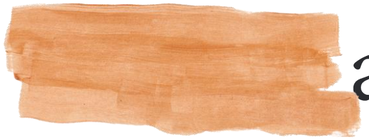
Introduction to Air Pollution and its Global Significance

Pallavi Pant, PhD
Health Effects Institute

December 1, 2025 | African School on Air Quality and Pollution Prevention in Ghana

gravioris caeli (heavy heaven) | *infamis aer* (infamous air)

"No sooner had I left behind the oppressive atmosphere of the city  and that reek of smoking cookers which pour out, along with clouds of ashes, all the poisonous fumes they've accumulated in their interiors whenever they're started up, than I noticed the change in my condition"

Seneca, AD 61, Rome
https://www.smithsonianmag.com/science-nature/air-pollution-goes-back-way-further-you-think-180957716/

gravioris caeli (heavy heaven) | *infamis aer* (infamous air)

"No sooner had I left behind the oppressive atmosphere of the city [Rome] and that reek of smoking cookers which pour out, along with clouds of ashes, all the poisonous fumes they've accumulated in their interiors whenever they're started up, than I noticed the change in my condition"

Seneca, AD 61, Rome
https://www.smithsonianmag.com/science-nature/air-pollution-goes-back-way-further-you-think-180957716/

“As air pollution increased over time, contrast and visibility in paintings decreased.”

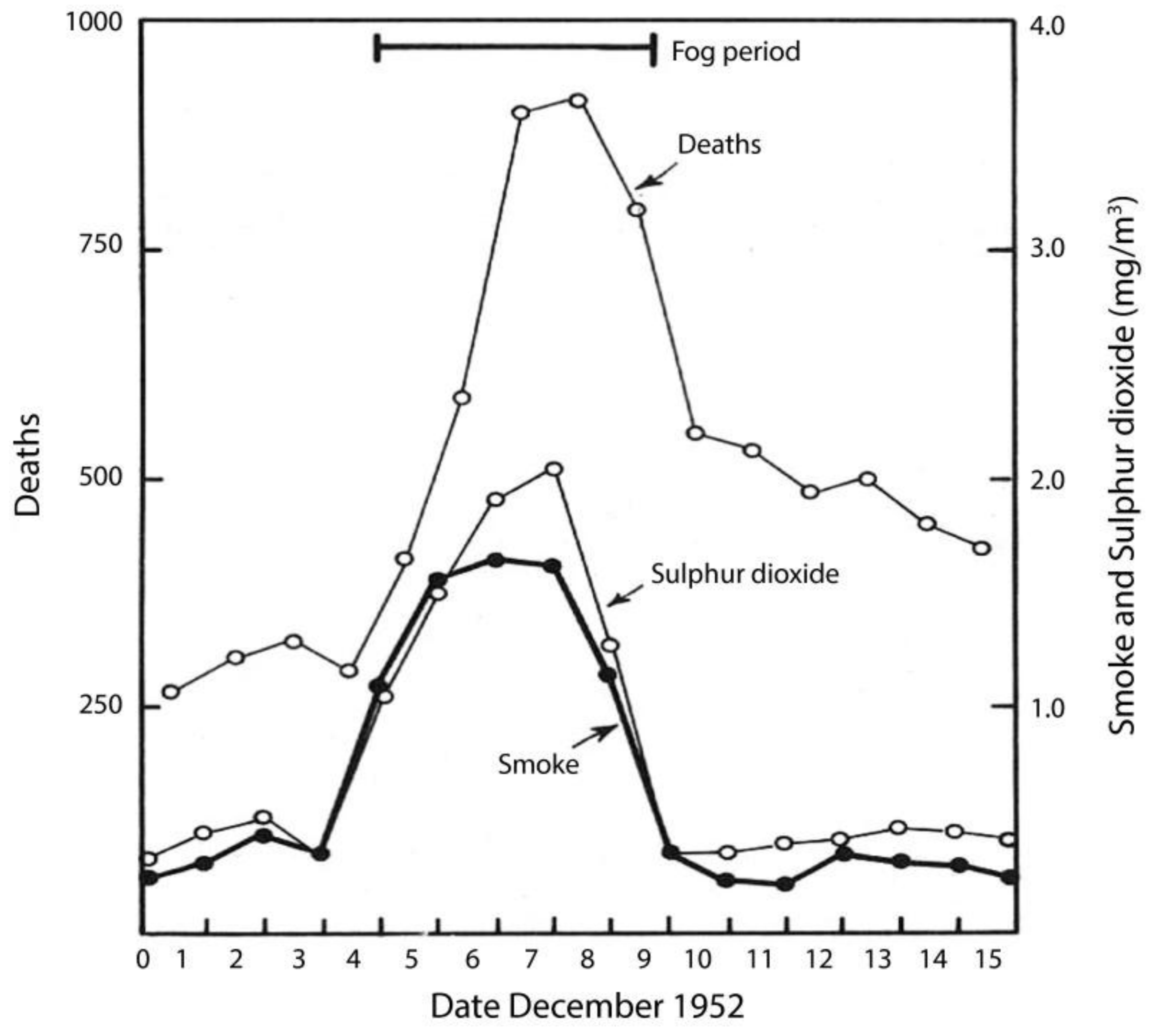
Albright and Huybers. 2023. Paintings by Turner and Monet depict trends in 19th century air pollution. *Proceedings of the National Academy of Sciences.* Vol. 120.
https://www.sciencenews.org/article/pollution-impressionist-monet-painters


Reassessment of the Lethal London Fog of 1952: Novel Indicators of Acute and Chronic Consequences of Acute Exposure to Air Pollution

Michelle L. Bell[1] and Devra Lee Davis[2]

[1]Johns Hopkins University, Baltimore, Maryland, USA; [2]Carnegie Mellon University, Pittsburgh, Pennsylvania, USA

12,000 excess deaths occurred from December 1952 - February 1953 as a result of acute and persisting effects of the 1952 London smog episode.



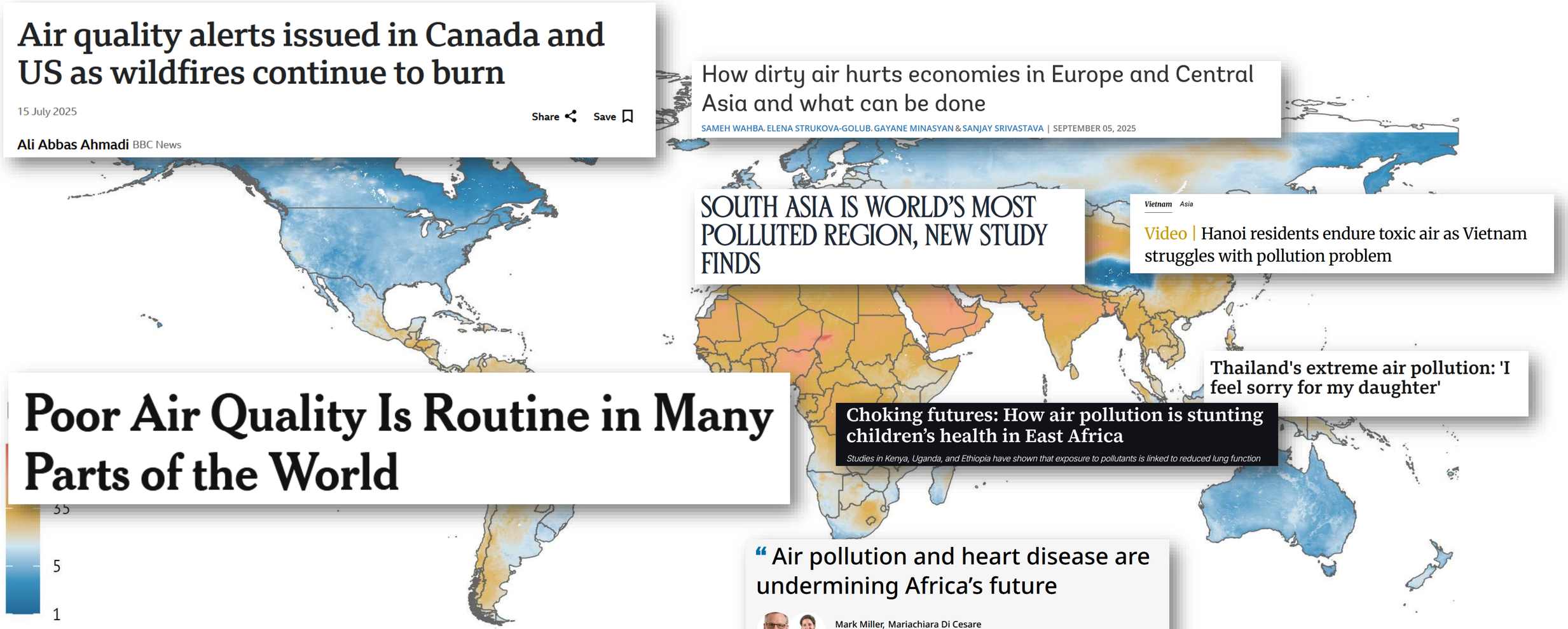
Killer Smog, https://www.bbc.co.uk/programmes/m001fmtb

Image: https://www.bbc.com/future/article/20151221-the-lethal-effects-of-london-fog

Brimblecombe P. The Big Smoke: A History of Air Pollution in London Since Medieval Times. 1st ed. London, UK: Routledge Kegan & Paul; 1987.

Bell and Davis. 2001. Reassessment of the Lethal London Fog of 1952: Novel Indicators of Acute and Chronic Consequences of Acute Exposure to Air Pollution . *Environmental Health Perspectives,* Vol. 109, Supplement 3 (Jun., 2001), pp. 389-394.

A vast majority of the world's population is exposed to poor air quality.



