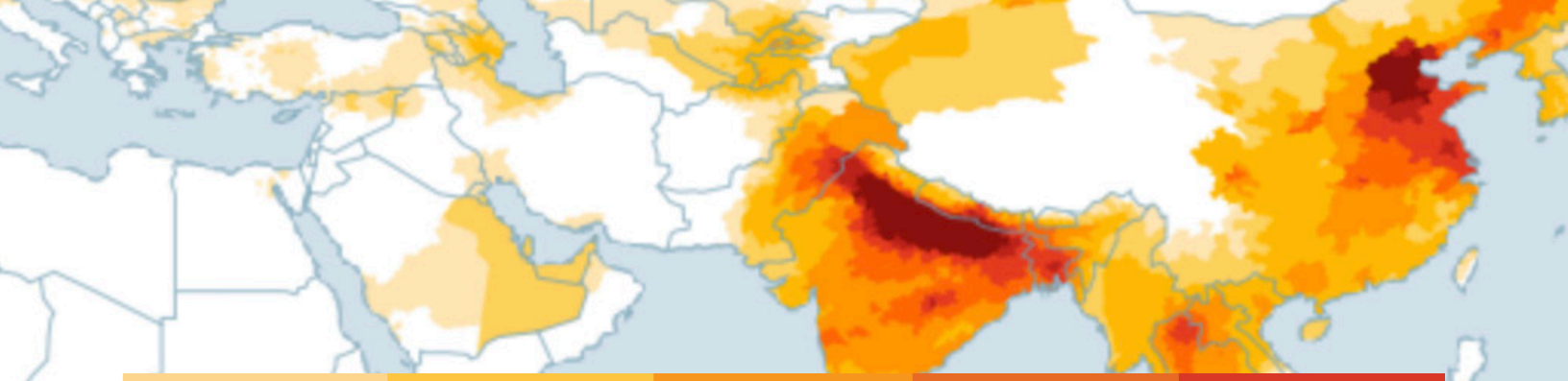**AIR QUALITY LIFE INDEX®** | UPDATE FEBRUARY 2019

Pakistan's Air Pollution Challenge & Potential for Longer Lives

*By Michael Greenstone and Qing (Claire) Fan*

SUMMARY

Pakistan had the fifth most polluted air in the world in 2016, due mostly to vehicular and industrial emissions and crop burning. If sustained, this air pollution would cut 2.7 years off the lives of the typical Pakistani, relative to what their life expectancy would be if the World Health Organization (WHO) guideline was met; and 2.2 years relative to its own air quality standard. The district of Lahore suffers the worst, with the average residents losing 5.3 years off their lives, relative to the WHO guideline. As the government begins to confront the air quality problem, this analysis shows that Pakistan has the opportunity to vastly clean up its air. If the country achieved sustained improvements in air quality comparable to what China has achieved in recent years, its residents would live 1.2 years longer on average. Those in Lahore would live 1.9 years longer.

Figure 1 · Countries with Worst Air Pollution – $PM_{2.5}$ Concentration in 2016 and Life Expectancy Gain Through Permanently Reducing $PM_{2.5}$ to WHO Guideline
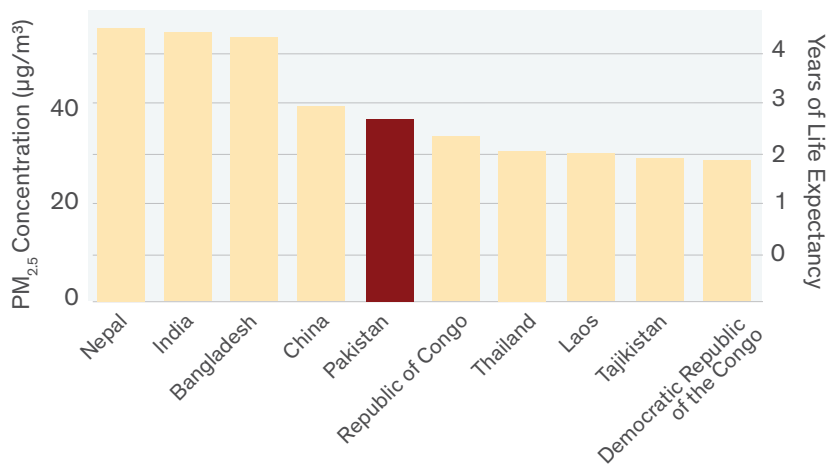
Pakistan's Pollution Challenge

Pakistan had the fifth most polluted air in the world in 2016, driven by the common culprits in much of South Asia: emissions from vehicles, industrial activity such as brick kilns, factories, and power plants, and crop burning (see Figure 1). This level of air pollution is undermining Pakistanis' health, cutting the average life expectancy short by 2.7 years, relative to what it would be if the WHO guideline of 10 μg/m³ for long-term fine particulate matter ($PM_{2.5}$) pollution was met; and 2.2 years relative to its own air quality standard of 15 μg/m³.

