg/m^3 in 2023, 10 percent higher relative to 2022, the average resident could live 3.3 years longer if the country met the WHO guideline. In the most polluted parts of the country, like the districts of Mahottari and Rautahat in Madhesh province, residents stand to gain more than 5.3 years of life expectancy from cleaner air.

44 South Asia is defined as the following 8 countries: Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, Sri Lanka.

45 We define this region as the following seven states and union territories: Bihar, Chandigarh, Delhi, Haryana, Punjab, Uttar Pradesh, and West Bengal.

Figure 5.1 · Comparison of selected major global threats to life expectancy in South Asian countries



Sources: Global Burden of Disease (https://vizhub.healthdata.org/gbd-results/) level-2 causes and risks data and WHO Life Tables (https://apps.who.int/gho/data/node.main.LIFECOUNTRY?lang=en) were combined with the Life table method to arrive at these results. "$PM_{2.5}$ relative to WHO guideline" bar displays the reduction in life expectancy relative to the WHO guideline as calculated by latest AQLI (2023) data.

In Pakistan, where the $PM_{2.5}$ concentration was 39 µg/m³ in 2023, 6.1 percent higher compared to the particulate levels in 2022, the average resident could gain 3.3 years from meeting the WHO guideline. Those in Lahore, the most polluted city in the country, could gain 5.8 years. Those in Karachi, the largest city in Pakistan, could gain 2.7 years. Those in Pakistan's capital of Islamabad could gain 4.5 years if particulate concentrations were reduced to meet the WHO guideline.

POLICY PROGRESS TOWARDS CLEAN AIR IN THE REGION

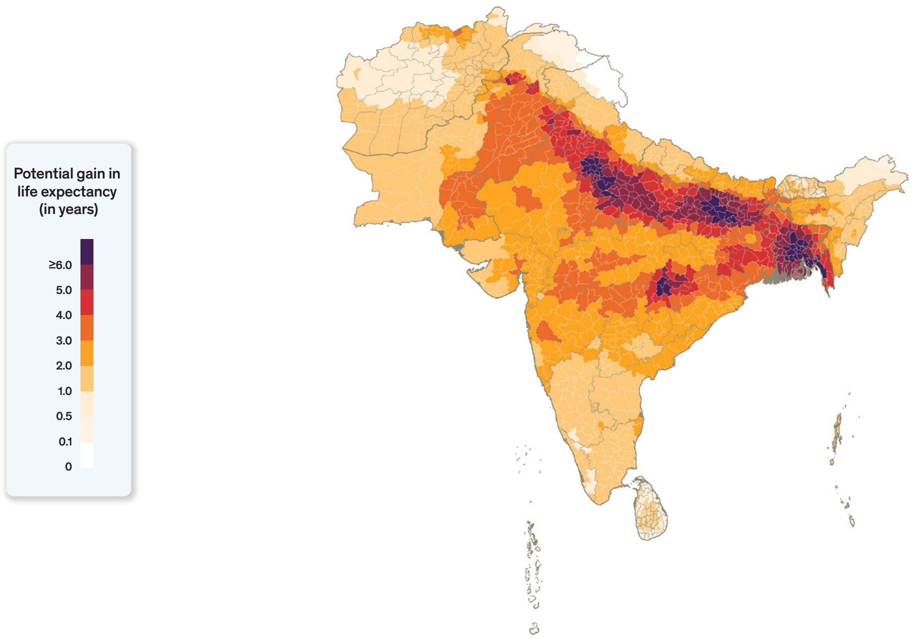
In 2022, Bangladesh's Ministry of the Environment, Forest and Climate Change published the Air Pollution Control Rules 2022. According to the Rules, Bangladesh will have to create a National Air Quality Control Plan, monitor air quality country-wide, identify air pollution activities, and establish standards for emissions from industry, automobiles, and specific projects (power generation, textiles, cement, fertilizers, etc.). Additionally, in Dhaka, the law governing brick kiln production was amended in 2019 to prohibit the establishment of brick kilns near residential, commercial, agricultural, and environmentally sensitive areas. The government is also planning to phase out the use of bricks in favor of concrete blocks by 2025 to reduce air pollution stemming from brick production.

In India, the country with the highest health burden of pollution in South Asia, the Government launched its National Clean Air Programme (NCAP) in 2019 with the stated goal of reducing 2017 particulate pollution levels by 20 to 30 percent by the year 2024. In 2022, the Government of India revamped its NCAP goal, aiming to achieve a 40 percent reduction in particulate pollution levels by 2026 in 131 non-attainment cities. If India were to meet this target, the residents in the non-attainment cities would see their life expectancy increase by 2 years compared to 2017. As of 2023, pollution in the districts with non-attainment cities has declined by 10.7 percent relative to 2017, adding 6 months to the life expectancy of 445.5 million residents of these districts.

Nepal has instituted an Air Quality Management Action Plan for Kathmandu Valley. The plan uses an integrated urban air quality management framework and calls for incorporating air quality objectives with sectoral policies. The plan also identifies transport, brick manufacturing, and construction as the most polluting industries, and adopted measures to strengthen air quality monitoring, develop emissions inventory, and conduct impact assessments, along with specific policies for a sustainable transport system, emissions reduction, and eco-friendly construction.

In 2023, the Government of Pakistan introduced the National Clean Air Policy to provide a framework for improving air quality in Pakistan. The five priority sectors identified for targeted clean air action are transport, industry, agriculture, waste, and

Figure 5.2 · Potential gain in life expectancy from permanently reducing $PM_{2.5}$ from the 2023 concentrations to the WHO guideline



households. The policy outlines one priority intervention across each of the five sectors, with the aim of reducing air pollutant emissions from all major sources. In the transport sector, the key action is to implement Euro-5 and Euro-6 fuel quality standards. For industry, enforcing emission standards is critical to reducing pollution from industrial sources. In agriculture, efforts should focus on preventing the burning of crop residues, a major seasonal contributor to air pollution. In the waste sector, preventing the open burning of municipal solid waste is a key priority. Lastly, in the household sector, promoting the use of low-emission cooking technologies can significantly reduce indoor air pollution and its associated health impacts.

Section 6

China records an increase in fine particulate concentrations after a decade of sustained decrease

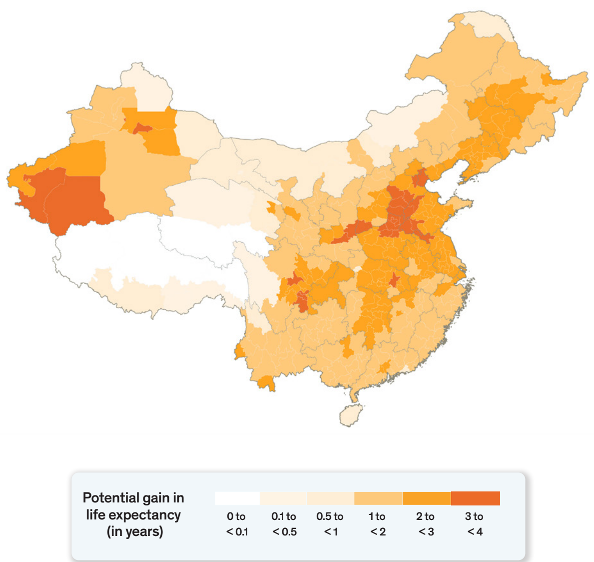
After a decade of declining pollution concentrations in China, particulate levels increased in 2023. If China's 2023 pollution levels were reduced to meet the WHO guideline, the average Chinese resident could gain 2.2 years in life expectancy.

After a decade of consistent decline—China's particulate concentrations increased by 2.8 percent from 2022 to 2023. This increase has been attributed to both higher emissions and unfavorable weather conditions, particularly in Lhasa, Tianjin and Jinan.[46] As a result, compared to 2022, when the entire population of China breathed air that met the country's annual $PM_{2.5}$ standard of 35 µg/m³, in 2023, 14.1 percent of China's population breathed air that did not meet its standard.

In 24 out of China's 36 provinces, $PM_{2.5}$ concentrations were higher in 2023 relative to 2022. The highest increases were observed in the provinces of Beijing and Chongqing, where $PM_{2.5}$ concentrations increased by 4 µg/m³ and 3 µg/m³, respectively. If the 2023 concentrations in these provinces were reduced to meet the WHO guideline, an average resident in these provinces could gain 2.5 years of life expectancy (Figure 6.1).

46 Refer Footnote 13

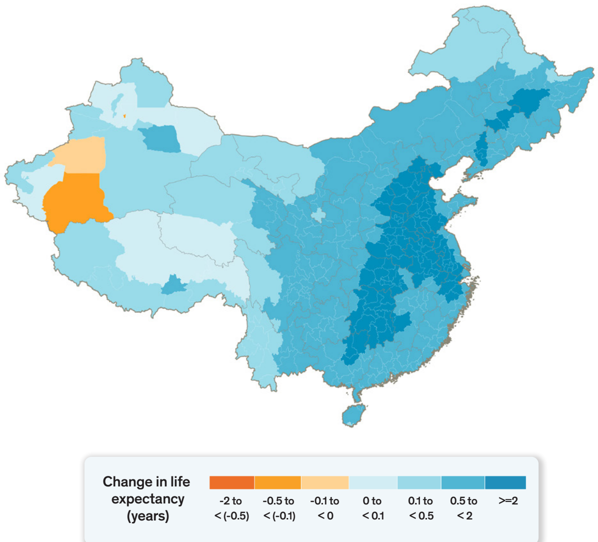
Figure 6.1 · Potential gain in life expectancy from permanently reducing $PM_{2.5}$ from 2023 concentration to the WHO guideline



While particulate concentrations were higher relative to 2022, they still remain 40.8 percent lower than they were in 2014 when China launched its "war on air pollution" by introducing the National Air Quality Action Plan. As a result of this reduction, Chinese residents are likely to live 1.8 years longer (Figure 6.2). To meet the goals laid out in its National Air Quality Action Plan, the government began to restrict the number of cars on the road in large cities such as Beijing, Shanghai, and Guangzhou. In the industrial sector, iron and steel-making capacity was reduced. New coal plants were banned in the Beijing-Tianjin-Hebei (BTH), Pearl River Delta (PRD) and Yangtze River Delta (YRD) regions. Existing plants were mandated to reduce their emissions or switch to natural gas and renewable energy sources, while others were closed or relocated. In addition, coal-fired boilers used for heating homes in the north were replaced with gas or electric heaters.

While China has made significant improvements in reducing its pollution—allowing most of the population to meet the country's national standard—there is more to be done. The entire population of China is exposed to air that does not meet the WHO guideline for $PM_{2.5}$. As a result, particulate pollution is the second greatest external threat to life expectancy in China, preceded only by smoking (Figure 6.3). The impact of particulate pollution on life expectancy in China is 1.3 times dietary risks and 5 times other environmental risks.

Figure 6.2 · Improvements in life expectancy due to reduced pollution between 2014 and 2023 in China



Note: Virtually all Chinese residents are projected to see their life expectancy improve (blue) due to recent reductions in particulate pollution since 2014, if those reductions persist.