Air quality alerts issued in Canada and US as wildfires continue to burn

15 July 2025

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Ali Abbas Ahmadi BBC News

How dirty air hurts economies in Europe and Central Asia and what can be done

SAMEH WAHBA, ELENA STRUKOVA-GOLUB, GAYANE MINASYAN & SANJAY SRIVASTAVA | SEPTEMBER 05, 2025

SOUTH ASIA IS WORLD'S MOST POLLUTED REGION, NEW STUDY FINDS

Vietnam Asia

Video | Hanoi residents endure toxic air as Vietnam struggles with pollution problem

Poor Air Quality Is Routine in Many Parts of the World

Thailand's extreme air pollution: 'I feel sorry for my daughter'

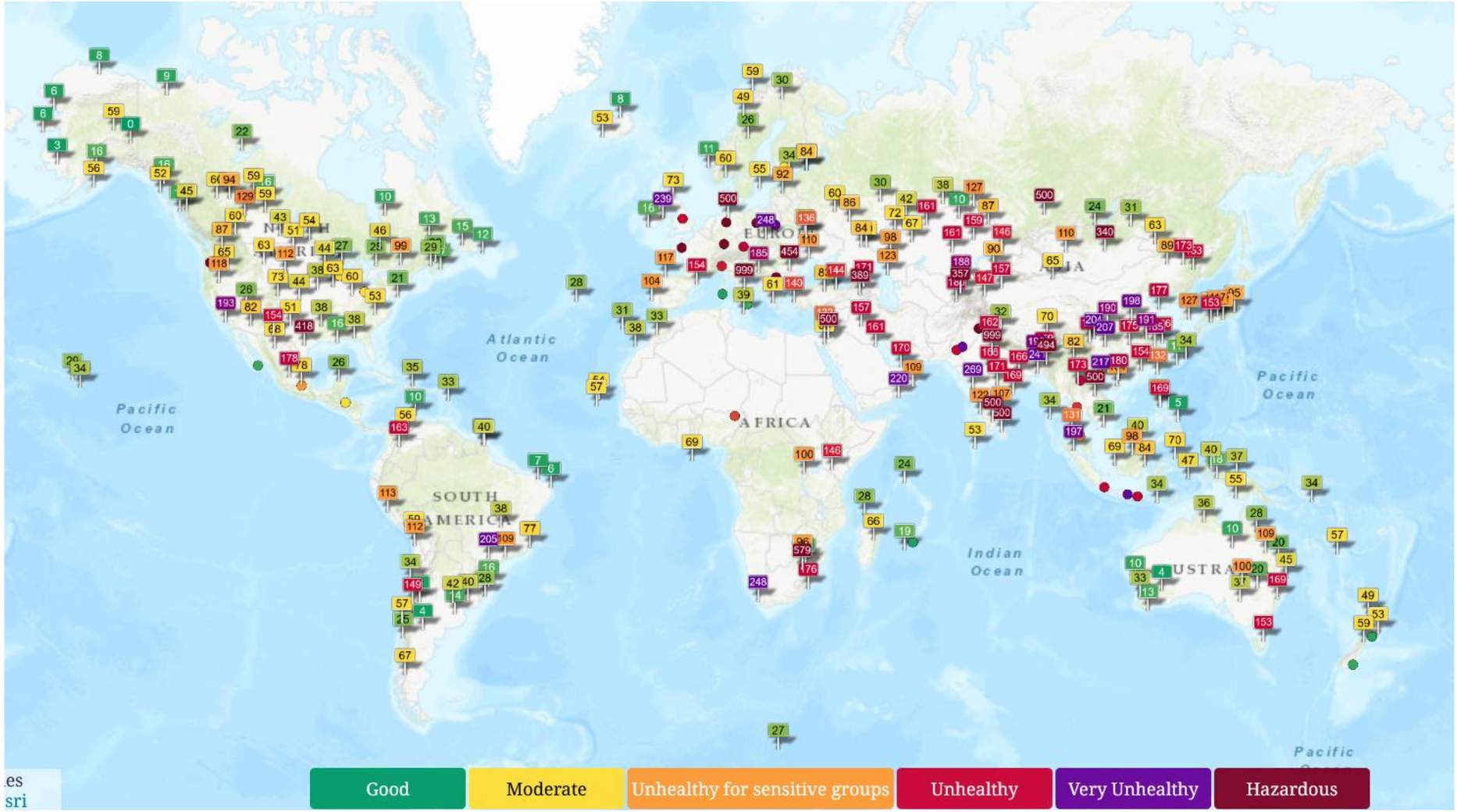
Choking futures: How air pollution is stunting children's health in East Africa

Studies in Kenya, Uganda, and Ethiopia have shown that exposure to pollutants is linked to reduced lung function

"Air pollution and heart disease are undermining Africa's future

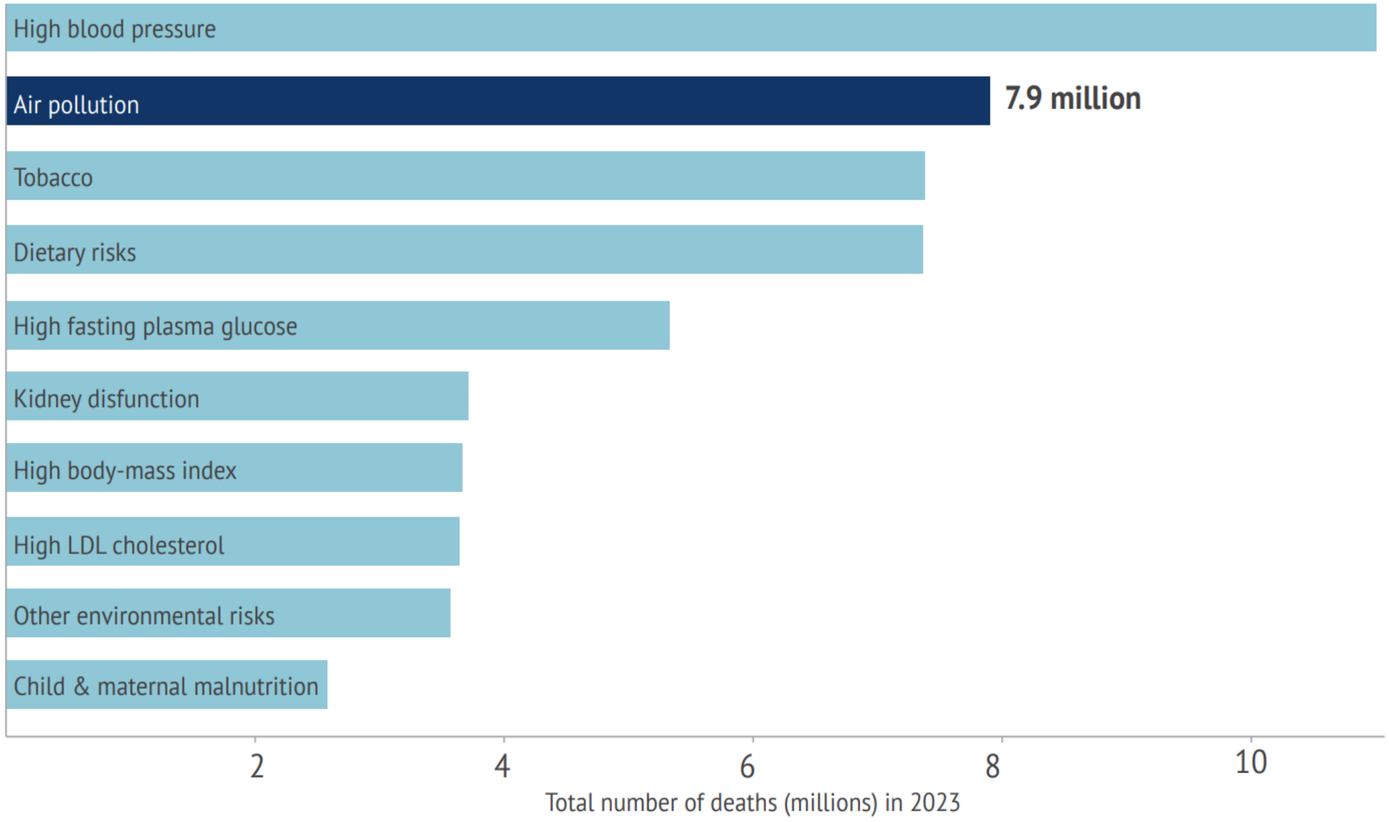
Mark Miller, Mariachiara Di Cesare
Published: December 11, 2024 | World Heart Federation