In 2016, 98 percent of Pakistan's over 200 million people lived in areas where the annual average particulate pollution level exceeded the WHO guideline (see Figure 2). Ninety-seven percent of the population lived in areas where it exceeded Pakistan's own $PM_{2.5}$ standard. These high concentrations are the result of a 54 percent increase in $PM_{2.5}$ concentrations since 1998.

The areas of Pakistan that fare the worst are located along its eastern border, particularly in the province of Punjab where the average resident lives 3.8 years less relative to if the WHO guideline was met. The most polluted district in the province, as well as in the country, is Lahore, which includes the country's second-largest city with a population of 11 million. Air quality in Lahore has declined over the last two decades: in 1998, its pollution concentration was 33 μg/m³. By 2016, it had doubled to 64 μg/m³—more than six times the WHO guideline. If $PM_{2.5}$ concentrations are sustained at this level, the life expectancy lost would be 5.3 years for the typical person, relative to what it would be if the WHO guideline was met. In Faisalabad, the district containing Pakistan's third-largest city, residents lose an average of 4.8 years, relative to the WHO guideline.

The Dawn of a New Era?

The Pakistani government has begun to respond to the air pollution challenge. In 2017, the government of Punjab took emergency measures to ban crop burning and enforce emissions regulations on factories and vehicles. They also experimented with shutting down coal-fired power plants to control short-term air pollution, although this led to power outages.

In 2018, Prime Minister Imran Khan came into power and told his cabinet that pollution "is a serious issue that must be addressed." Following a court order, his government began to restart or install air quality monitors. Khan also shuttered factories in 12 highly-polluted districts for two months this winter, and has pushed brick kiln owners to shift to cleaner technologies. Some kiln operators have been fined for using the dirtiest technologies, as have some farmers for their crop burning. Additionally, the government is considering setting higher emissions standards for vehicles.

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 particulates air pollution from other factors that affect health. The more recent of the two studies 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. The AQLI applied this finding to Pakistan's $PM_{2.5}$ concentrations, taken from satellite-derived $PM_{2.5}$ measurements, to determine the current life expectancy impacts of air pollution in Pakistan and the potential impacts of air pollution reduction. To learn more about the methodology used by the AQLI, visit: aqli.epic. uchicago.edu/about/methodology

Figure 2 · $PM_{2.5}$ Concentration in 2016

$PM_{2.5}$ (μg/m³)
- 0 to 10
- 10 to 15
- 15 to 30
- 30 to 40
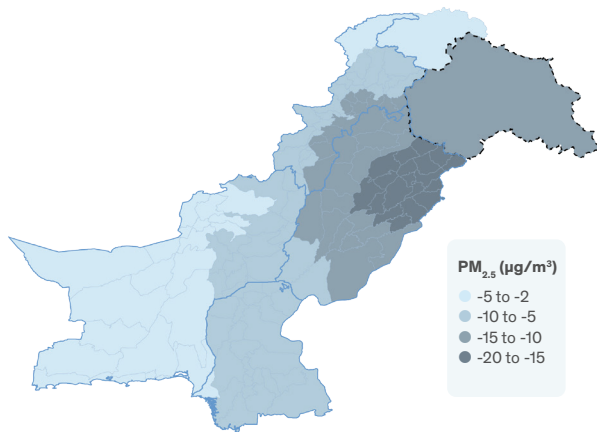- 40 to 50
- 50 to 60
- 60 to 70
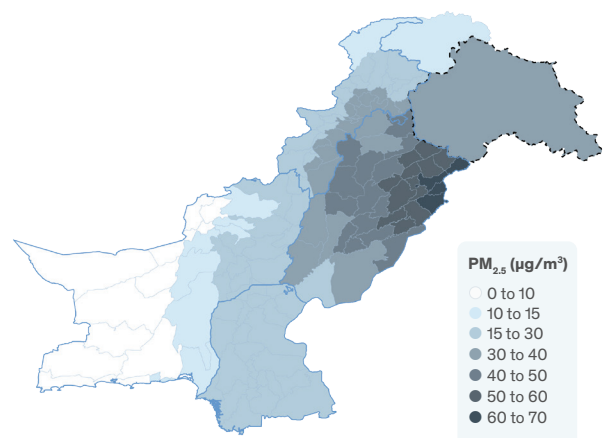
Note: Pakistan's regions and borders follow the Survey of Pakistan.