POLICY PROGRESS TOWARDS CLEAN AIR IN CHINA

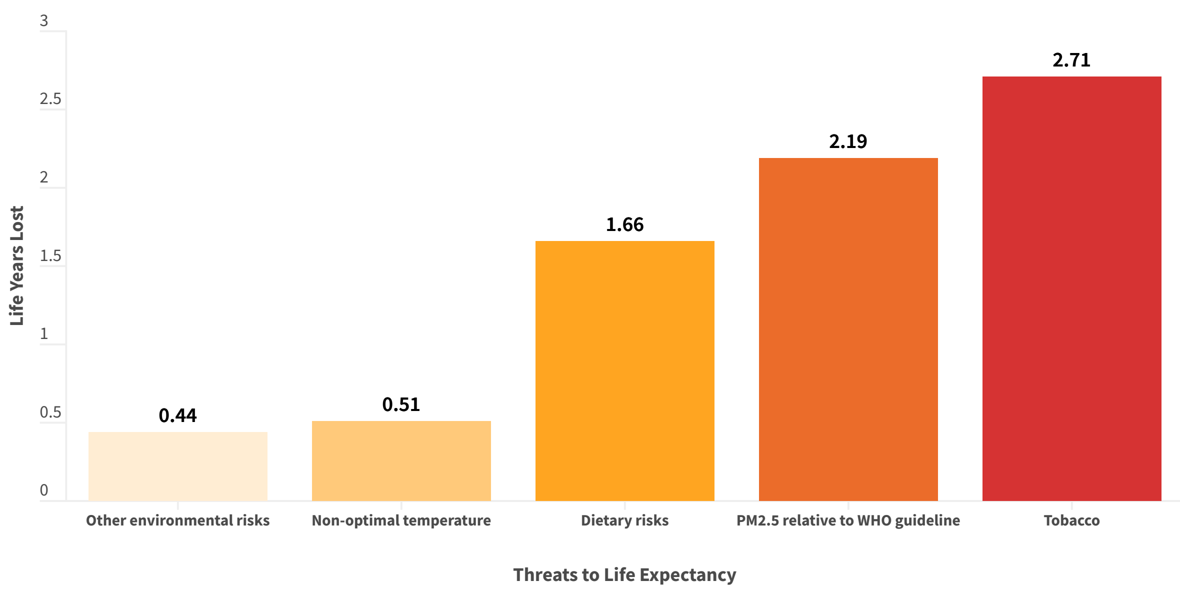
Recognizing that pollution was still a significant health threat, in November 2023, China published its third pollution control plan.[47] The plan sets a 2025 target of reducing particulate pollution in all cities at the prefecture level and above by 10 percent compared to 2020. It targets a 20 percent reduction in the $PM_{2.5}$ level of the BTH region and a 15 percent reduction in the pollution level of the Fenwei Plain compared to its 2020 level.[48]

As of 2023, only 22 percent of China's prefectures have reduced their $PM_{2.5}$ concentrations by 10 percent or more relative to 2020. $PM_{2.5}$ concentrations in the BTH regions are 7.4 percent lower compared to those in 2020, and in Fenwei Plain the $PM_{2.5}$concentrations are lower by 8.8 percent relative to 2020. As a result of these reductions in particulate concentrations, an average Chinese resident is likely to live 0.36 months longer relative to what they would have had the 2020 levels of $PM_{2.5}$ persisted.

47 Dialogue earth. 2023. "New air pollution control plan released" https://dialogue.earth/en/digest/new-air-pollution-control-plan-released/

48 Fenwei Plain is defined as the following prefectures: Xi'an, Baoji, Xianyang, Weinan, Tongchuan in Shaanxi province; Jinzhong, Luliang, Linfen, Yuncheng in Shanxi province; Luoyang, Sanmenxia in Henan province. Source: Liu, S.; Ju, T.; Pan, B.; Li, M.; Peng, S. 2022. "Aerosol Analysis of China's Fenwei Plain from 2012 to 2020 Based on OMI Satellite Data." Atmosphere 13(10): 1728. https://www.mdpi.com/2073-4433/13/10/1728

Figure 6.3 · Top 5 external threats to life expectancy in China



Sources: Global Burden of Disease (https://vizhub.healthdata.org/gbd-results/) level-2 causes and risks data and WHO Life Tables (https://apps.who.int/gho/data/node.main.LIFECOUNTRY?lang=en) were combined with the Life table method to arrive at these results. "$PM_{2.5}$ relative to WHO guideline" bar displays the reduction in life expectancy relative to the WHO guideline as calculated by latest AQLI (2023) data.

Section 7

Most Latin Americans are breathing air exceeding the WHO guideline

In 2023, 97.9 percent of Latin America's population was exposed to particulate concentrations that exceeded the WHO guideline. While an average resident of the region could gain an additional year of life expectancy if pollution levels in the region met the WHO guideline, in the most polluted regions of Latin America, gains could be higher than 4 years, comparable to some of the most polluted regions in South Asia.

Particulate concentrations in Latin America have consistently increased since 1998. In 2023, the region's particulate concentration was 15.4 $\mu g/m^3$, 4.3 percent higher than in 2022 and 14 percent higher than in 1998. This means that an average resident of this region would have lived 2.3 months longer had pollution levels remained unchanged since 1998.[49]

The highest increases in particulate concentration can be seen in Bolivia, Honduras, and El Salvador, making these the most polluted countries in the region. Consequently, particulate pollution has emerged as the greatest external health threat in Latin America's most polluted countries. The impact of particulate pollution on life expectancy in these countries is 4.2 times higher than child and maternal malnutrition, 2.7 times higher than self-harm and interpersonal violence, and 3.4 times higher than tobacco (Figure 7.1).

Bolivia is the most polluted country in Latin America, with an annual average particulate pollution level of 32.2 $\mu g/m^3$. An average resident of Bolivia could gain 2.7 years of life expectancy if pollution levels were brought down to meet the WHO guideline. In Bolivia's most polluted region, the province of Ichilo in the Santa Cruz Department, an average resident could live 4.2 years longer if particulate concentrations here were brought down to meet the WHO guideline (Figure 7.2).

Beyond urban regions in Bolivia, rural parts of the country are also exposed to high levels of particulate pollution. For example, in Marbán (Department of Beni)—a rural region containing some of the country's worst air quality—residents could gain 4.1 years of life expectancy if the WHO guideline was met (Figure 7.2).

In Guatemala, the average life expectancy is 2.1 years lower than what it would be if the WHO guideline were met. Zona 8 is the country's most polluted municipality, and residents here could live 4 years longer if particulate concentrations here met the WHO guideline (Figure 7.2).

In Brazil, Latin America's most populous country, 218.2 million people could gain 8.4 months of life expectancy—or a total of 151.9 million life years—if particulate concentrations here were reduced to meet the WHO guideline. In the Amazonian federative units of Rondônia, Amazonas, and Acre, residents could live 2.7 years longer by breathing air with particulate concentrations that meet the WHO guideline. These regions experience high levels of particulate pollution primarily due to the burning of the rainforests. The fires are a result of deforestation and illegal fires set to clear land for farming and cattle grazing [50] (Figure 7.2).

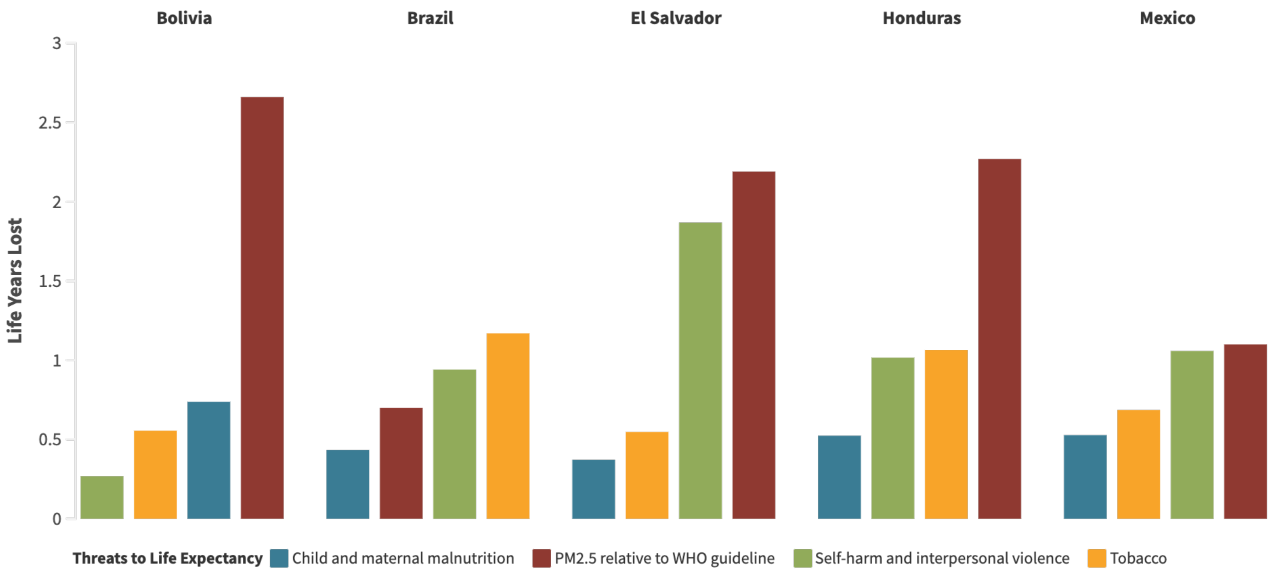
POLICY PROGRESS TOWARDS CLEAN AIR IN THE REGION

Mexico and Brazil are the only two countries in the region to have formulated national-level clean air policies.

49 Latin America region is defined as the following 21 countries and territory: México, Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica, Panama, Colombia, Venezuela, Ecuador, Peru, Bolivia, Brazil, Paraguay, Chile, Argentina, Uruguay, Cuba, Haiti, Dominican Republic, Puerto Rico.

50 Rainforest Foundation US. 2024. "Amazon Rainforest Fires" https://rainforest-foundation.org/engage/brazil-amazon-fires/

Figure 7.1 · Comparison of selected major threats to life expectancy in Latin America's most polluted countries



Sources: Global Burden of Disease (https://vizhub.healthdata.org/gbd-results/) level-2 causes and risks data and WHO Life Tables (https://apps.who.int/gho/data/node.main.LIFECOUNTRY?lang=en) were combined with the Life table method to arrive at these results. "$PM_{2.5}$ relative to WHO guideline" bar displays the reduction in life expectancy relative to the WHO guideline as calculated by latest AQLI (2023) data.

Presented in 2017, Mexico's National Air Quality Strategy sets up state-wise air quality improvement programs to include all stakeholders in the air pollution conversation and aims to reduce pollution to meet the WHO guideline by 2030.[51] The policy plans to do so by updating vehicular and industrial emissions standards, investing in clean fuel in public transportation, developing a national air quality index, and an emissions inventory and air quality modelling platform. Beyond the National Air Quality Strategy, in 2014, Mexico's Secretariat of Environment and Natural Resources mandated all heavy-duty vehicles sold after January 2018 are required to meet the Euro-6 or US-EPA 2010 standards.[52]

Brazil unveiled its national Air Quality Policy in 2024 with a final target to reduce annual average $PM_{2.5}$ concentrations to the WHO guideline with interim targets for reductions in 2025, 2033 and 2044.[53] Alongside the policy, Brazil also launched the VigiAir Panel, a collaboration between the country's ministries of Health and Environment and Climate Change, which will use satellite-derived data from Copernicus Atmosphere Monitoring Service to provide user-friendly $PM_{2.5}$ information across municipalities.[54] The progress of the policy remains to be seen.