Global air quality today



https://aqicn.org/map/world/

The big picture: air pollution's toll in 2023



7.9 million
global deaths in 2023

1 in 8
deaths linked to exposure to air pollution

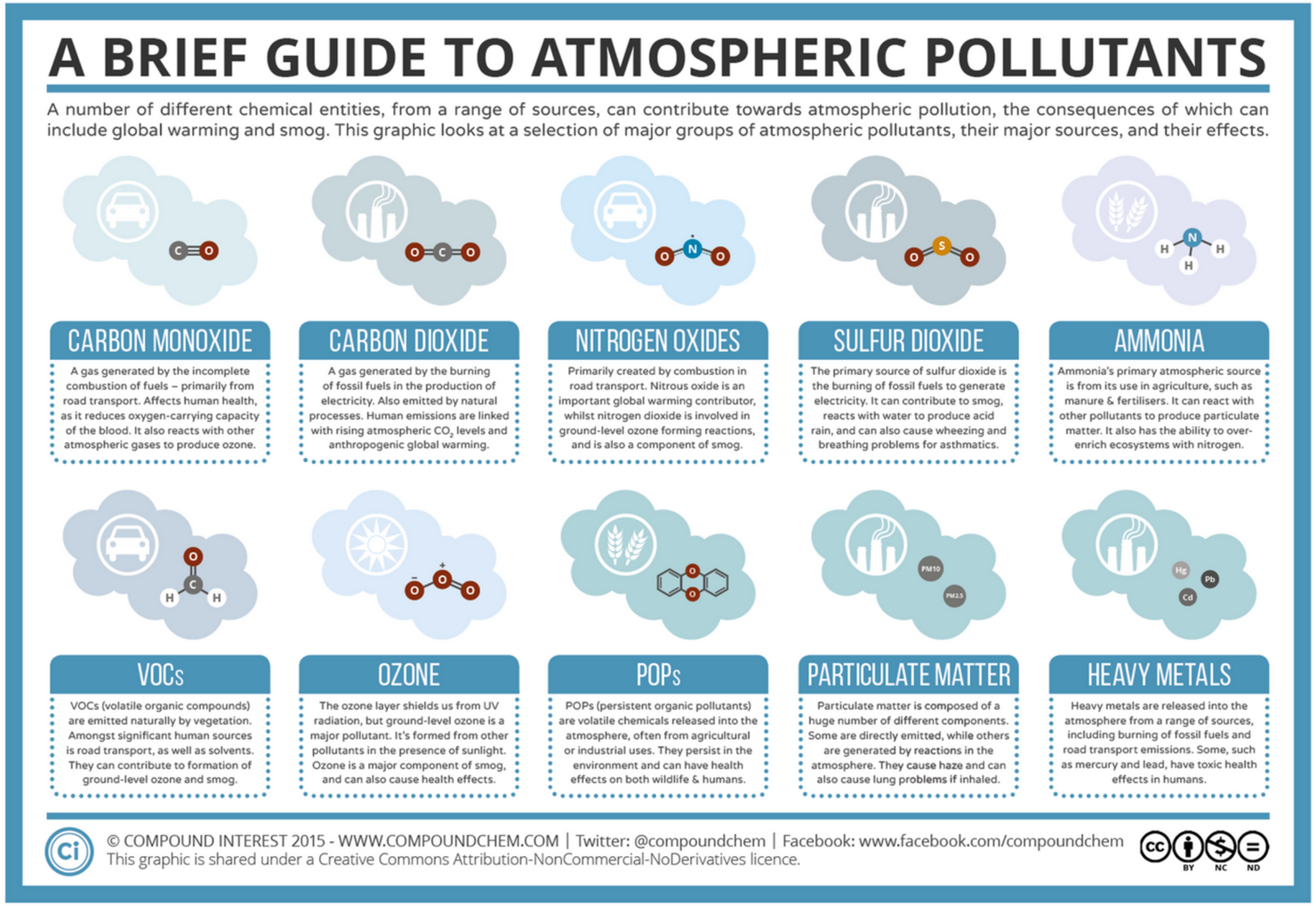
86% of air pollution deaths
attributable to noncommunicable diseases

3-5x
Higher disease burden in LMICs compared to high-income countries

90% of air pollution deaths
in low- and middle-income countries

https://www.stateofglobalair.org/

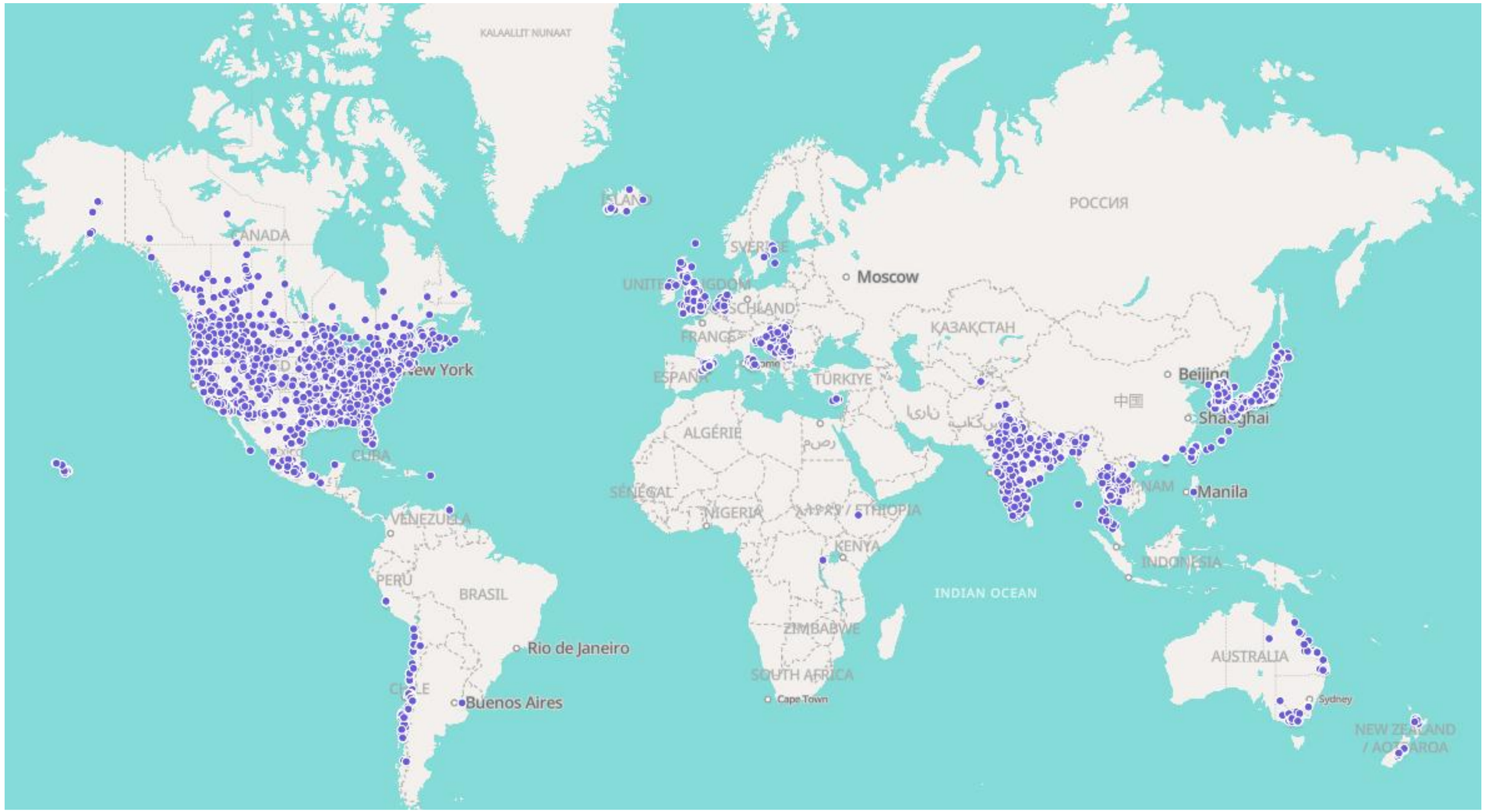
Key air pollutants of concern



Indoor | outdoor

Anthropogenic/human-made | Natural

While data gaps are closing, some regions still have limited data



https://openaq.org/

Okure et al ., AirQo

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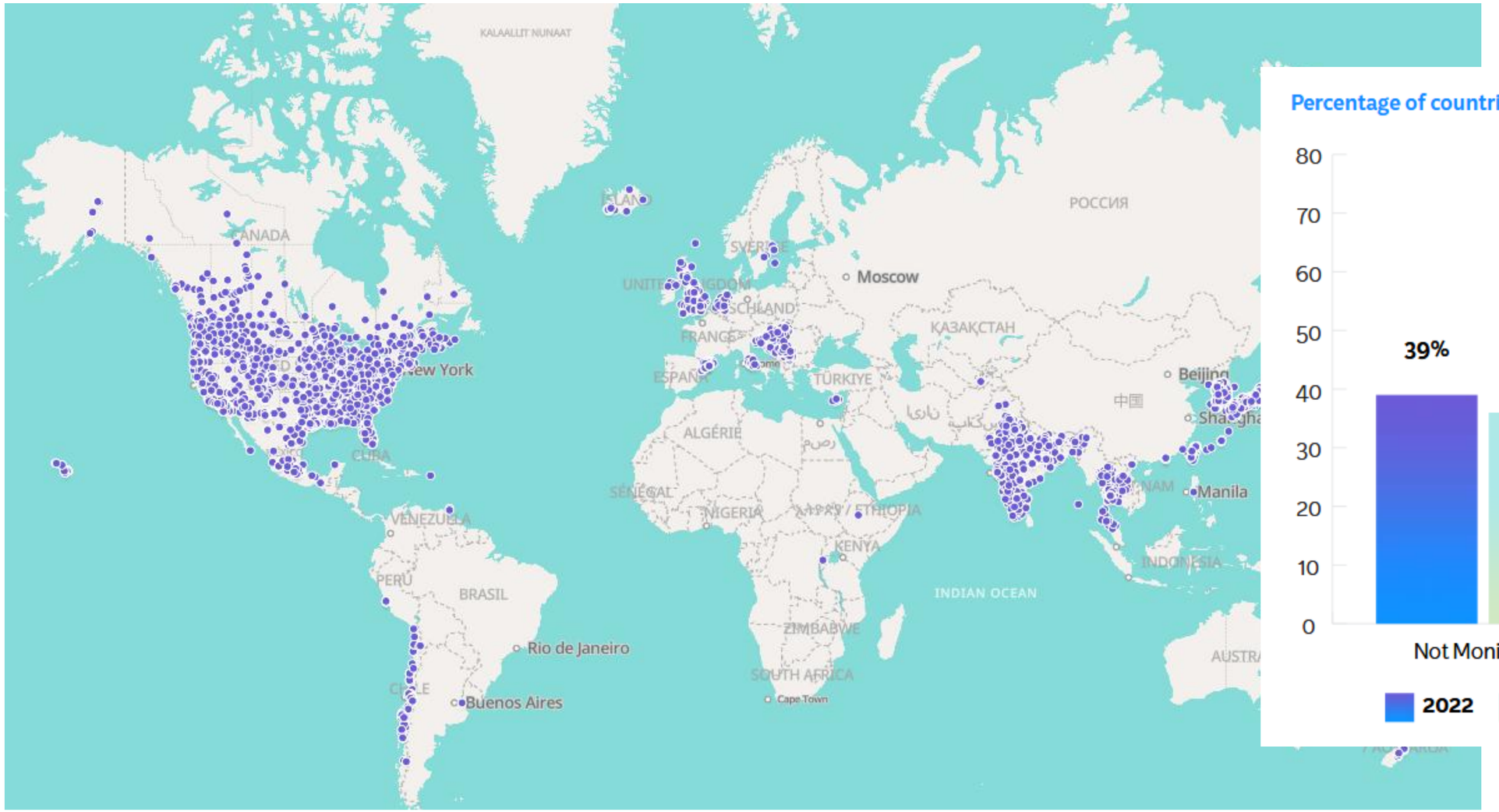