Figure 3 · Life Expectancy Gain from Achieving 32% Reduction in PM$_{2.5}$ in 10 Largest Cities and All of Pakistan
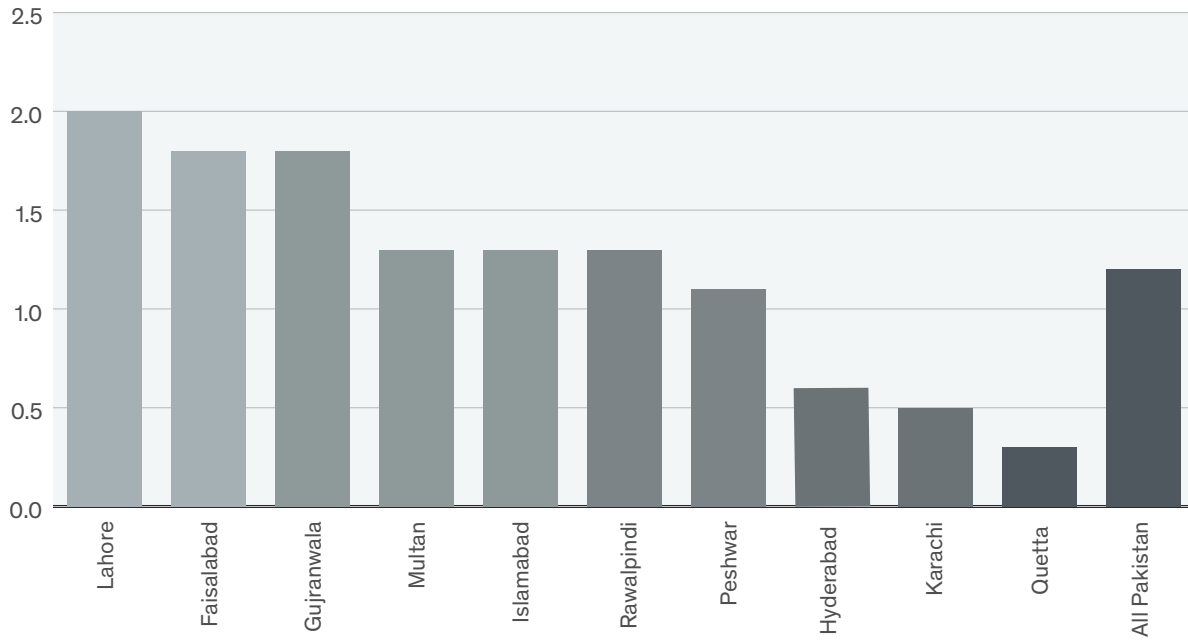
Note: This graph includes the 10 cities with the largest populations according to Pakistan's 2017 Census. Since the AQLI's data for Pakistan is at the district level, the life expectancy statistics depicted are those associated with the districts that contain the cities. For details on other districts and cities, please see the Appendix.

Figure 4 · Change in PM$_{2.5}$ from 32% PM$_{2.5}$ Reduction

PM$_{2.5}$ (µg/m³)
- -5 to -2
- -10 to -5
- -15 to -10
- -20 to -15

Note: Pakistan's regions and borders follow the Survey of Pakistan.

Figure 5 · Life Expectancy Gain from Achieving 32% PM$_{2.5}$ Reduction
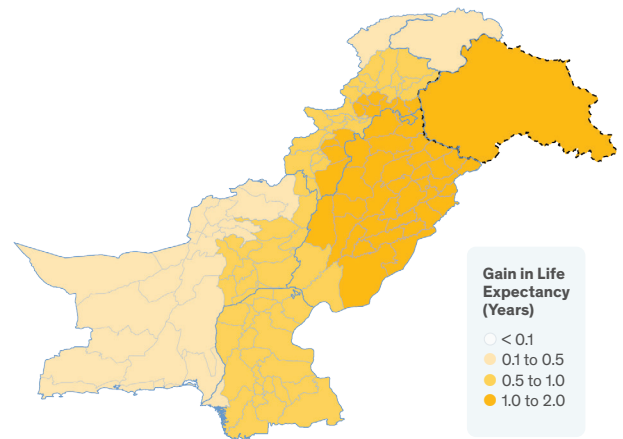
Gain in Life Expectancy (Years)
- < 0.1
- 0.1 to 0.5
- 0.5 to 1.0
- 1.0 to 2.0

Note: Pakistan's regions and borders follow the Survey of Pakistan.