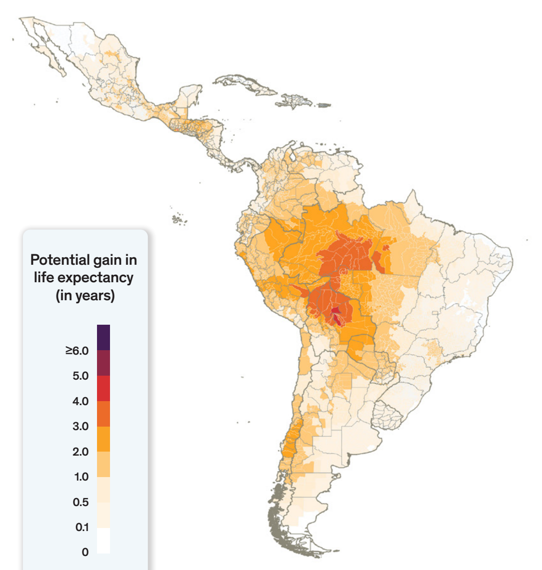
51 Ministry of Environment and Natural Resources. 2017. "Semarnat presents National Air Quality Strategy" https://www.gob.mx/semarnat/prensa/presenta-semarnat-estrategia-nacional-de-calidad-del-aire

52 Climate and Clean Air Coalition (CCAC). 2024. "MEXICO HEAVY-DUTY VEHICLE EMISSIONS STANDARDS" https://www.ccacoalition.org/sites/default/files/resources/ICCT%20Mexico%20vehicle%20emission%20standards.pdf

53 Ronan Adler Tavellaa, Fernando Rafael de Moura, Simone Georges El Khouri Miraglia and Flavio Manoel Rodrigues da Silva Júnior. 2024. "A New Dawn for Air Quality in Brazil" The Lancet Planetary health Volume 8, Issue 10e717-e718 https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(24)00203-1/fulltext

54 Refer Footnote 53

Figure 7.2 · Potential gain in life expectancy from permanently reducing $PM_{2.5}$ from 2023 concentration to the WHO guideline



While the national-level policy is recent, Brazil has a track record of implementing pollution reduction policies. For instance, Brazil's PROCONVE program, initiated in 1987, also aims to reduce vehicle emissions. Vehicles are required to comply with Euro-6 standards, with increasingly stringent requirements.[55] The last phase of the program for agriculture and road machinery began in January 2015, and for light and heavy vehicles began in January 2022.[56] As a result of these policies, particulate pollution in Brazil has remained stable between 10 µg/m³ and 12 µg/m³ for the last twenty years. Further reducing pollution to meet the WHO guideline would add 8.4 months to the national average life expectancy.

Other policies in the region focus on vehicle emissions, especially in cities in Latin America's most polluted countries like Guatemala and Bolivia, among others.[57] Guatemala has partnered with the World Bank to plan the implementation of an emissions reduction program, and Bolivia published a resolution to regulate vehicle emissions in 2022.[58, 59]

Several Latin American cities have local policy instruments to reduce urban air pollution and traffic congestion. Bogotá, Mexico City, Santiago de Chile, and Quito have implemented license plate-based restrictions on car use.[60] Bogota's bus rapid transit (BRT) system (largest in the world), dedicated bus lanes and BRT routes in Brazil's Curitiba are other examples of Latin American cities taking measures to reduce vehicular pollution. As a result of these policies, pollution levels in most of these cities have remained stable over the past 10 years, in contrast to the rest of the region where pollution levels have increased. Yet, there is significant scope for reducing their pollution. If pollution were reduced to permanently meet the WHO guideline, an average resident in Colombia's capital city of Bogota, would live 1.2 years longer, those in Mexico's capital Mexico City would live 1.6 years longer, and those in Ecuador's capital Quito would live 1.2 years longer.

55 Brazilian Institute of Environment and Renewable Natural Resources. 2011. "Air Pollution Control Program by Motor Vehicles" https://www.gov.br/ibama/pt-br/assuntos/emissoes-e-residuos/emissoes/arquivos/manual%20proconve%20promot_english.pdf

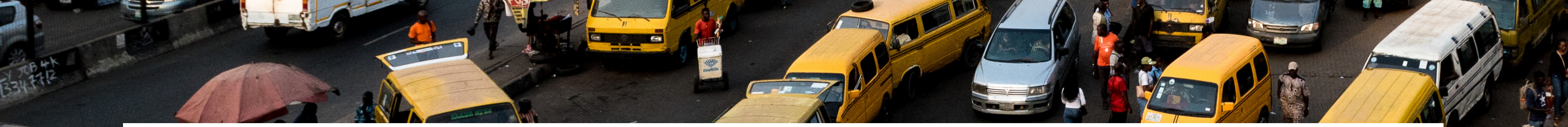
56 Brazilian institute of environment and renewable resources. 2022. "Vehicle emissions control program (Proconve)" https://www.gov.br/ibama/pt-br/assuntos/emissoes-e-residuos/emissoes/programa-de-controle-de-emissoes-veiculares-proconve

57 Guatemala: International Women's Media Foundation. 2018. "How Outdated Cars Live On in a Smoggy Afterlife."; Bolivia: Mardoñez, V., Uzu, G., Andrade, M., Borlaza, L. J. S., Pandolfi, M., Weber, S., Moreno, I., Jaffrezo, J.-L., Besombes, J.-L., Alastuey, A., Perez, N., Močnik, G., and Laj, P., 2022; Peru: Pinedo-Jáuregui, C., Verano-Cachay, J., Barrantes-Santos, V., 2020.

58 Worldbank. 2024. "ENVIRONMENTAL AND SOCIAL COMMITMENT PLAN (ESCP)" https://documents1.worldbank.org/curated/en/099120924140542710/pdf/P1671321e1d84b03219ea7103504ce8fd17.pdf

59 Ministry of public services and housing. 2022. "Ministerial resolution no 64" https://members.wto.org/crnattachments/2022/TBT/BOL/modification/22_4123_00_s.pdf

60 Boso, À., Oltra, C., Garrido, J. et al. 2023. "Understanding Public Acceptance of Automobile Restriction Policies: A Qualitative Study in Four Latin American Cities." https://doi.org/10.1007/s12115-023-00867-4



Section 8

Pollution is the greatest external health threat in Central and West Africa's most polluted countries

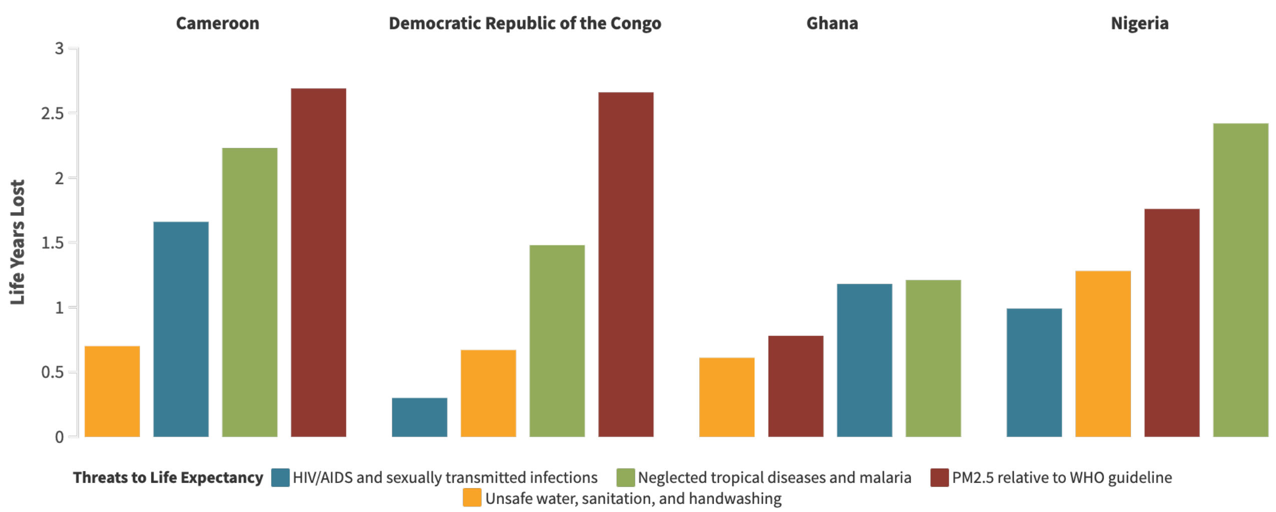
Particulate concentrations in Central and West Africa fell by 1.7 µg/m³ in 2023 compared to 2022 but have remained largely unchanged over the past decade. While the average resident of this region loses 1.6 years of life expectancy due to air pollution, the toll exceeds 5 years in the most polluted regions.

Over the last decade, particulate pollution levels in Central and West Africa have fluctuated between 20 µg/m³ and 22 µg/m³.[61] In 2023, the $PM_{2.5}$ concentration in the region was 20.9 µg/m³—more than four times the WHO guideline. As a result, an average resident of this region can lose 1.6 years of life expectancy. Collectively, the region is losing 1.1 billion years of life expectancy because of poor air.

For many years, the public health discourse in Sub-Saharan Africa has largely centered around infectious diseases, but the data show

61 Central Africa is defined as the following 11 countries: Angola, Burundi, Cameroon, Central African Republic, Chad, Republic of the Congo, Democratic Republic of the Congo, Equatorial Guinea, Gabon, São Tomé and Príncipe, Rwanda. West Africa is defined as the following 16 countries: Benin, Burkina Faso, Cabo Verde, Gambia, Ghana, Guinea, Guinea-Bissau, Côte d'Ivoire, Liberia, Mali, Mauritania, Niger, Nigeria, Senegal, Sierra Leone, Togo.

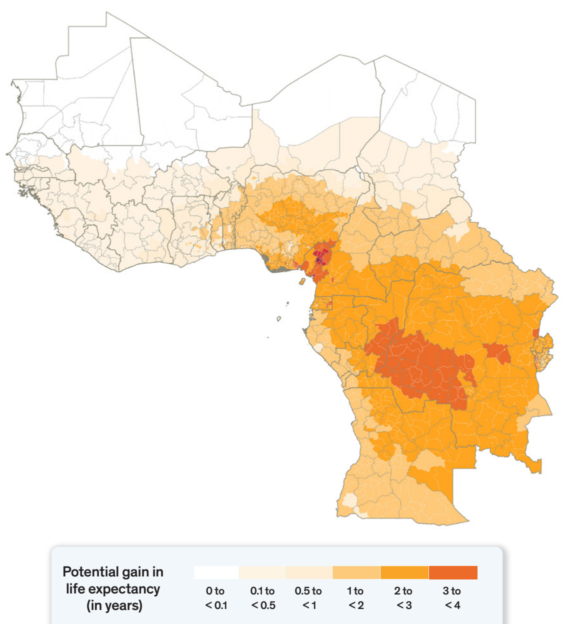
Figure 8.1 · Comparison of selected major global threats to life expectancy in the most populous countries in Central and West Africa



Sources: Global Burden of Disease (https://vizhub.healthdata.org/gbd-results/) level-2 causes and risks data and WHO Life Tables (https://apps.who.int/gho/data/node.main.LIFECOUNTRY?lang=en) were combined with the Life table method to arrive at these results. "$PM_{2.5}$ relative to WHO guideline" bar displays the reduction in life expectancy relative to the WHO guideline as calculated by latest AQLI (2023) data.

that the health impacts of particulate pollution exposure are no less serious. In the region's most polluted countries—Cameroon and the Democratic Republic of Congo—particulate pollution is the greatest external threat to life expectancy. Pollution's impact is 1.6 and 8.8 times greater than HIV/AIDS in Cameroon and the Democratic Republic of the Congo, respectively, and 1.2 and 1.8 times greater than infectious diseases, respectively (Figure 8.1). Cameroon was the most polluted country on the African continent in 2023, with an annual-average particulate concentration of 32.5 μg/m³, or nearly 6.5 times the WHO guideline. As a result, average life expectancy is 2.7 years lower than what it would be if the country met the WHO guideline. In Ouest province, the most polluted part of Cameroon, residents could live 4.4 years longer if pollution were reduced to meet the WHO guideline. In the most polluted region in the country and all of Sub-Saharan Africa—the Menoua department in Ouest province—an average resident is likely to gain 5.1 years of life expectancy if particulate concentrations were to meet the WHO guideline (Figure 8.2).