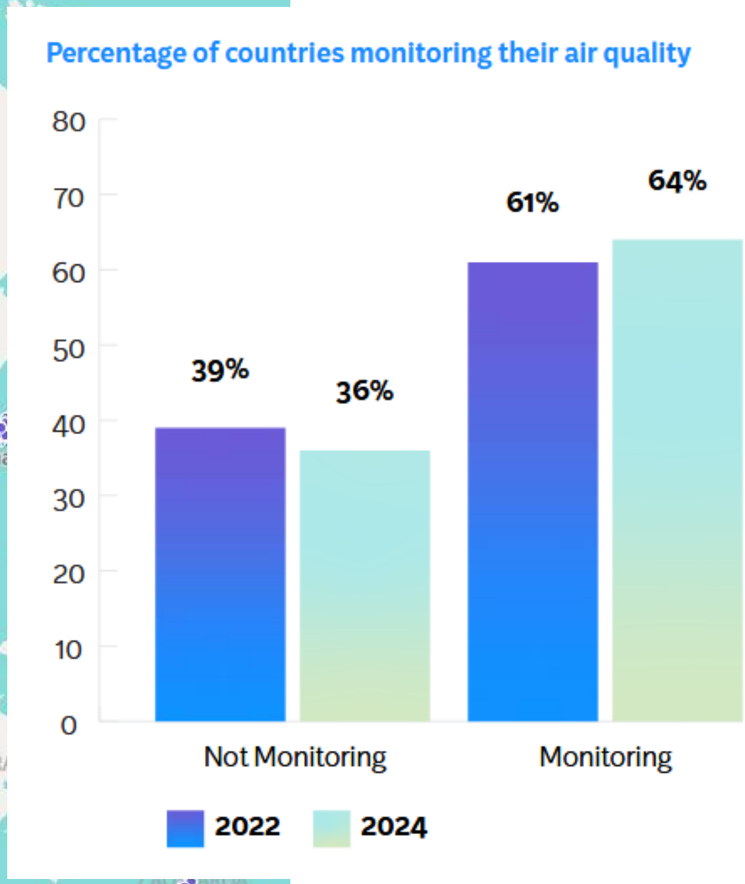

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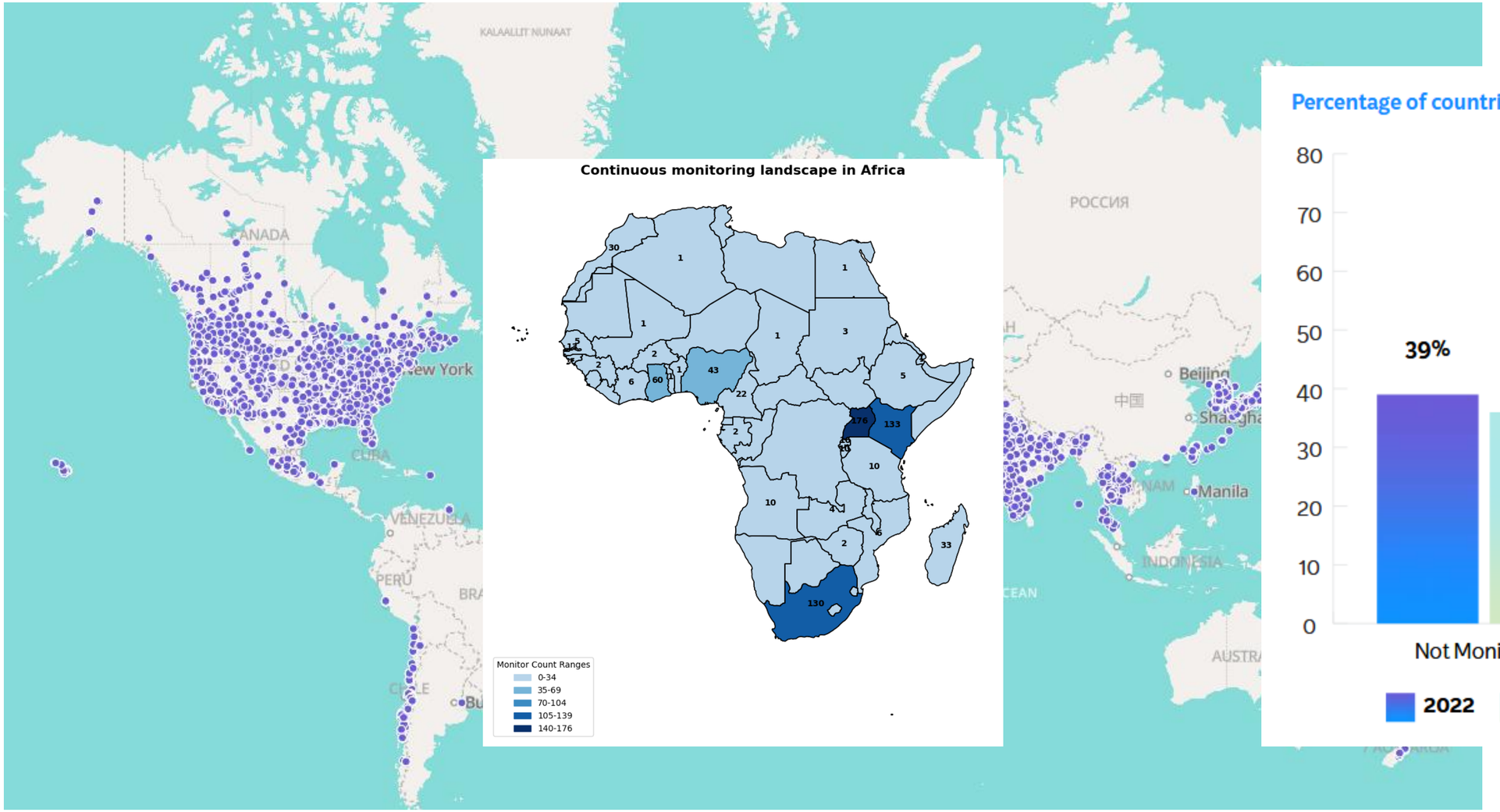