Potential Impacts

Throughout history, countries all over the world have experienced intense air pollution during periods of rapid industrialization. At the same time, in countries where citizens demand change and governments follow-up with strong policies, there are successful track records of air pollution reductions. That legacy of environmental improvement is evidence that Pakistan's pollution today does not need to be tomorrow's fate.

In fact, China has seen tremendous progress in improving air quality in the last few years. In 2014, the government declared a "war against pollution" and instituted a nationwide plan to confront it. According to measurements from ground-level monitors, particulate pollution in China's cities has been reduced by 32 percent on average since the 'war against pollution' was announced.[1] Though these reductions are generally larger than the reductions found with the satellite-derived pollution data used in the AQLI, if they are confirmed and sustained over time, life expectancy would improve by 2.3 years. India, having declared its own war against pollution in January 2019, would be on a similar path if it succeeds in meeting its stated pollution reduction target of 20-30 percent.

Pakistan has the opportunity to experience the same progress. If Pakistan were to achieve the same 32 percent pollution reduction experienced in China and to sustain it, its residents would live 1.2 years longer on average. This would take the country 52 percent of the way to achieving its air quality standard and 43 percent of the way toward meeting the WHO guideline. Those in the highly-polluted district of Lahore would live 2 years longer (see Figures 3-5).

CONCLUSION

According to the AQLI, $PM_{2.5}$ air pollution is shortening the average person's life expectancy by about 1.8 years globally. Pakistan had the fifth highest amount of particulate pollution in the world in 2016. As a result, the typical Pakistani is losing 2.7 years due to this pollution. In some places, like Lahore, the loss is as much as 5.3 years.

In the last several decades other countries, including Japan, the United States, and the United Kingdom, have enacted and successfully enforced policies to reduce air pollution, underscoring that today's air pollution need not be tomorrow's fate. And more recently, China has greatly reduced $PM_{2.5}$ concentrations after "declaring a war on pollution." The AQLI makes concrete that the benefits of these policies can be measured in perhaps the most important metric — longer and healthier lives (see Appendix).

> "If Pakistan's government is successful in following through on their recent plans to reduce air pollution, the reward will be longer and healthier lives for Pakistanis."
>
> **Michael Greenstone,** Milton Friedman Distinguished Service Professor in Economics, the College and the Harris School; Director, EPIC

---

1   The monitor data generally show higher PM2.5 concentrations, and larger percent reductions, than the satellite-derived pollution data used in the AQLI. For more information about our analysis of Chinese monitor data, see "Is China Winning its War on Pollution" at aqli.epic.uchicago.edu/reports

---

Note: The AQLI follows the Survey of Pakistan's delineation of Pakistan's national borders and the disputed territory of Jammu and Kashmir. The country-level statistics in this report were aggregated excluding the region marked as disputed in this map.

Appendix Table | Current and Potential PM$_{2.5}$ and Life Expectancy Impact in 50 Most Populous Districts

| Province | District | Population (Millions) [1] | PM$_{2.5}$ Concentration (µg/m³) | | Life Expectancy Gain (Years) from Reducing PM$_{2.5}$ from 2016 Concentration | | |
			2016	After 32% Reduction	To WHO Guideline of 10 µg/m³	To National Standard of 15 µg/m³	By 32% [2]
All Pakistan		203.2	37	25	2.7	2.2	1.2
Sindh	Karachi City	22.4	16	11	0.5	0.1	0.5
Punjab	Lahore	9.4	64	43	5.3	4.8	2.0
Punjab	Faisalabad	8.1	59	40	4.8	4.3	1.8
Punjab	Gujranwala	5.1	58	40	4.7	4.3	1.8
Punjab	Rawalpindi	4.9	41	28	3.0	2.5	1.3
Punjab	Rahim Yar Khan	4.7	28	19	1.8	1.3	0.9
Punjab	Multan	4.6	42	28	3.1	2.6	1.3
Punjab	Sialkot	4.0	57	39	4.6	4.2	1.8
Punjab	Sargodha	4.0	49	34	3.9	3.4	1.5
Punjab	Muzaffargarh	3.9	38	26	2.8	2.3	1.2
Punjab	Bahawalpur	3.6	34	23	2.4	1.9	1.1
Punjab	Kasur	3.5	61	41	5.0	4.5	1.9
Punjab	Okara	3.3	59	40	4.8	4.3	1.8
Punjab	Vehari	3.1	44	30	3.3	2.8	1.4
Punjab	Khanewal	3.1	46	31	3.5	3.1	1.5
Punjab	Gujrat	3.1	52	35	4.1	3.6	1.6
Khyber Pakhtunkhwa	Peshawar	3.1	34	23	2.3	1.9	1.1
Punjab	Bahawalnagar	3.0	42	29	3.1	2.7	1.3
Punjab	Sheikhupura	3.0	61	42	5.0	4.6	1.9
Punjab	Jhang	2.8	48	33	3.7	3.2	1.5
Punjab	Sahiwal	2.7	55	38	4.4	3.9	1.7
Punjab	Dera Ghazi Khan	2.4	34	23	2.3	1.9	1.1
Punjab	Toba Tek Singh	2.4	50	34	3.9	3.4	1.6
Sindh	Khairpur	2.2	26	18	1.6	1.1	0.8