Figure 8.2 · Potential gain in life expectancy from permanently reducing $PM_{2.5}$ from 2023 concentration to the WHO guideline



Democratic Republic of the Congo (DRC) was the second most polluted country in Africa. The average life expectancy could increase by 2.7 years if particulate pollution was reduced to meet the WHO guideline. In Kinshasa, the capital and largest city of the DRC, the particulate pollution level was lower than in 2022. Yet, its 12.7 million residents could potentially live 3.2 years longer if particulate concentrations met the WHO guideline. The situation is worse in a cluster of regions to the east of Kinshasa—namely, Mai-Ndombe, Kwilu, and Kasaï—where residents could add 3.3 to 3.5 years to their life expectancy by breathing cleaner air. In these regions, high air pollution levels have been largely attributed to waste burning, mining, and industrial practices such as mineral processing and cement manufacturing. Moreover, with the prevalence of dirty indoor cookstoves, residents face additional exposure to high levels of air pollution indoors.[62]

Following Cameroon and DRC, Rwanda, the Republic of Congo, Equatorial Guinea, and Burundi were the most polluted countries in Central and West Africa. These countries are also among the most polluted countries in the world. Their stories are similar. In the Republic of the Congo's capital city of Brazzaville, residents are losing 3.1 years; in Rwanda's capital, Kigali, it is 2.4 years; in Burundi's capital of Gitega, it is 2 years; and in Bata, Equatorial Guinea, it is 2.2 years.

Although central African countries experience higher levels of pollution, the West African country of Nigeria, on account of its large population, faces the highest health burden of air pollution in Africa. In 2023, the particulate pollution level in Nigeria was 22.9 μg/m³—more than four times the WHO guideline, reducing Nigerian residents' lives by 1.8 years. Cumulatively, Nigeria's 403.9 million life years lost to pollution make up 22 percent of the total life years lost to pollution in all of Africa.

In the Federal Capital Territory, home to Nigeria's capital city of Abuja and one of the most polluted regions in the country, residents could gain 2.5 years of life expectancy if particulate pollution were permanently reduced to meet the WHO guideline. In Lagos, Nigeria's largest city with 22.2 million people, residents could see their life expectancy increase by 1.6 years. Following the trend from previous years, Niger River Delta—which is the most polluted region in Nigeria, with an average pollution of 29.7 μg/m³—faces a loss of 2.4 years of life expectancy relative to the WHO guideline.[63, 64]

POLICY PROGRESS TOWARDS CLEAN AIR IN CENTRAL AND WEST AFRICA

Currently, only seven out of 61 African countries have national-level air quality policies. Three of these countries lie in Central and West Africa and are also among the countries that share their data publicly. For more countries to implement air quality management programs, data is needed, and for data generation, air quality monitoring networks are essential.

Nigeria's National Environmental Standards Regulations and

62 Interactive Country Fisches. "Democratic Republic of Congo: Pollution."

63 Niger river delta is defined as the following nine states: Rivers, Delta, Akwa Ibom, Imo, Edo, Ondo, Cross River, Abia, Bayelsa

64 The conversation. 2023. "Niger delta is rich in resources, but environmental destruction is pushing people into poverty" https://theconversation.com/niger-delta-is-rich-in-resources-but-environmental-destruction-is-pushing-people-into-poverty-214598

Enforcement Agency (NESREA) implemented its air quality regulation in 2021.[65] The regulation sets ambient quality standards in the country, limits industrial, vehicular and indoor emissions, and promotes investment in less polluting technology.[66] In June 2021, NESREA partnered with Clarity Movement Co. to provide air quality data in Nigeria.[67]

Rwanda released its air quality law in 2016.[68] The law establishes ambient air quality standards and targets emissions reduction in the three main polluting sectors— transport, waste burning, and indoor biomass burning. In 2018, Rwanda Environment Management Authority (REMA) adopted the country's first ambient $PM_{2.5}$ standards, and in September 2021, REMA launched its air quality monitoring network, which provides real-time air quality information in 13 sites.[69,70]

In Senegal, air pollution prevention is regulated by the 2003 decree on air pollution prevention. The legislation sets industrial, transport, outdoor waste burning, and indoor biomass burning emissions limits, and promotes overall electrification as well as non-grid electrification for rural areas and cleaner cooking fuels.[71]

In Ghana, the Environmental Protection Agency introduced a Greater Accra Metropolitan Area (GAMA) Air Quality Management Plan in 2018, with the goal of bringing GAMA in compliance with the country's air quality standards and maintaining the compliance as the area grows economically.[72]

Togo, in partnership with the Climate and Clean Air Coalition, implemented a National Plan for the Reduction of Air Pollutants and Short-Lived Climate Pollutants with a goal of reducing particulate pollution by 45 percent, which was formally endorsed by the Minister of Environment, Sustainable Development and the Protection of Nature in 2020.[73]

Outside of Central and West Africa, Kenya, Morocco, Eswatini, and South Africa also have national level air quality legislations, and Ethiopia's first air quality management plan focuses on the Addis Ababa region.[74,75]

Despite the progress in recent years, many African countries still lack the tools and resources to manage and mitigate air pollution. Between 2015 and 2022, African countries received less than 2 percent of the philanthropic funding going towards confronting air pollution.[76]

65 Federal Republic of Nigeria Official Gazette. 2021. https://www.nesrea.gov.ng/wp-content/uploads/2023/07/Airquality_Regulation.pdf

66 Refer footnote 65

67 Clarity. 2021. "Nigeria Set to Deploy New Technology to Monitor Air Quality" https://www.clarity.io/blog/nesrea-selects-claritys-air-quality-monitoring-technology-to-deliver-actionable-data-to-inform-policy-decisions

68 Rwanda Environment Management Authority. 2016. "Official Gazette No. 23" https://rema.gov.rw/fileadmin/templates/Documents/rema_doc/Laws/Air%20Pollution%20Law.pdf

69 Republic of Rwanda. 2021. "Rwanda launches Air Quality Monitoring System" https://www.gov.rw/blog-detail/rwanda-launches-air-quality-monitoring-system

70 Rwanda Environment Management Authority. "Air Quality dashboard" https://aq.rema.gov.rw/

71 United Nations Environment Program. 2015. "Senegal Air Quality Policies " https://wedocs.unep.org/bitstream/handle/20.500.11822/17099/Senegal.pdf?sequence=1

72 EPA Ghana. 2018. "The Greater Accra Metropolitan Areas Air Quality Management Plan" https://www.ccacoalition.org/sites/default/files/resources/2018_Greater-Accra-Region-Air-Quality-Management_EPA-Ghana.pdf

73 CCAC secretariat. 2020. "Togo's Minister of Environment endorses first National Plan to Reduce Air Pollutants and Short-Lived Climate Pollutants" https://www.ccacoalition.org/news/togos-minister-environment-endorses-first-national-plan-reduce-air-pollutants-and-short-lived-climate-pollutants

74 Air Quality Life Index (AQLI). 2025. "National air quality policy database" Country_air_quality_policy

75 US EPA. 2025. "Addis Ababa City Air Quality Management Plan (2021 to 2025)" https://www.epa.gov/system/files/documents/2021-11/final-aqmp-addis-ababa.pdf

76 Clean Air Fund. 2024. "Philanthropic Foundation Funding For Clean Air: Advancing Climate Action, Health And Social Justice" https://s40026.pcdn.co/wp-content/uploads/Clean-Air-Fund-Philanthropic-Foundation-Funding.pdf

Section 9

Particulate pollution is a major health threat in parts of the Middle East and North Africa

94.7 percent of the Middle East and North Africa's population lives in areas where particulate pollution exceeds the WHO guideline. In the region's most polluted areas, residents could gain 3.2 years of life expectancy by breathing air that meets the WHO guideline.

In 2023, population-weighted particulate pollution in the Middle East and North Africa (MENA) was 16.8 µg/m³, 0.6 percent higher than in 2022. If particulate concentrations were permanently reduced to meet the WHO guideline, the region's 475.5 million residents could gain 1.2 years of life expectancy (Figure 9.1).

In Qatar, the region's most polluted country, an average resident could live 3.1 years longer if particulate concentrations were brought down to meet the WHO guideline. In Doha, the country's capital and largest city, residents could gain 3.1 years of life expectancy by breathing air that meets the WHO guideline. Particulate pollution in Qatar has largely been attributed to industrial emissions and construction to support the rapid urbanization.[77]

In Saudi Arabia, the second most polluted country in the region, residents stand to gain 2 years of life expectancy by breathing air that meets the WHO guideline. In Riyadh, Saudi Arabia's capital and its most populous governorate, residents stand to gain 2.5 years of life expectancy on average. The situation is even worse in the country's most polluted district, Al Ahsa, in the Ash-Sharqiyah province, where 1.1 million people could gain 3.2 years of life expectancy.

77 The Peninsula. 2024. "Signs of air quality improvement in Doha after major construction boom" https://thepeninsulaqatar.com/article/31/03/2024/signs-of-air-quality-improvement-in-doha-after-major-construction-boom

Figure 9.1 · Potential gain in life expectancy from permanently reducing $PM_{2.5}$ from the 2023 concentrations to the WHO guideline

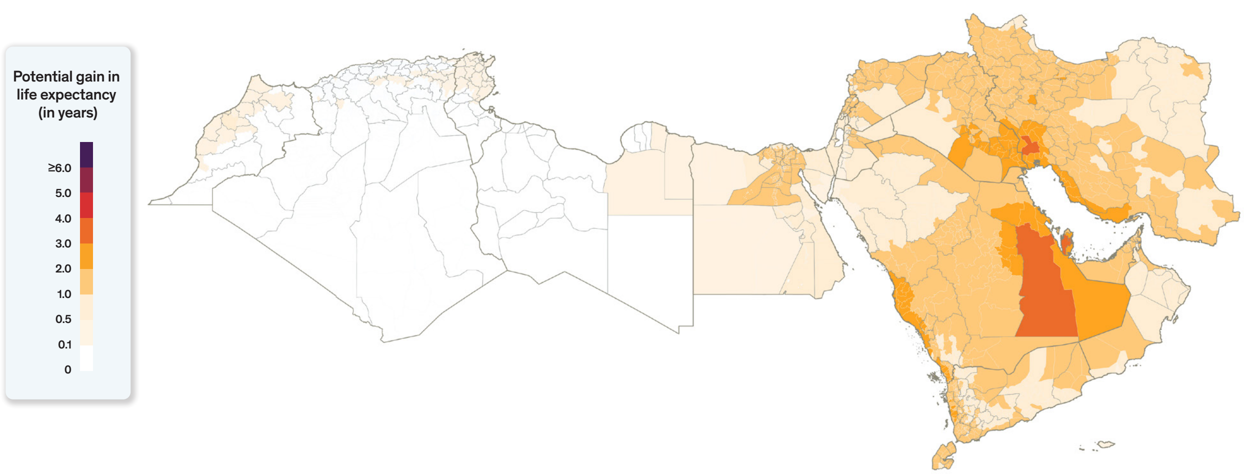
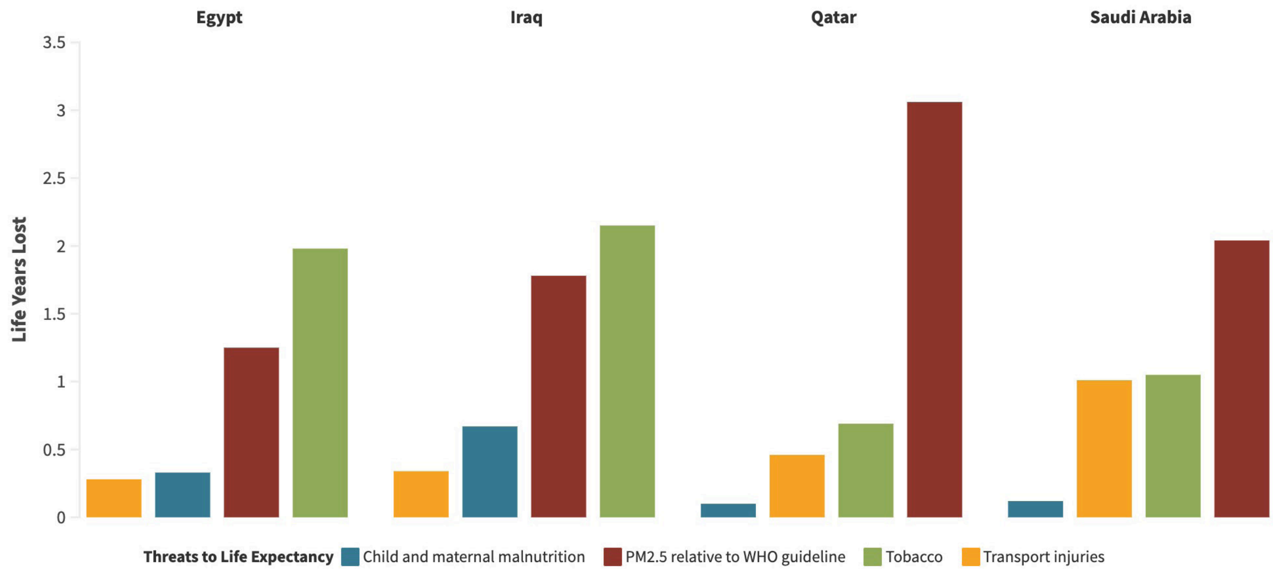