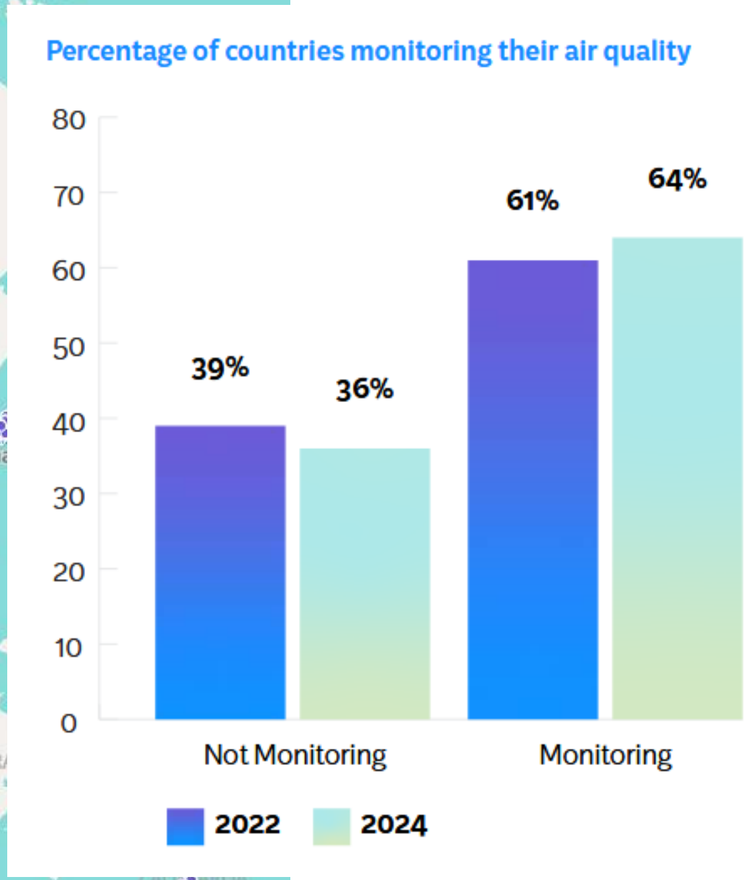

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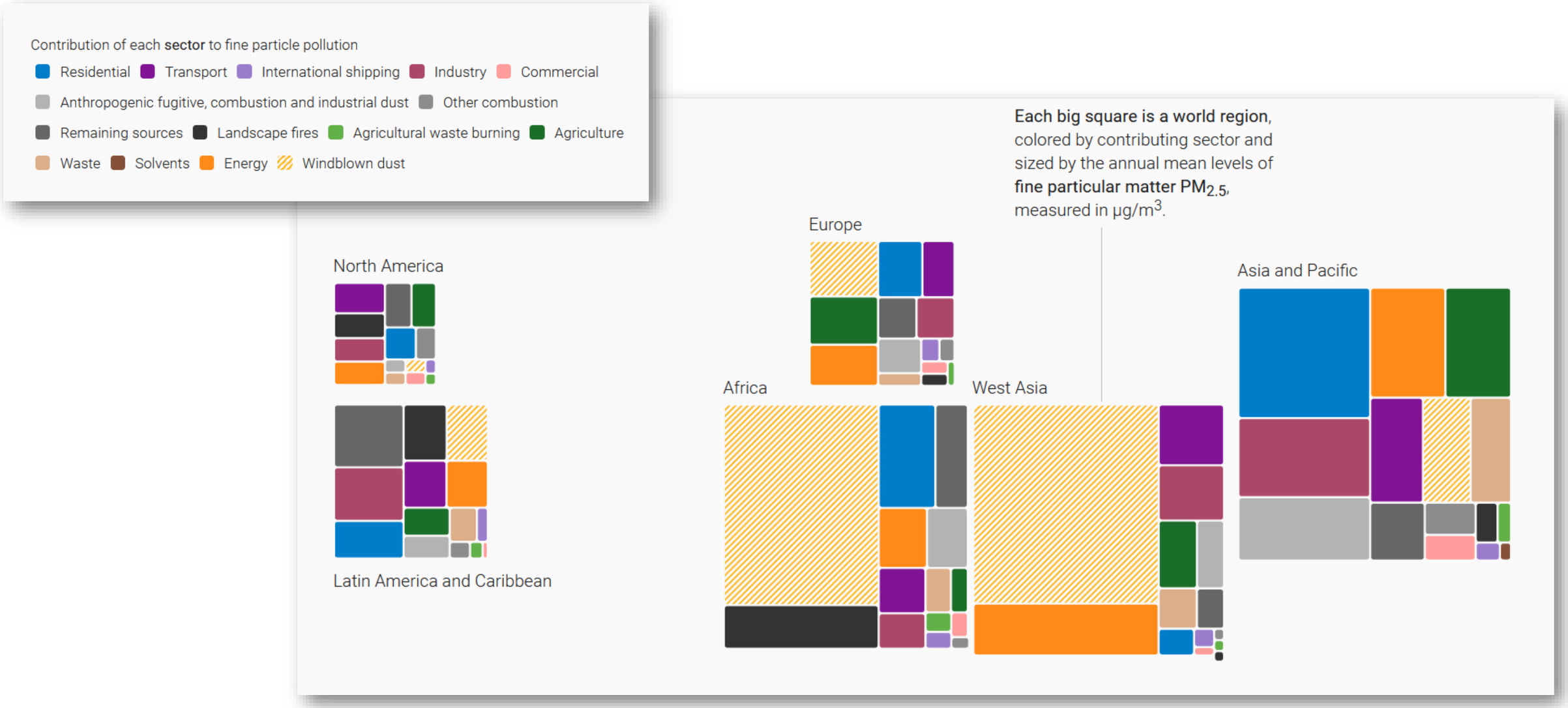
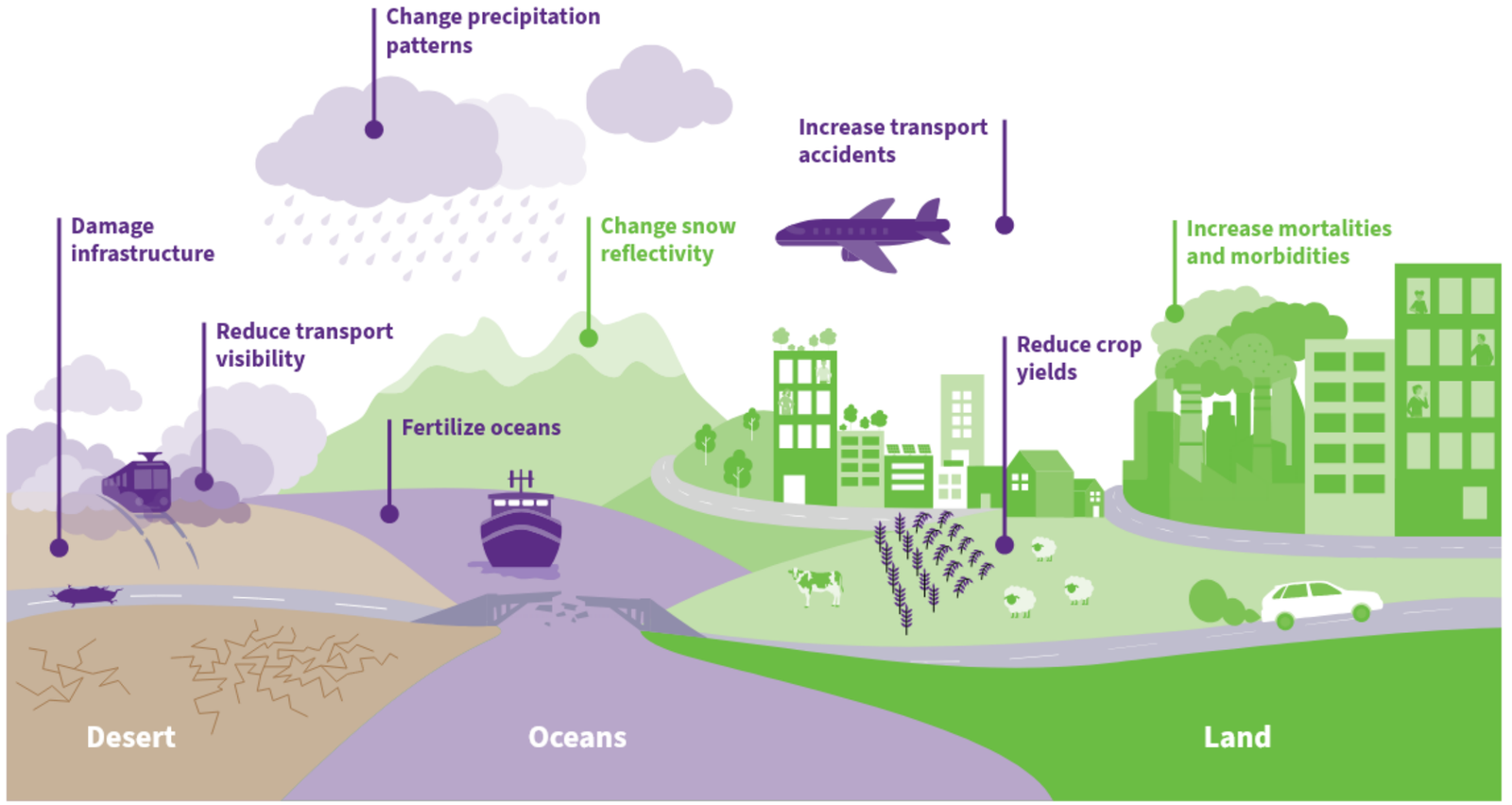
Okure et al ., AirQo

Major sources of air pollution vary by region and country



https://www.unep.org/interactive/air-pollution-note/

Sand and dust storms



"mega" sand and dust storms now affect an estimated **330 million people** annually.

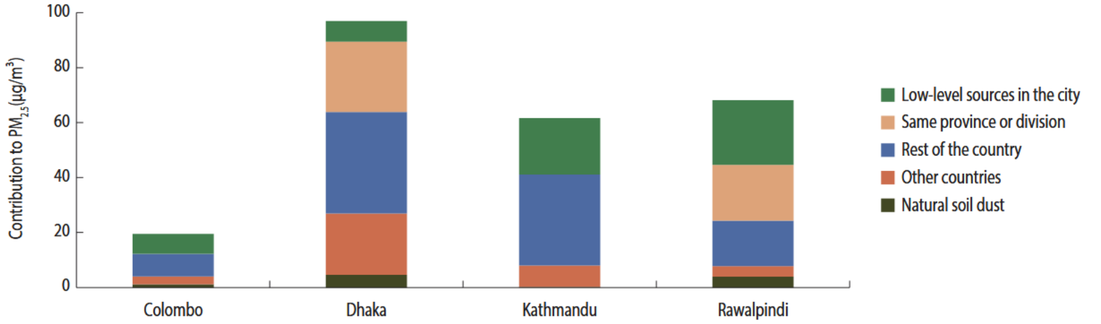
Impacts on visibility, air quality

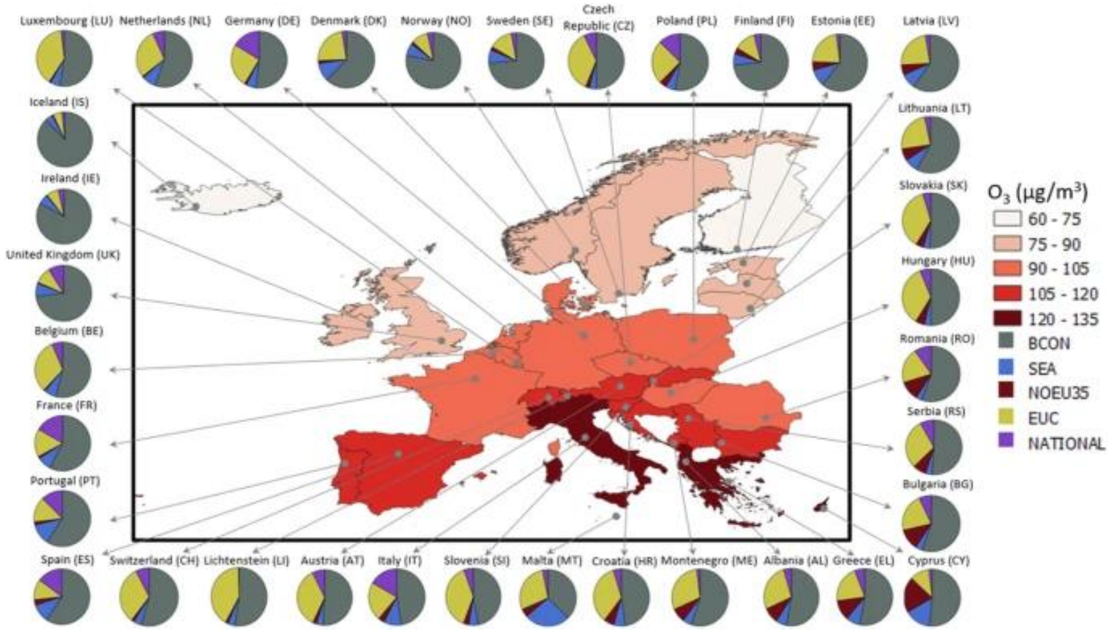
Respiratory and cardiovascular illnesses; meningitis outbreaks (West Africa)