1   Population statistics were aggregated from LandScan (2015) gridded population data. The all-Pakistan population was aggregated using the national borders depicted by the Survey of Pakistan.

2   As China achieved from 2013-2017. For more information, see Is China Winning its War on Pollution?

Appendix Table | Current and Potential PM$_{2.5}$ and Life Expectancy Impact in 50 Most Populous Districts

Province	District	Population (Millions) [1]	PM$_{2.5}$ Concentration (μg/m³)		Life Expectancy Gain (Years) from Reducing PM$_{2.5}$ from 2016 Concentration		
			2016	After 32% Reduction	To WHO Guideline of 10 μg/m³	To National Standard of 15 μg/m³	By 32% [2]
Khyber Pakhtunkhwa	Mardan	2.2	35	24	2.5	2.0	1.1
Sindh	Hyderabad	2.2	19	13	0.9	0.4	0.6
Sindh	Sanghar	2.1	20	14	1.0	0.5	0.6
Punjab	Attock	1.9	37	25	2.6	2.1	1.2
Khyber Pakhtunkhwa	Swat	1.9	25	17	1.5	1.0	0.8
Punjab	Pakpattan	1.9	54	37	4.3	3.8	1.7
Punjab	Narowal	1.9	61	42	5.0	4.5	1.9
Punjab	Nankana Sahib	1.9	60	41	4.9	4.4	1.9
Punjab	Lodhran	1.7	41	28	3.0	2.5	1.3
Punjab	Mandi Bahauddin	1.7	51	35	4.0	3.5	1.6
Punjab	Layyah	1.7	41	28	3.0	2.5	1.3
Punjab	Rajanpur	1.7	31	21	2.0	1.6	1.0
Sindh	Badin	1.6	18	12	0.8	0.3	0.6
Punjab	Chakwal	1.6	39	27	2.8	2.3	1.2
Sindh	Dadu	1.6	22	15	1.2	0.7	0.7
Khyber Pakhtunkhwa	Swabi	1.6	36	25	2.6	2.1	1.1
Sindh	Naushahro Feroze	1.6	24	16	1.4	0.9	0.8
Khyber Pakhtunkhwa	Charsadda	1.6	34	23	2.3	1.9	1.1
Punjab	Mianwali	1.6	41	28	3.0	2.5	1.3
Punjab	Bhakkar	1.6	42	29	3.2	2.7	1.3
Sindh	Shaheed Benazirabad	1.6	22	15	1.1	0.6	0.7
Islamabad Capital Territory	Islamabad	1.5	41	28	3.1	2.6	1.3
Khyber Pakhtunkhwa	Mansehra	1.5	30	20	1.9	1.5	0.9
Sindh	Larkana	1.5	27	18	1.7	1.2	0.9
Punjab	Chiniot	1.4	55	37	4.4	3.9	1.7
Sindh	Ghotki	1.4	26	18	1.6	1.1	0.8

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 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.

aqli.epic.uchicago.edu   @UChiEnergy #AQLI

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.

epic.uchicago.edu   @UChiEnergy   /UChicagoEnergy

FURTHER READING

Introducing the Air Quality Life Index: Twelve Facts about Particulate Air Pollution, Human Health, and Global Policy

Is China Winning its War on Pollution?

India's 'War Against Pollution': An Opportunity for Longer Lives

aqli.epic.uchicago.edu/reports

EPIC | ENERGY POLICY INSTITUTE AT THE UNIVERSITY OF CHICAGO

THE UNIVERSITY OF CHICAGO