Figure 9.2 · Comparison of selected major global threats to life expectancy in the four most populous countries in Middle East and North Africa



Sources: Global Burden of Disease (https://vizhub.healthdata.org/gbd-results/) level-2 causes and risks data and WHO Life Tables (https://apps.who.int/gho/data/node.main.LIFECOUNTRY?lang=en) were combined with the Life table method to arrive at these results. "$PM_{2.5}$ relative to WHO guideline" bar displays the reduction in life expectancy relative to the WHO guideline as calculated by latest AQLI (2023) data.

In Iraq, an average resident could gain 1.8 years of life expectancy if particulate concentrations met the WHO guideline. In Baghdad, Iraq's capital and its most populous governorate, residents stand to lose 1.9 years of life expectancy on average. The situation is even worse in the most polluted district, Abu al Khasib, in the neighboring Al-Basrah governorate, where 200,000 people are losing 3 years of life expectancy due to particulate pollution. Air pollution in Iraq has been attributed to vehicle exhaust, electric generators, fires at oil and gas refineries, and continuous military conflict in the region.[78]

Despite having lower average particulate pollution than Qatar, Saudi Arabia, and Iraq, Egypt faces the highest health burden in the region due to its large population. In 2023, the particulate pollution level in Egypt was 17.8 $\mu g/m^3$—more than three times the WHO guideline. As a result, an average resident of Egypt could live 1.3 years longer if pollution levels were brought down to meet the WHO guideline. In the city-governorate of Cairo, the capital of Egypt and the largest megacity in the Middle East and North Africa, an average resident could gain 1.7 years of life expectancy by breathing air that meets the WHO guideline. In Alexandria, the largest city in the Mediterranean and an important tourism and industrial hub of Egypt, the condition is slightly better with 15 $\mu g/m^3$ particulate pollution levels translating to 1 year of reduced life expectancy. Traffic congestion and vehicle exhaust, agriculture slash and burn practices, and coal-fired power plants are major sources of particulate pollution in Egypt.[79, 80]

While particulate pollution is among the top five external threats to life expectancy in each of these countries, it is the greatest external threat in Qatar and Saudi Arabia. In Qatar and Saudi Arabia, the impact of particulate pollution is 4.5 and 1.9 times higher than that of tobacco, and 6.6 and 2 times higher than that of transport injuries, respectively (Figure 9.2).

POLICY PROGRESS TOWARDS CLEAN AIR IN THE REGION

Eight out of the nineteen countries in the MENA region have $PM_{2.5}$ standards, and seven countries have environment-related legislative instruments that also include provisions relevant to mitigating air pollution. The countries with pollution policies tend to be some of the less polluted countries in the region.

Iran enacted the Law on the Prevention of Air Pollution in 1995 and has updated it twice since then. In 2017, this law was repealed and a new Clean Air Law was introduced, which brought in stricter penalties for industries and individuals that violate

78 Ecohubmap. 2023. "Air pollution in Baghdad, Iraq" https://www.ecohubmap.com/hot-spot/air-pollution-in-baghdad-iraq/nxoml7sorv56#

79 Clean Air Fund. 2023. "From pollution to solution in Africa's cities" https://www.cleanairfund.org/clean-air-africas-cities/cairo/

80 IQAir. 2024. "Air quality in Egypt" https://www.iqair.com/us/egypt

pollution limits.[81, 82]

The Clean Air Law of Israel came into effect in 2012. Having undergone two revisions since then, it now includes clean air requirements for industrial facilities, measures to reduce vehicular pollution and greenhouse gasses, and renewable fuel standards for biofuels.[83]

The Lebanese Parliament enacted the Law on the Protection of the Environment in 2018. It comprises 34 articles related to air quality monitoring and management, and prevention of air pollution.[84, 85]

In 2021, Morocco, in partnership with the Climate and Clean Air Coalition, finalised its national action plan to reduce short-lived climate pollutants. Full implementation of the plan aims to reduce particulate matter from the transport sector in Morocco by 51.6 percent from 2014 levels.[86]

81 Food and Agriculture Organization. 2024. "FAOLEX Database"https://www.fao.org/faolex/results/details/en/c/LEX-FAOC182168/

82 Radio free Europe. 2023. "Iran's Environmental Standards, Polluted Reality Mix Like Oil And Water"https://www.rferl.org/a/iran-environmental-standards-pollution-smog/32385813.html#

83 Library of congress. "Regulation of Air Pollution: Israel" https://maint.loc.gov/law/help/air-pollution/israel.php#_ftn14

84 Office of the United Nations High Commissioner for Human Rights. 2018. "Environment management in Lebanon" https://www.ohchr.org/sites/default/files/Documents/Issues/Environment/SREnvironment/Pollution/Lebanon.pdf

85 Food and Agriculture Organization. 2019. FAOLEX Database https://www.fao.org/faolex/results/details/en/c/LEX-FAOC176635/

86 Climate and Clean Air Coalition (CCAC) Secretariat. 2022. "Morocco's National Action Plan Signals New Era in the Country's Climate and Clean Air Commitment" https://www.ccacoalition.org/news/moroccos-national-action-plan-signals-new-era-countrys-climate-and-clean-air-commitment

Section 10

Air pollution remains a major burden in Southeast Asia

Like South Asia, most parts of Southeast Asia experienced an increase in $PM_{2.5}$ concentrations in 2023 compared to 2022. As a result, an average Southeast Asian resident could live 1.6 years longer if particulate concentrations were reduced to meet the WHO guideline, and as much as 4.7 years longer in the most polluted regions.

In 2023, the entire population of Southeast Asia breathed air with $PM_{2.5}$ levels that were 4.2 times higher than the WHO guideline. Particulate concentrations in the region were 3.4 percent higher relative to 2022, with the highest increase in Laos (20 percent) and the lowest increase in Indonesia (5.6 percent). The highest decreases relative to 2022 were observed in Cambodia (14.9 percent) and Vietnam (5.9 percent). Although particulate concentration in the region in 2023 was lower compared to the last decade, Laos and Myanmar saw an increase of more than 10 percent.

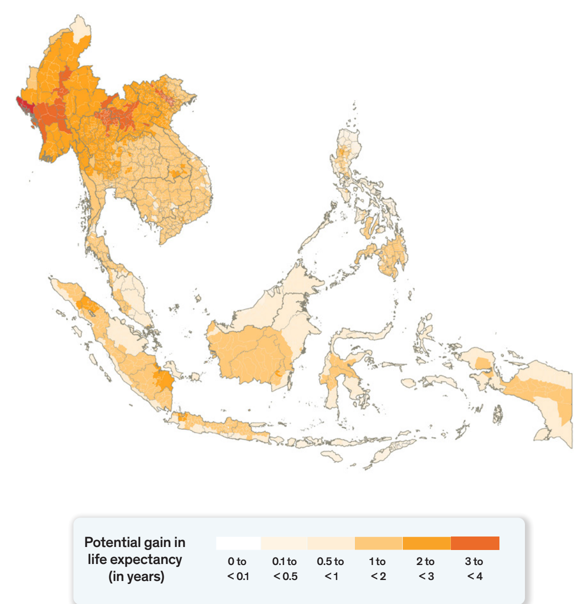
Across the region, air pollution reduces average life expectancy by 1.6 years, relative to what it would be if the WHO guideline of 5 µg/m³ were permanently met. In the 11 countries that make up this region, an estimated 1.1 billion total life years are lost due to air pollution.[87]

In 2023, the population-weighted particulate concentration in Myanmar, the most polluted Southeast Asian country, was 33.4 µg/m³. With sustained exposure to such levels of particulate matter, residents of Myanmar could lose 2.8 years of life expectancy (Figure 10.1). This is significantly more than the impact of other health threats in Myanmar, such as child and maternal malnutrition (1.1 years) or transport injuries (0.36 years) (Figure 10.2). In Yangon and Mandalay, the most populated regions in Myanmar, residents could gain 2.7 and 3.3 years of life expectancy, respectively, if the WHO guideline were met.

In Indonesia, Southeast Asia's most populous country, particulate concentrations reached 18.6 µg/m³ in 2023, the highest level since 2019. Indonesia's entire population breathed air that did not meet the WHO guideline. Further, 72.9 percent of the country's population breathed air that did not meet the country's own standard of 15 µg/m³. Particulate pollution is the greatest health threat in the country after smoking, more deadly than transportation injuries and child and maternal malnutrition.

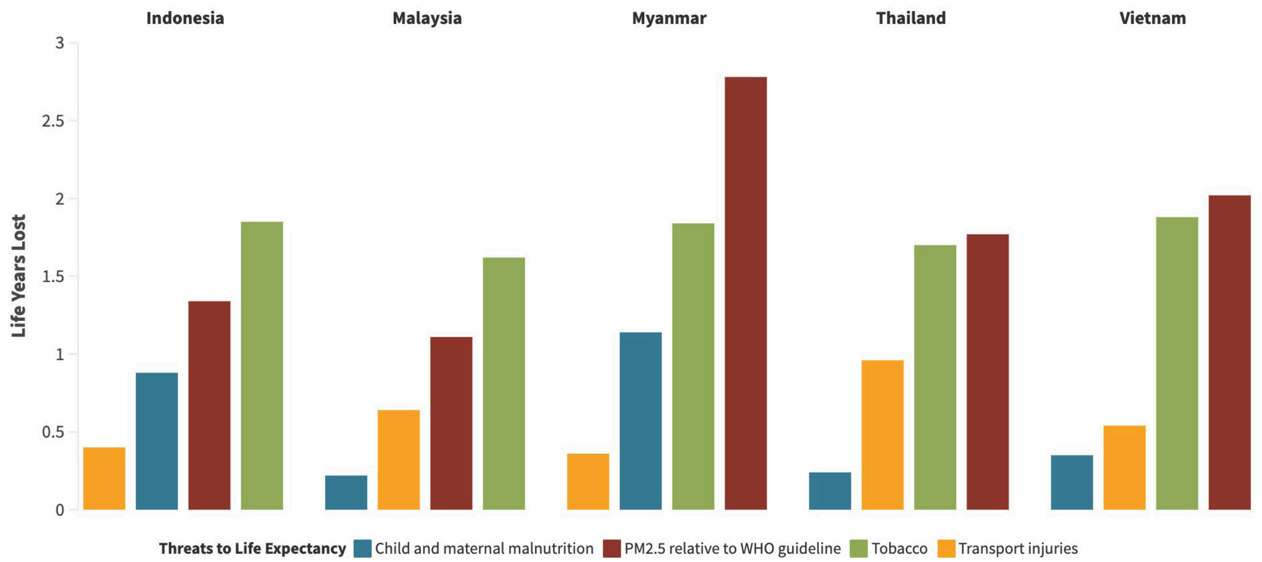
While particulate concentrations in Indonesia's current capital of Nusantara were 14.8 µg/m³, in Indonesia's former capital of Jakarta pollution concentrations were 29.9 µg/m³. As a result, compared to a resident of Nusantara, a resident of Jakarta could lose 1.5 additional

Figure 10.1 · Potential gain in life expectancy from permanently reducing $PM_{2.5}$ from the 2023 concentrations to the WHO guideline



87 Southeast Asia includes the following countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, The Philippines, Singapore, Thailand, Timor-Leste, and Vietnam

Figure 10.2 · Comparison of selected major global threats to life expectancy in Southeast Asian countries



Sources: Global Burden of Disease (https://vizhub.healthdata.org/gbd-results/) level-2 causes and risks data and WHO Life Tables (https://apps.who.int/gho/data/node.main.LIFECOUNTRY?lang=en) were combined with the Life table method to arrive at these results. "$PM_{2.5}$ relative to WHO guideline" bar displays the reduction in life expectancy relative to the WHO guideline as calculated by latest AQLI (2023) data.

years of life expectancy due to pollution that exceeds the WHO guideline. [88]

Similar to previous years, Indonesia's most polluted regions were distributed across the provinces of North Sumatra, South Sumatra, West Java, Jakarta and Banten. Particulate concentrations in Indonesia's most polluted regency of Medan was 36 µg/m³, 10.9 percent higher than its concentration in 2022. Here, residents stand to gain 3 years of life expectancy if pollution were to be reined in to meet the WHO guideline.