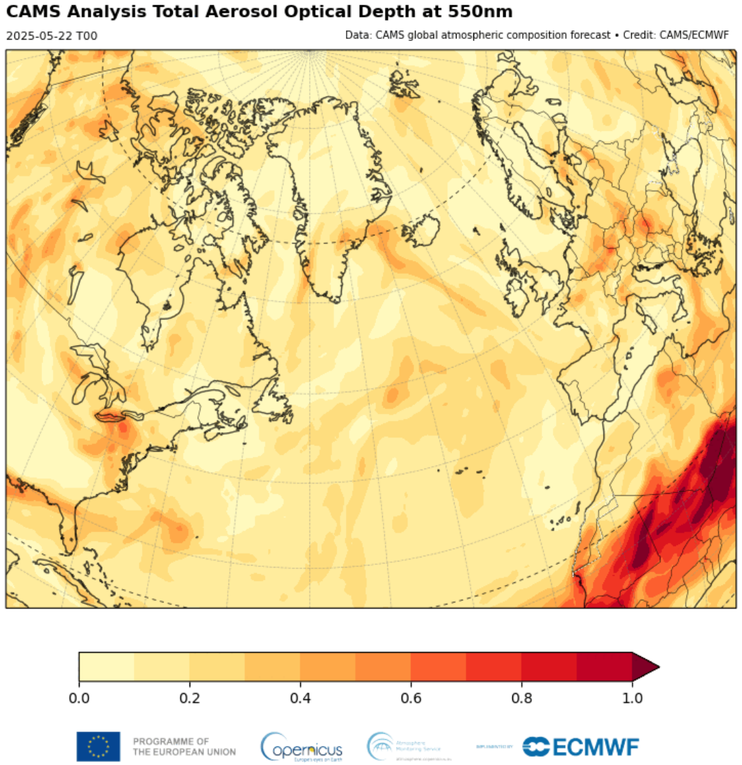
Image: inDust
https://news.mongabay.com/short-article/2025/10/supercharged-dust-storms-are-exposing-millions-to-deadly-air-pollution/

https://www.who.int/publications/i/item/B09453

Air pollution does not respect geographical or political borders







https://www.who.int/publications/i/item/B09459

World Bank. 2023. Striving for Clean Air: Air Pollution and Public Health in South Asia. South Asia Development Matters. Washington, DC: World Bank. doi:10.1596/978-1-4648-1831-8.

Garatachea et al. 2024. National and transboundary contributions to surface ozone concentration across European countries. *Communications Earth and Environment*, Volume 5.

CAMS tracks smoke from intense Canadian wildfires reaching Europe

Air Quality and Agriculture

Image: CGIAR

Air pollution has a negative impact on crop productivity and yield, with implications for food security. As a sector, agriculture also contributes to air pollution.

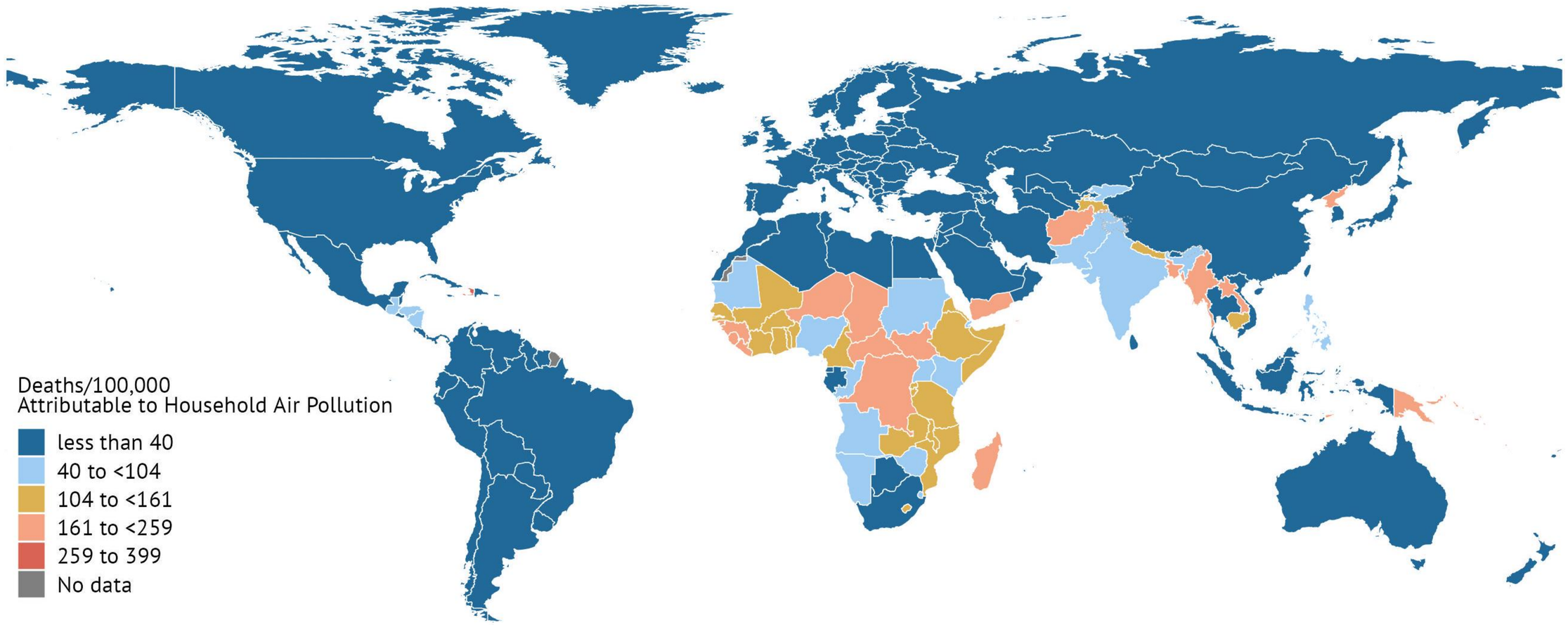
"Globally aggregated yield losses for the four staple crops 3.6 ± 1.1% for maize, 2.6 ± 0.8% for rice, 6.7 ± 4.1% for soybean, and 7.2 ± 7.3% for wheat."

"Reductions in ozone, particulate matter, nitrogen dioxide, and sulfur dioxide between 1999 and 2019 contributed to about 20% of the increase in U.S. corn and soybean yield gains during that period – an amount worth about $5 billion per year"

https://www.who.int/publications/i/item/B09401

Tai et al. 2021. Impacts of Surface Ozone Pollution on Global Crop Yields: Comparing Different Ozone Exposure Metrics and Incorporating Co-effects of CO2. *Front. Sustain. Food Syst.*, Volume 5.
Lobell and Burney. 2021. Cleaner air has contributed one-fifth of US maize and soybean yield gains since 1999. *Environmental Research Letters*, 16 074049.

2.8 million deaths due to exposure to household air pollution in 2023

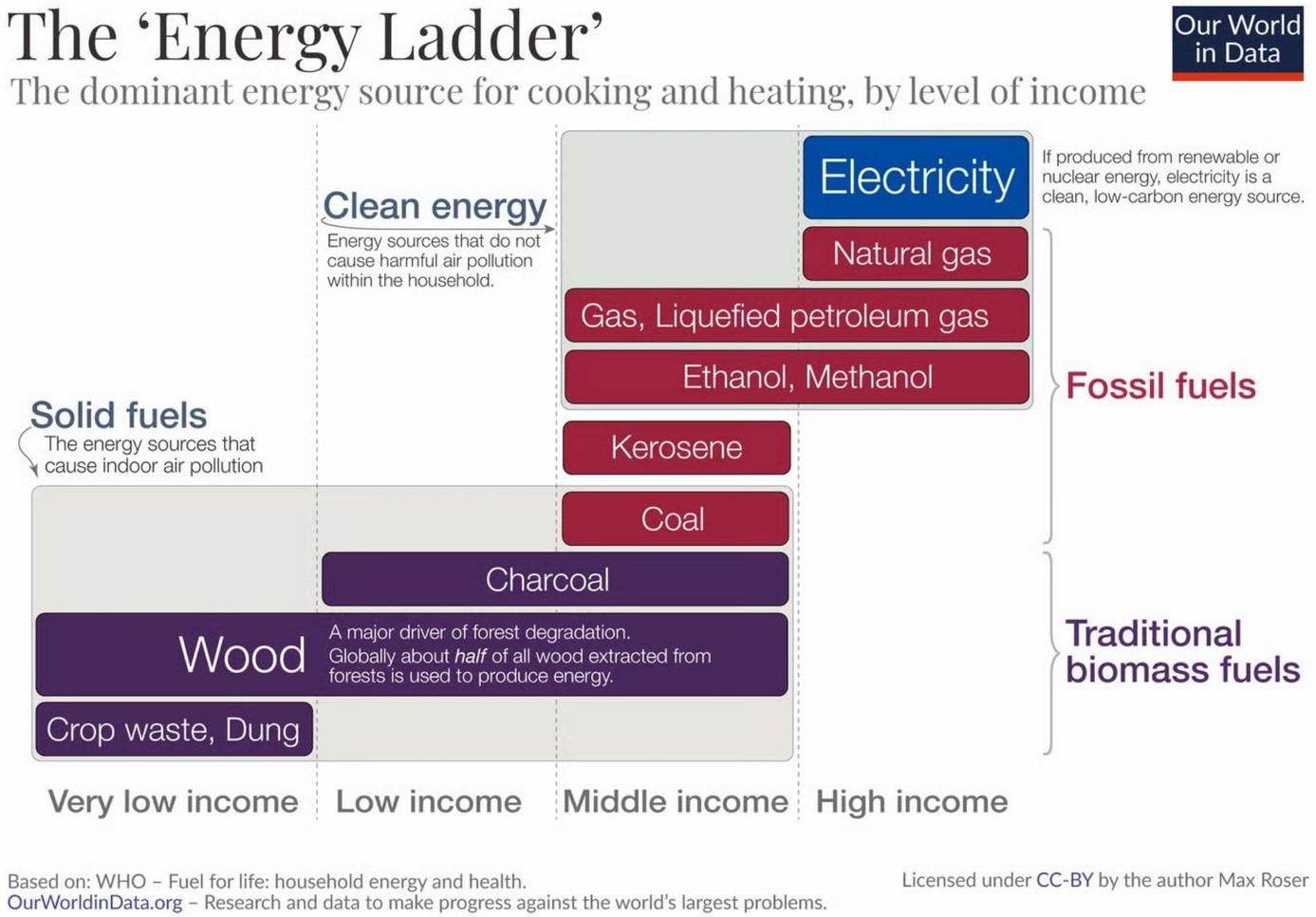


Air Quality and Energy

2.1 billion people remain dependent on polluting fuels and technologies

Across 24 African countries, **over 90%** of the population is exposed to HAP from cooking with solid fuels.