In 2023, Indonesia also experienced its worst fire episode since 2019. The Indonesian provinces of Central Kalimantan, South Kalimantan, and South Sumatra were the worst hit, with the average loss in life expectancy in these districts being 1.4 years, 7 months, and 1.92 years, respectively, due to pollution not meeting the WHO guideline.[89]

In Thailand, the $PM_{2.5}$ concentration stood at 23.1 µg/m³—-the highest level since 2015. Particulate pollution is the greatest health threat in the country, with the impact on life expectancy greater than smoking, transport injuries and child and maternal malnutrition. At the provincial level, particulate concentrations varied widely, ranging from 40.9 µg/m³ in Chiang Rai in the North, to 21 µg/m³ in the metropolis of Bangkok, to 14.4 µg/m³ in Phuket in the South. This variation is partly due to fires in Thailand's northern region (including the regions surrounding Chiang Mai, Chiang Rai, Saraburi, and Phayao, for instance) that have increased the amount of regional air pollution.[90] As a result, residents of Chiang Rai could gain 2.7 years of their life expectancy, compared to the 1.6 years that residents of Bangkok could gain by breathing air that meets the WHO guideline.

In Vietnam, the second most polluted country in Southeast Asia, there are even sharper differences between regions. In the capital city of Hanoi, home to more than 8.8 million people and one of Vietnam's major industrial centers, life expectancy could increase by 3.5 years if air quality met the WHO guideline. The impacts of air pollution are much lower in many of Vietnam's central regions, where coastal provinces such as Quang Ngai would see 1 year of added life expectancy if air quality met the WHO guideline. Overall, the average Vietnamese citizen stands to gain 2 years in life expectancy, if pollution was permanently reduced to the WHO guideline. This threat to life expectancy is significantly larger than other external health threats in Vietnam such as tobacco (1.9 years) or transport injuries (0.5 years) (Figure 10.2).

In the Philippines, particulate pollution levels have hovered between 15 to 18 µg/m³ over the last decade. As a result, the average Philippine resident could live 1.2 years longer by breathing air that meets the WHO guideline. In Metro Manila, the national capital region and the largest province in the country, residents could live

88 $PM_{2.5}$ concentrations for Nusantara were not available in our database. To estimate particulate concentrations for Nusantara, we consider the population weighted average $PM_{2.5}$ value of Kutai Kartanegara and Penajam Paser Utara (the two regencies whose parts are being converted to Nusantara).

89 Mongabay. 2024. "2023 fires increase fivefold in Indonesia amid El Niño" https://news.mongabay.com/2024/01/2023-fires-increase-fivefold-in-indonesia-amid-el-nino/

90 NASA MODIS. 2023. "Fires in Southeast Asia" https://modis.gsfc.nasa.gov/gallery/individual.php?db_date=2023-04-10

2 years longer by breathing air that meets the WHO guideline.

POLICY PROGRESS TOWARDS CLEAN AIR IN SOUTHEAST ASIA

As of June 2025, Vietnam, Cambodia and Singapore are the only Southeast Asian countries that have a national-level policy/plan for controlling air pollution [91], but efforts are underway in several countries.

In Indonesia, Jakarta residents won a lawsuit claiming that the government had failed to deliver safe, clean air to its citizens in 2021. In 2022, the provincial government launched an air pollution control strategy to reduce the impact of air pollution by 2030, following which an air pollution task force comprising several government agencies was created.[92, 93]

In Thailand, a group of citizens and Civil Society Organisations similarly sued the national government and its agencies for failing to protect the citizens' right to clean air.[94] Around the same time, Thailand ratcheted up its annual ambient $PM_{2.5}$ standard and prepared to accept its first Clean Air Bill. Starting in 2020, numerous versions of a Clean Air Act were drafted by political parties and Civil Society Organisations. The citizens' draft was submitted by the grassroots organization Thailand Clean Air Network in 2022. [95] By 2024, Thailand had seven different drafts of legislation for clean air, including drafts presented by the government, the opposition party, and civil society. In January 2024, the Thai cabinet voted to unanimously accept in principle all seven drafts of the Clean Air Bill.[96] A parliamentary committee will now be set up to consolidate the different efforts and make amendments to the Cabinet's draft before it is presented to the Parliament for further debate.

In 2024, Thailand officially adopted the Euro-5 standard for diesel vehicles. The standard was adopted after the Thai Industrial Standards Institute accepted applications from February to December 2023 and recorded 50 applications from 25 automobile manufacturers. The Energy ministry plans to propose Euro-6 standards by January 1, 2025.

In 2024, the Government of Thailand, Laos PDR, and Myanmar launched the "Joint Plan of Action – Clear Sky Strategy" aimed at increasing cooperation between the three countries towards tackling the issue of transboundary haze.

91 Refer Footnote 74

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Section 11

Oceania residents are breathing the cleanest air in the world

73.1 percent of Oceania's population breathes air that meets the WHO guideline, making Oceania the cleanest world region. However, in the most polluted locations in this region, air pollution is reducing people's lives by 1.2 years.

In 2023, the annual-average population-weighted $PM_{2.5}$ concentration in Oceania stood at 5.4 µg/m³. Papua New Guinea and Solomon Islands are the only two countries in the region where the particulate concentrations exceeded the WHO guideline.[97] An average resident of these countries could potentially gain 3.4 and 1.4 months of life expectancy, respectively, if pollution levels in these countries were brought down to meet the WHO guideline, adding 6.3 million years of life expectancy to the region's population.

Particulate concentrations in only 267 out of 1279 district-equivalent regions in Oceania exceed the WHO guideline. If particulate concentrations in these 267 districts were reduced to meet the WHO guideline, an average resident here could gain 1.8 months of life expectancy, adding 6.3 million years of life expectancy to Oceania's population (Figure 11.1).

The most polluted region in Oceania is the North Fly district of Western province in Papua New Guinea. Here, an average resident could live 1.1 years longer if particulate concentrations were brought down to meet the WHO guideline.

In Australia, Oceania's most populous country and home to 60 percent of the region's population, particulate concentrations are well below the WHO guideline and are therefore unlikely to have a significant impact on life expectancy in the country (Figure 11.1).

While particulate pollution is not a significant health threat in Oceania, in the most polluted countries of the region, the impact of particulate pollution on life expectancy is comparable to other external threats like self-harm and interpersonal violence (Figure 11.2).

97 Oceania region is defined as the following 29 countries and territory: American Samoa,Australia,Christmas Island,Cocos Islands,Cook Islands,Fiji,French Polynesia,Guam,Heard Island and McDonald Island,Kiribati,Marshall Islands,Micronesia,Nauru,New Caledonia,New Zealand,Niue,Norfolk Island,Northern Mariana Islands,Palau,Papua New Guinea,Pitcairn Islands, Samoa,Solomon Islands,Tokelau,Tonga,Tuvalu,United States Minor Outlying Islands,Vanuatu,Wallis and Futuna

Figure 11.1 · Potential gain in life expectancy from permanently reducing $PM_{2.5}$ from 2023 concentration to the WHO guideline

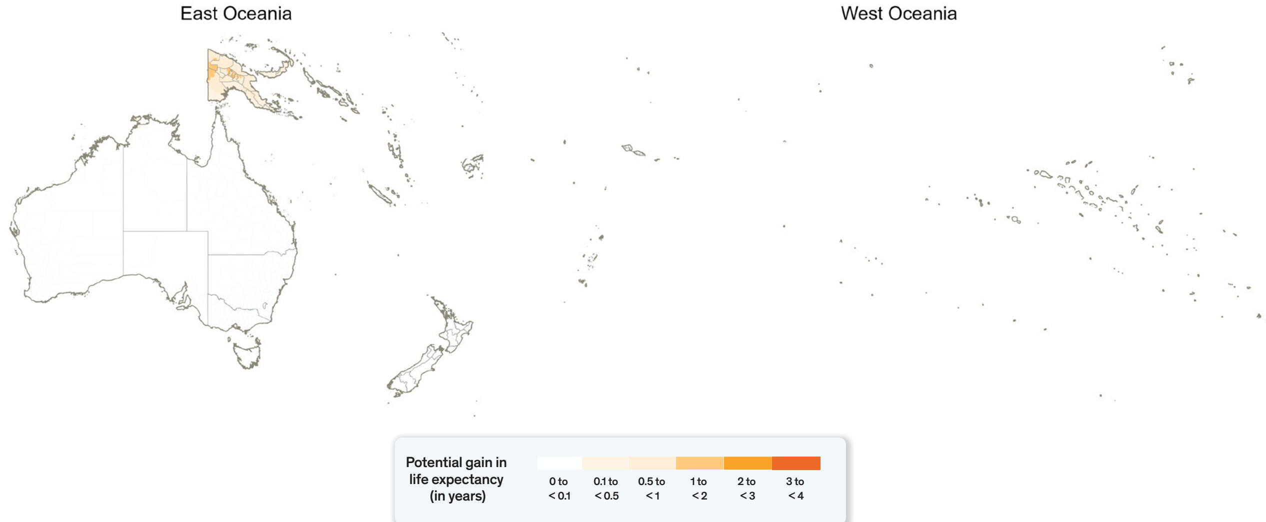
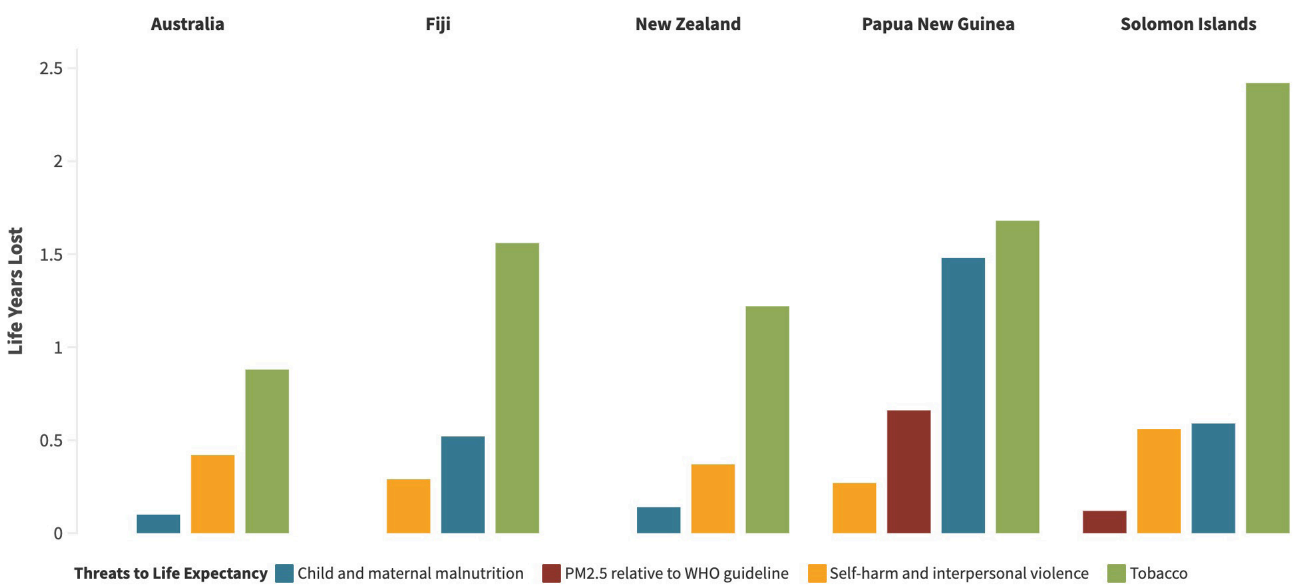