Sustainable Development Goal 7: Access to energy



https://ourworldindata.org/energy-ladder

Air Quality and Climate

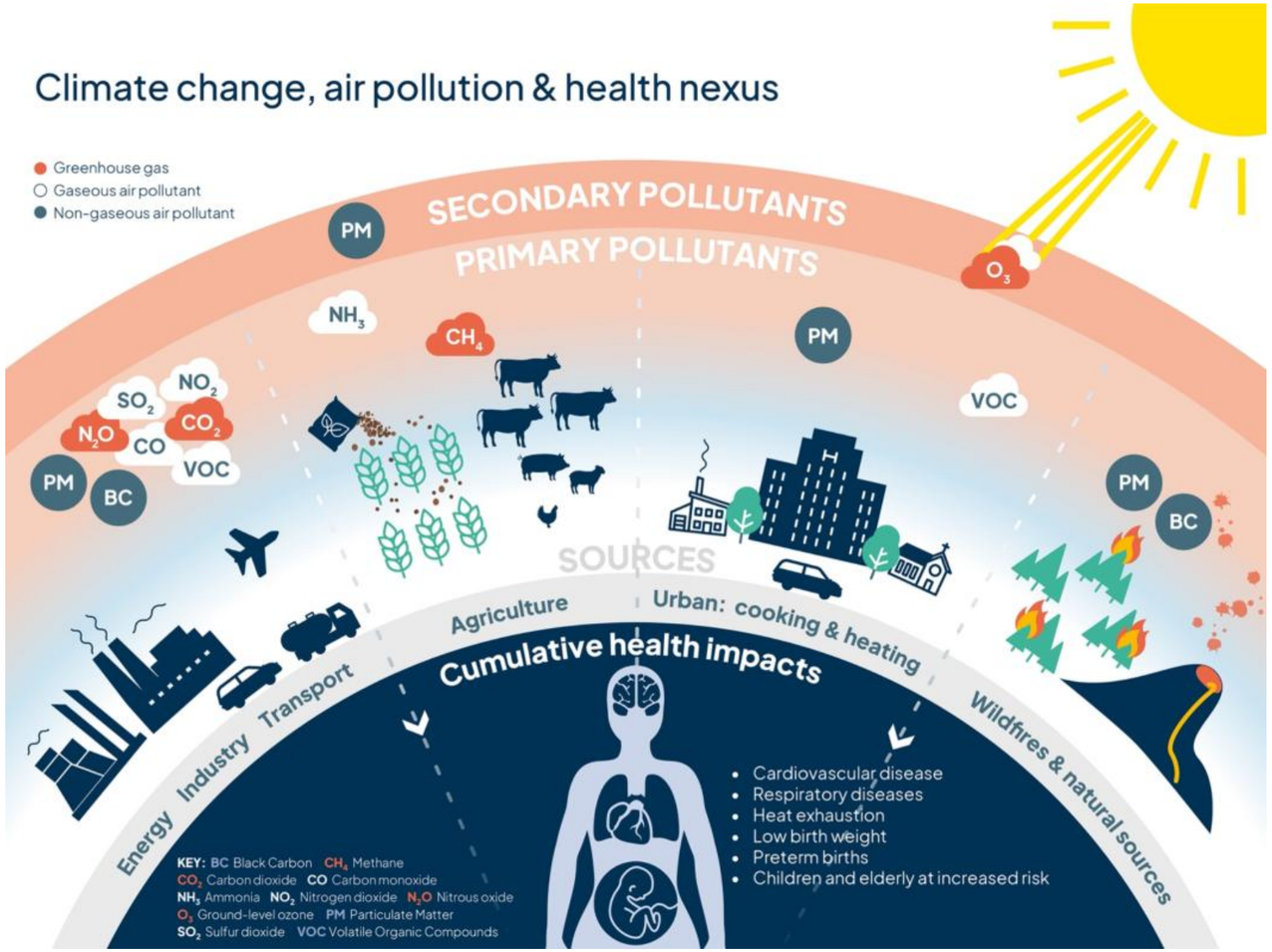


Figure: Centre for Climate Engagement, University of Cambridge, UK
WMO Air Quality and Climate Bulletin 2025

Joint effects of extreme heat and air pollution

Increasing wildfires and bushfires- impact on air quality and health

"enhanced $PM_{2.5}$ associated with biomass burning in northern Canada, the Amazon, Siberia and central Africa [in 2024]"

Pollen season/allergies

Sand and dust storms

Other ?

https://www.youtube.com/watch?v=ay7Mp_HDxnM

Superpollutants

SUPER POLLUTANTS

Climate pollutants	Major human sources	Atmospheric lifetime
Carbon Dioxide (CO_2)		Centuries
Methane (CH_4)		Decades
Tropospheric Ozone (O_3)*	CH_4 CO VOCs	Weeks to months
Carbon Monoxide (CO)*		Weeks to months
Volatile Organic Compounds (VOCs)*		Minutes to years
Fluorinated-gases (F-gases; e.g. hydrofluorocarbons (HFCs))		Years to decades
Nitrous Oxide (N_2O)**		Centuries
Black Carbon (BC)*		Days

* Air pollutant
** Depletes the ozone layer

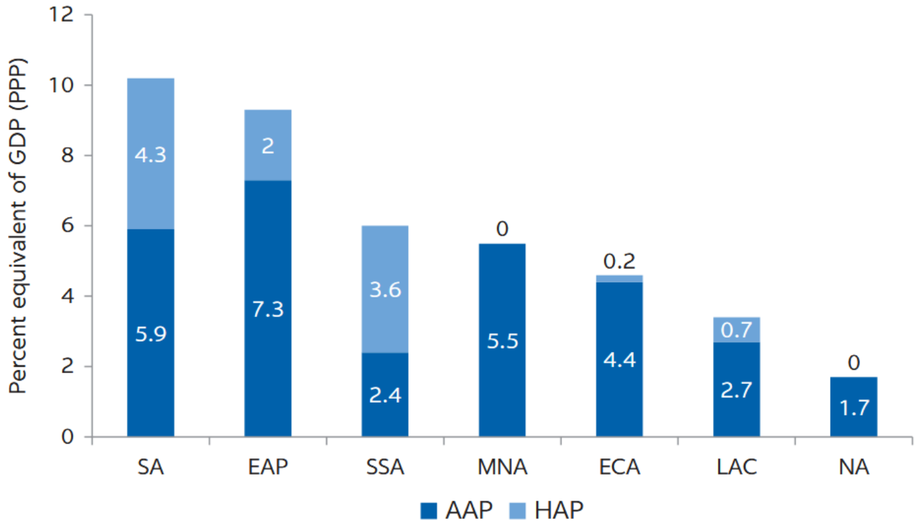
Extremely potent climate pollutants; greater impacts on warming than carbon dioxide per tonne; include methane, black carbon and tropospheric ozone

"*reducing super pollutants could prevent millions of premature deaths annually and save tens of millions of tonnes of crops annually*"

https://www.ccacoalition.org/sites/default/files/resources/files/Super%20Pollutant%20Factsheet_0.pdf
https://wellcome.org/insights/articles/what-are-super-pollutants-and-how-do-they-impact-our-health

Economic cost of air pollution

Global economic costs from ambient air pollution total ~ US$6 trillion per year, equivalent to 4.6 % of global GDP in 2020



68% highly-skilled employees limit working hours in Sofia, Bulgaria due to air pollution

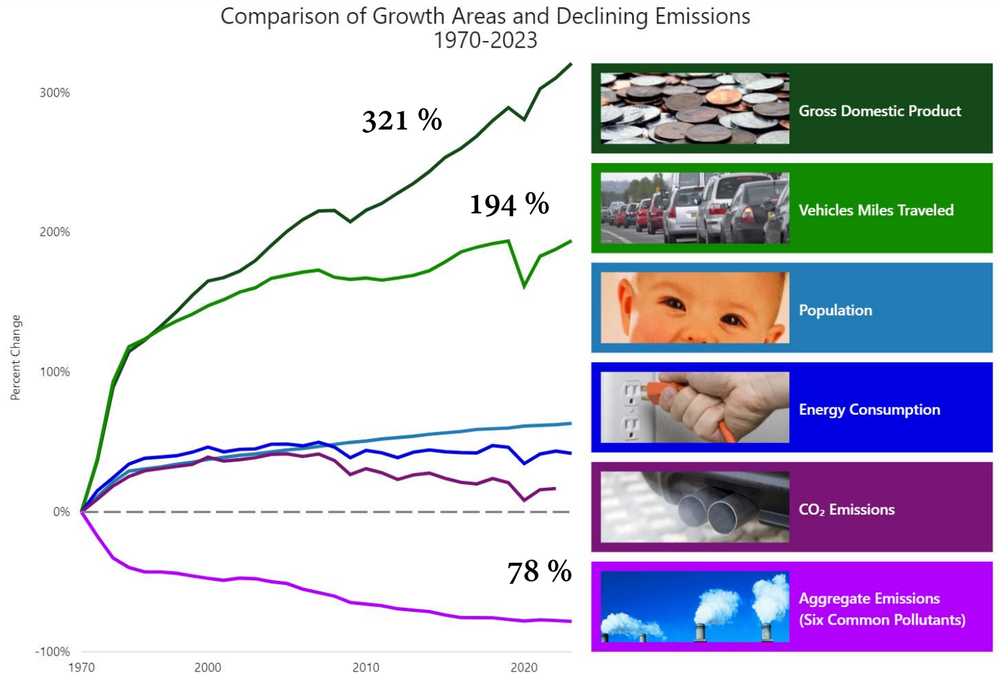
USD$2,500 Average healthcare cost related to air pollution for each American