Figure 11.2 · Comparison of selected major global threats to life expectancy in some of the most populous countries in Oceania



Sources: Global Burden of Disease (https://vizhub.healthdata.org/gbd-results/) level-2 causes and risks data and WHO Life Tables (https://apps.who.int/gho/data/node.main.LIFECOUNTRY?lang=en) were combined with the Life table method to arrive at these results. "$PM_{2.5}$ relative to WHO guideline" bar displays the reduction in life expectancy relative to the WHO guideline as calculated by latest AQLI (2023) data.

Conclusion

In 2023, air pollution was the greatest external threat to life expectancy worldwide, with particulate pollution reducing average life expectancy by 1.9 years, costing nearly 15 billion life years globally. Yet, over five billion people around the world, many of whom live in some of the world's most polluted countries, don't have access to information that can meaningfully aid public or policy action.

The Energy Policy Institute at the University of Chicago (EPIC), through its programmes the Air Quality Life Index (AQLI) and the EPIC Air Quality Fund are committed to filling these gaps in air quality information. Since its introduction in 2024, the EPIC Air Quality Fund has invested nearly five times the average annual philanthropic funding directed towards the entire continent of Africa, home to many of the world's most polluted countries. However, the stark asymmetry in the availability and density of air quality monitoring worldwide, as highlighted in Section 2 of this report, points to the need for much larger and more coordinated philanthropic investments.

Where air quality information has been made accessible to policymakers and the public, meaningful action has often followed. In countries such as the United States, China, and Poland, this has translated into reduced particulate concentrations and gains in life expectancy. That said, whether the availability of air quality data directly causes reductions in pollution levels remains an open question. To explore this further, we are preparing to launch a global randomized controlled trial to assess how air quality information is motivating action in different parts of the world.

Finally, while data is critical to catalysing action, data alone is not enough. To meaningfully reduce particulate pollution and extend lives worldwide, especially in the hardest-hit regions, investments in monitoring and other air quality management infrastructure must be matched by political will, ambitious policies, capacity building, and sustained enforcement.

Appendix I: Methodology

The life expectancy calculations made by the AQLI are based on a pair of peer-reviewed studies, Chen et al. (2013) and Ebenstein et al. (2017), co-authored by Michael Greenstone, that exploit a unique natural experiment in China. By comparing two subgroups of the population that experienced prolonged exposure to different levels of particulate air pollution, the studies were able to plausibly isolate the effect of particulate air pollution from other factors that affect health. Although the study was based solely on a Chinese setting, together, the regions and years covered in the study saw a wide range of pollution levels - spanning 27-307 µg/m³ of PM_{10} (approximately equivalent to 18-200 µg/m³ of $PM_{2.5}$). Thus, the relationship between life expectancy and particulate pollution that underlies the AQLI is derived from a $PM_{2.5}$ distribution similar to the observed global distribution, providing a credible basis for generalizing the measured pollution-life expectancy relationship from Ebenstein et al. (2017).

We'd like to note that the global $PM_{2.5}$ annual average measurements in this AQLI update range from less than 1 µg/m³ to 84 µg/m³. For life expectancy estimates for regions with particulate concentrations lower than those in Ebenstein et al. (2017) - home to approximately 40 percent of the world population, the AQLI assumes the same linear relationship between long-term exposure to $PM_{2.5}$ and life expectancy, as the rest of the concentration range. Though it is possible that the pollution-life expectancy relationship is nonlinear over certain ranges of $PM_{2.5}$ concentrations and/or that there is a threshold below which $PM_{2.5}$ has no effect, we are unaware of credible empirical evidence that would cause a rejection of the linearity assumption.

Ebenstein et al. (2017) found that sustained exposure to an additional 10 µg/m³ of PM_{10} reduces life expectancy by 0.64 years. In terms of $PM_{2.5}$, this translates to the relationship that an additional 10 µg/m³ of $PM_{2.5}$ reduces life expectancy by 0.98 years. This metric is then combined with sea-salt and mineral dust removed satellite-derived $PM_{2.5}$ data. All 2025 annual average $PM_{2.5}$ values are population-weighted and AQLI's source of population data is https://landscan.ornl.gov/. We are grateful to the Atmospheric Composition Analysis Group, based at the Washington University in St. Louis for providing us with the satellite data. The original dataset can be found here: https://sites.wustl.edu/acag/datasets/surface-pm2-5/.

To learn more deeply about the methodology used by the AQLI, visit: aqli.epic.uchicago.edu/about/methodology

Appendix Table · 2023 Annual average $PM_{2.5}$ pollution concentrations by country and corresponding potential life expectancy gains, if WHO guideline or national standard were met

Country or Territory	Annual Average 2023 $PM_{2.5}$ Concentration (µg/m³)	National Standard (µg/m³)	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the WHO Guideline of 5 µg/m³	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the country's National Standard
Åland	3.83		0	
Afghanistan	20.96	35	1.56	0
Akrotiri and Dhekelia	10.97		0.59	
Albania	10.67	10	0.56	0.07
Algeria	5.26		0.03	
American Samoa	1.22	9	0	0
Andorra	7.07	25	0.2	0
Angola	23.27		1.79	
Anguilla	2.19		0	
Antigua and Barbuda	2.64		0	
Argentina	12.21		0.71	
Armenia	20.35		1.5	
Aruba	5.46		0.05	
Australia	3.7	8	0	0
Austria	8.68	10	0.36	0
Azerbaijan	12.46		0.73	
Bahamas	3.69		0	
Bahrain	21.04	25	1.57	0
Bangladesh	60.84	35	5.47	2.53
Barbados	2.42	10	0	0
Belarus	9.5	15	0.44	0
Belgium	7.58	10	0.25	0
Belize	12.95		0.78	
Benin	16.38		1.12	
Bermuda	3.77		0	
Bhutan	25.41		2	
Bolivia	32.17		2.66	
Bonaire, Sint Eustatius and Saba	4.06		0	
Bosnia and Herzegovina	21.28	20	1.6	0.13
Botswana	15.86		1.06	
Bouvet Island	0	5	0	0
Brazil	12.14	10	0.7	0.21
British Indian Ocean Territory	0		0	
British Virgin Islands	1.96		0	
Brunei	8.9		0.38	
Bulgaria	14.59	10	0.94	0.45
Burkina Faso	8.22		0.32	
Burundi	29.35		2.39	
Côte d'Ivoire	10		0.49	
Cabo Verde	2.32		0	
Cambodia	18.82	25	1.35	0
Cameroon	32.48		2.69	
Canada	9.24	8.8	0.42	0.04
Cayman Islands	9.14		0.41	
Central African Republic	24.46		1.91	
Chad	12.36		0.72	
Chile	24.2	20	1.88	0.41
China	27.37	35	2.19	0
Christmas Island	2.57		0	
Clipperton Island	0		0	
Cocos Islands	2.2		0	
Colombia	16.17	20	1.09	0
Comoros	5.72		0.07	
Cook Islands	1.03		0	
Costa Rica	13.37		0.82	
Croatia	12.31	10	0.72	0.23
Cuba	6.92		0.19	
Curaçao	5.14		0.01	
Cyprus	12.49	10	0.73	0.24
Czechia	10.08	10	0.5	0.01
Democratic Republic of the Congo	32.13		2.66	
Denmark	6.79	10	0.18	0
Djibouti	19.97		1.47	
Dominica	2.82		0	
Dominican Republic	7.12	15	0.21	0
Ecuador	17.29	15	1.2	0.22
Egypt	17.79	50	1.25	0
El Salvador	27.32	15	2.19	1.21
Equatorial Guinea	29.91		2.44	
Eritrea	12.08		0.69	
Estonia	5.55	10	0.05	0
Ethiopia	14.7		0.95	
Falkland Islands	2.86		0	
Faroe Islands	2.76		0	
Fiji	2.67		0	
Finland	4.28	10	0	0
France	7.09	10	0.2	0
French Guiana	6.1		0.11	
French Polynesia	1.14		0	
French Southern Territories	0		0	
Gabon	25.3		1.99	
Gambia	6.9		0.19	
Georgia	13.64	20	0.85	0
Germany	7.42	10	0.24	0
Ghana	12.91		0.78	
Gibraltar	6.86		0.18	
Greece	11.12	10	0.6	0.11
Greenland	1.24		0	

* No national standard specified and/or data not available.

Country or Territory	Annual Average 2023 $PM_{2.5}$ Concentration (μg/m³)	National Standard (μg/m³)	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the WHO Guideline of 5 μg/m³	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the country's National Standard
Grenada	2.51		0	
Guadeloupe	2.91		0	
Guam	0.66	9	0	0
Guatemala	26.44		2.1	
Guernsey	6.09		0.11	
Guinea	9.38		0.43	
Guinea-Bissau	7.92		0.29	
Guyana	7.78		0.27	
Haiti	8.68		0.36	
Heard Island and McDonald Island	0		0	
Honduras	28.21		2.27	
Hungary	10.34	10	0.52	0.03
Iceland	3.25	10	0	0
India	40.97	40	3.53	0.1
Indonesia	18.63	15	1.34	0.36
Iran	20.19	12	1.49	0.8
Iraq	23.2	10	1.78	1.29
Ireland	4.98	10	0	0
Isle of Man	4.87		0	
Israel	12.56	25	0.74	0
Italy	11.58	10	0.64	0.15
Jamaica	14.1	12	0.89	0.21
Japan	10.54	15	0.54	0
Jersey	6.49		0.15	
Jordan	16.4	15	1.12	0.14
Kazakhstan	11.64		0.65	
Kenya	16.06	35	1.08	0
Kiribati	1.29		0	
Kosovo	14.77		0.96	
Kuwait	22.21		1.69	
Kyrgyzstan	12.87		0.77	
Laos	28.87		2.34	
Latvia	11.52	10	0.64	0.15
Lebanon	17.59		1.23	
Lesotho	23.08		1.77	
Liberia	9.03		0.39	
Libya	5.37		0.04	
Liechtenstein	9.26		0.42	
Lithuania	8.33	10	0.33	0
Luxembourg	6.75	10	0.17	0
México	16.18	12	1.1	0.41
Macedonia	16.47		1.12	
Madagascar	8.8		0.37	
Malawi	18.39		1.31	
Malaysia	16.32	15	1.11	0.13

Country or Territory	Annual Average 2023 $PM_{2.5}$ Concentration (μg/m³)	National Standard (μg/m³)	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the WHO Guideline of 5 μg/m³	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the country's National Standard
Maldives	7.87		0.28	
Mali	6.37		0.13	
Malta	6.74	10	0.17	0
Marshall Islands	0.56		0	
Martinique	3.32		0	
Mauritania	3.4		0	
Mauritius	5.22		0.02	
Mayotte	6.57		0.15	
Micronesia	0.8		0	
Moldova	9.85	25	0.48	0
Monaco	8.53		0.35	
Mongolia	27.46	25	2.2	0.24
Montenegro	13.18	25	0.8	0
Montserrat	2.63		0	
Morocco	8.14		0.31	
Mozambique	13.62		0.84	
Myanmar	33.35		2.78	
Namibia	15.04		0.98	
Nauru	1.66		0	
Nepal	38.35		3.27	
Netherlands	7.6	10	0.25	0
New Caledonia	2.78		0	
New Zealand	3.43	10	0	0
Nicaragua	15.18		1	
Niger	9.5		0.44	
Nigeria	22.93	20	1.76	0.29
Niue	1.04		0	
Norfolk Island	1.54		0	
North Korea	19.88		1.46	
Northern Cyprus	12.2		0.71	
Northern Mariana Islands	0.47	9	0	0
Norway	5.16	5	0.02	0.02
Oman	13.64		0.85	
Pakistan	38.99	35	3.33	0.22
Palau	2.53	12	0	0
Palestine	12.64		0.75	
Panama	10.15	15	0.5	0
Papua New Guinea	11.69		0.66	
Paracel Islands	5.08		0.01	
Paraguay	16.96	15	1.17	0.19
Peru	24.2	25	1.88	0
Philippines	17.13	25	1.19	0
Pitcairn Islands	1.5		0	
Poland	12.91	10	0.78	0.29
Portugal	5.66	10	0.06	0

* No national standard specified and/or data not available.

Country or Territory	Annual Average 2023 $PM_{2.5}$ Concentration (μg/m³)	National Standard (μg/m³)	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the WHO Guideline of 5 μg/m³	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the country's National Standard
Puerto Rico	2.67	9	0	0
Qatar	36.22		3.06	
Réunion	2.7		0	
Republic of the Congo	30.01		2.45	
Romania	11.92	10	0.68	0.19
Russia	9.31	25	0.42	0
Rwanda	30.26	35	2.48	0
São Tomé and Príncipe	10.34		0.52	
Saint Helena, Ascension and Tris	1.84		0	
Saint Kitts and Nevis	2.86		0	
Saint Lucia	2.61		0	
Saint Pierre and Miquelon	4.44		0	
Saint Vincent and the Grenadines	2.5		0	
Saint Barthélemy	2.47		0	
Saint-Martin	2.47		0	
Samoa	1.36		0	
San Marino	10.76		0.56	
Saudi Arabia	25.84	15	2.04	1.06
Senegal	5.5	25	0.05	0
Serbia	14.65	25	0.95	0
Seychelles	4.22		0	
Sierra Leone	9.64		0.45	
Singapore	17.1	10	1.19	0.7
Sint Maarten	2.6		0	
Slovakia	11.18	10	0.61	0.12
Slovenia	10.77	10	0.57	0.08
Solomon Islands	6.27		0.12	
Somalia	8.27		0.32	
South Africa	22.33	20	1.7	0.23
South Georgia and the South Sand	0		0	
South Korea	21.62	15	1.63	0.65
South Sudan	13.46		0.83	
Spain	6.77	10	0.17	0
Spratly Islands	0		0	
Sri Lanka	16.15	25	1.09	0
Sudan	8.75	10	0.37	0
Suriname	6.8		0.18	
Svalbard and Jan Mayen	0		0	
Swaziland	15.91		1.07	
Sweden	4.73	10	0	0
Switzerland	7.32	10	0.23	0
Syria	18.1		1.28	
Taiwan	18.68	12	1.34	0.65
Tajikistan	21.27		1.59	

Country or Territory	Annual Average 2023 $PM_{2.5}$ Concentration (μg/m³)	National Standard (μg/m³)	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the WHO Guideline of 5 μg/m³	Life Expectancy Gains (in years) from reducing $PM_{2.5}$ from 2023 Concentrations to the country's National Standard
Tanzania	17.14		1.19	
Thailand	23.11	15	1.77	0.79
Timor-Leste	10.14		0.5	
Togo	14.55		0.94	
Tokelau	1.19		0	
Tonga	1.48		0	
Trinidad and Tobago	4.26	15	0	0
Tunisia	8.07		0.3	
Turkey	20.03		1.47	
Turkmenistan	12.5		0.74	
Turks and Caicos Islands	3.78		0	
Tuvalu	1.53		0	
Uganda	27.34	25	2.19	0.23
Ukraine	10.19	25	0.51	0
United Arab Emirates	19.18		1.39	
United Kingdom	7.27	20	0.22	0
United States	8.17	9	0.31	0
United States Minor Outlying Islands	2.5		0	
Uruguay	8.72		0.36	
Uzbekistan	19.12		1.38	
Vanuatu	4.11		0	
Vatican City	10.02		0.49	
Venezuela	14.07		0.89	
Vietnam	25.64	25	2.02	0.06
Virgin Islands, U.S.	2.23	9	0	0
Wallis and Futuna	1.65		0	
Western Sahara	4.84		0	
Yemen	16.09		1.09	
Zambia	25.2		1.98	
Zimbabwe	18.82		1.35	

* No national standard specified and/or data not available.

Appendix II: The evolution of satellite-derived $PM_{2.5}$ data

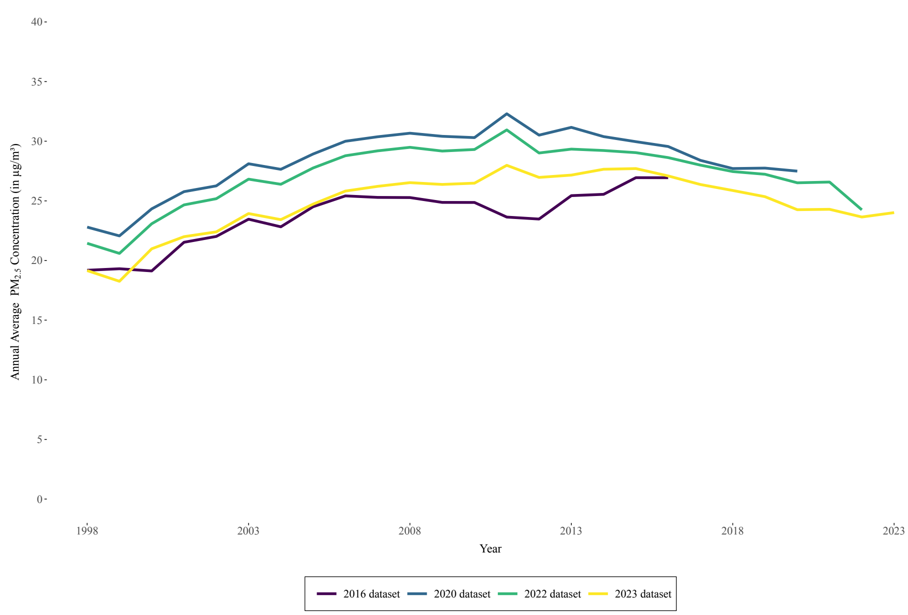
Reliable, geographically extensive pollution measurements are critical to understanding the extent of air pollution and its health impacts. Unfortunately, many areas around the world either lack extensive pollution monitoring systems or did not begin monitoring $PM_{2.5}$ until recently, making it impossible to track long-term global trends. To construct a single dataset of particulate pollution and its health impacts that is global in coverage, local in resolution, consistent in methodology, and that spans many years to reveal pollution trends over time, the latest AQLI data incorporates satellite-derived annual ambient $PM_{2.5}$ concentration estimates spanning 26 years from 1998-2023 by the Atmospheric Composition Analysis Group at the University of Washington (methodology described in van Donkelaar et al. (2021) and Donkelaar et al. (2024). The version of the dataset used in this AQLI update is available at https://sites.wustl.edu/acag/datasets/surface-pm2-5/#V5.GL.05.02. The AQLI uses a version of this data that excludes sea salt and dust.

There are differences between the satellite-derived $PM_{2.5}$ dataset used in this report and those used in previous AQLI reports. For example, in the new and revised 2023 dataset used this year, the estimated global population-weighted average $PM_{2.5}$ concentration for the year 2019 has been revised downwards (from 27.2 µg/m³ to 25.4 µg/m³) relative to the 2022 dataset used in our 2024 AQLI update (Figure A.1).

According to van Donkelaar et al. (2021), satellite-derived $PM_{2.5}$ data were constructed by converting measurements of aerosol optical depth (AOD) over each grid cell into $PM_{2.5}$ measurements using a chemical transport model called GEOS-Chem. These estimates were then subsequently calibrated to regional ground-based observations of both total and compositional mass using a Geographically Weighted Regression (GWR). Over time, improvements in the model and calibration inputs, alongside growing ground level monitoring coverage necessitate periodic updates to the historical $PM_{2.5}$ dataset

In Figure A.1, we plot and compare the global population-weighted $PM_{2.5}$ time trends using various years' versions of the annual average $PM_{2.5}$ dataset. Although the new and revised $PM_{2.5}$ dataset yields global average concentration levels that are lower on average than those estimated using the 2022, 2020 or 2016 reference datasets, the overall picture remains the same.

Figure A.1 · Comparing latest (2023 reference dataset) global annual average $PM_{2.5}$ concentration time series with various historical reference datasets



Note: The "2023 dataset" and "2022 dataset" lines plots the global population-weighted annual average $PM_{2.5}$ trend using data received from ACAG WUSTL and methodology described in van Donkelaar et al. (2021) and Donkelaar et al. (2024). The "2020 dataset" line plots the analogous trend using data from Hammer et al. (2020). The "2016 dataset" plots the trend using data from van Donkelaar et al. (2016). Note that the AQLI uses a version of all datasets that excludes sea salt and dust. To learn more about these versions, visit: https://sites.wustl.edu/acag/datasets/surface-pm2-5/.

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ABOUT THE AIR QUALITY LIFE INDEX

The AQLI is a pollution index that translates particulate air pollution into perhaps the most important metric that exists: its impact on life expectancy. Developed by the University of Chicago's Milton Friedman Distinguished Service Professor in Economics Michael Greenstone and his team at the Energy Policy Institute at the University of Chicago (EPIC), the AQLI is rooted in recent research that quantifies the causal relationship between long-term human exposure to air pollution and life expectancy. The Index then combines this research with hyper-localized, global particulate measurements, yielding unprecedented insight into the true cost of particulate pollution in communities around the world. The Index also illustrates how air pollution policies can increase life expectancy when they meet the World Health Organization's guideline for what is considered a safe level of exposure, existing national air quality standards, or user-defined air quality levels. This information can help to inform local communities and policymakers about the importance of air pollution policies in concrete terms.

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ABOUT EPIC

The Energy Policy Institute at the University of Chicago (EPIC) is confronting the global energy challenge by working to ensure that energy markets provide access to reliable, affordable energy, while limiting environmental and social damages. We do this using a unique interdisciplinary approach that translates robust, data-driven research into real-world impacts through strategic outreach and training for the next generation of global energy leaders.

The EPIC Clean Air Program is working to bring actionable information about the quality of the air we breathe and its impact on our health to every corner of the globe in order to motivate action and lay guideposts for efficient air pollution policies. This work includes an Air Quality Fund to bring high quality and high frequency air pollution monitoring and data access to the places of the world where it is needed most; the Air Quality Life Index (AQLI), which uses air pollution data to translate the impact of pollution on a person's life expectancy; and several particulate pollution trading markets being piloted in Indian cities in coordination with state governments.

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