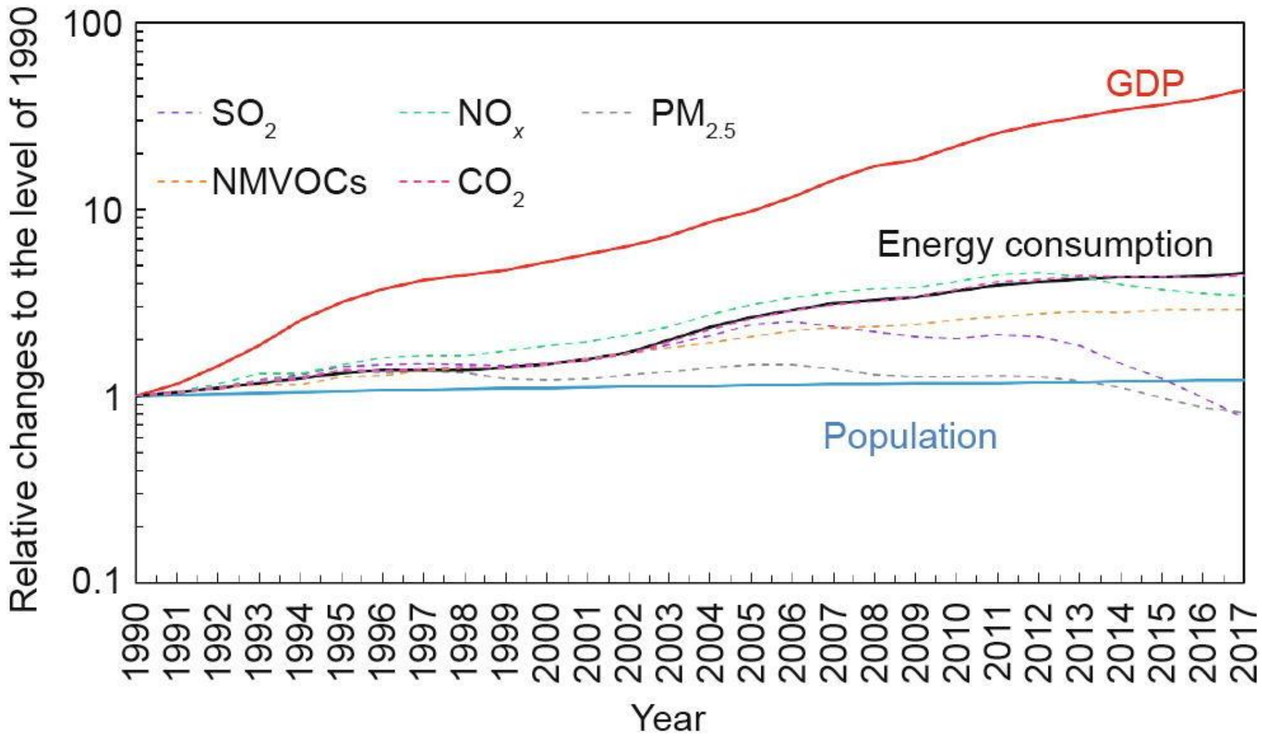
8% of insurance claims for hospitalizations in India linked to air pollution

8% decline in healthcare expenditure across 98 cities in China between 2015-2017 due to clean air action

The Global Health Cost of PM2.5 Air Pollution: A Case for Action Beyond 2021
https://www.weforum.org/stories/2021/06/air-pollution-cost-america-healthcare-study/
https://www.cleanairfund.org/news-item/air-pollution-and-talent-retention-a-sofia-case-study/
https://www.stateofglobalair.org/resources/report/state-global-air-report-2025
https://insuranceasia.com/insurance/news/children-drive-surge-in-pollution-linked-health-claims-in-india

Improvements in air quality vis-à-vis economic growth





https://www.epa.gov/air-trends/air-quality-national-summary

Lu et al. 2020. Progress of Air Pollution Control in China and Its Challenges and Opportunities in the Ecological Civilization Era. *Engineering*, Volume 6 (12), 1423-1431.

Critical drivers in the last decade

Increase in research output

(inter)national attention

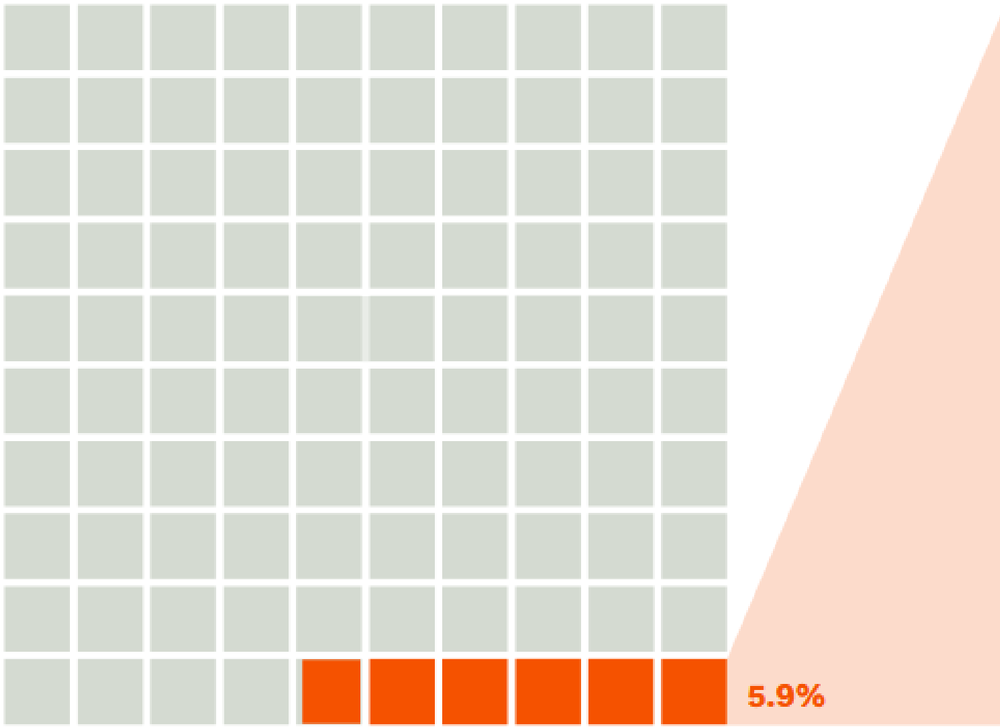
Data is increasingly accessible

Air quality data from low-cost sensors, satellites, models

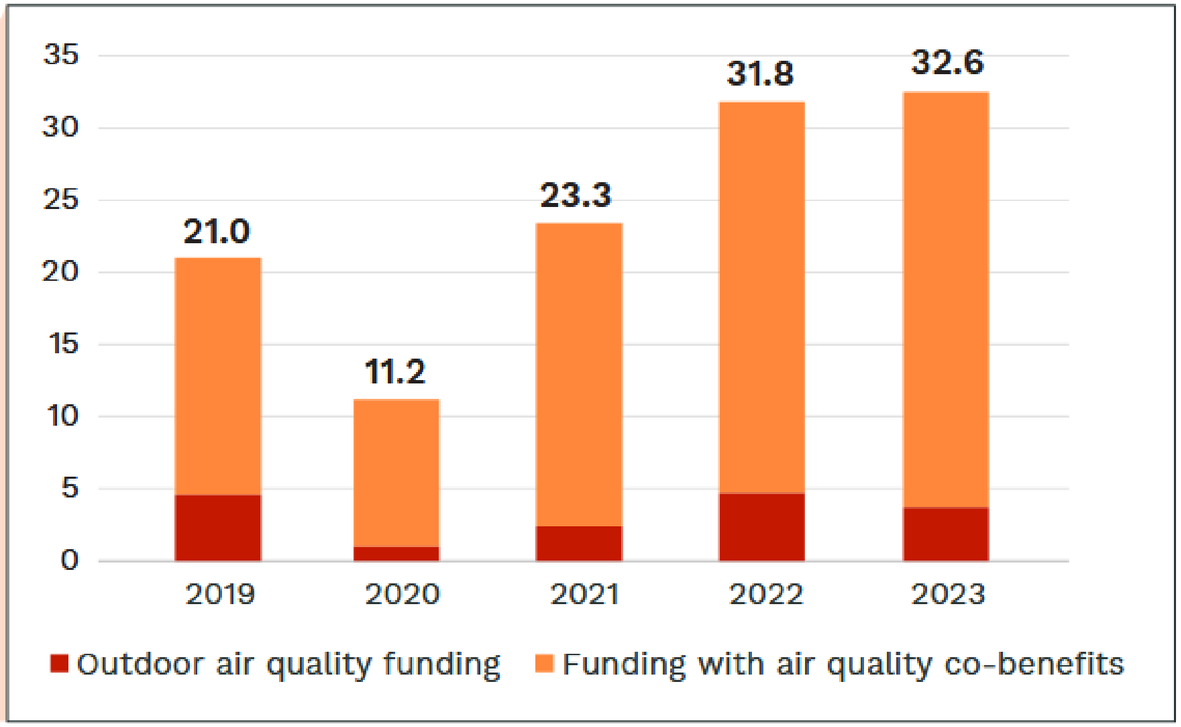
Social media

Despite the large impacts, funding for air quality remains limited.

International development funding, 2019 – 2023



Total air quality funding ($ billion)



https://www.cleanairfund.org/resource/air-quality-funding-2025

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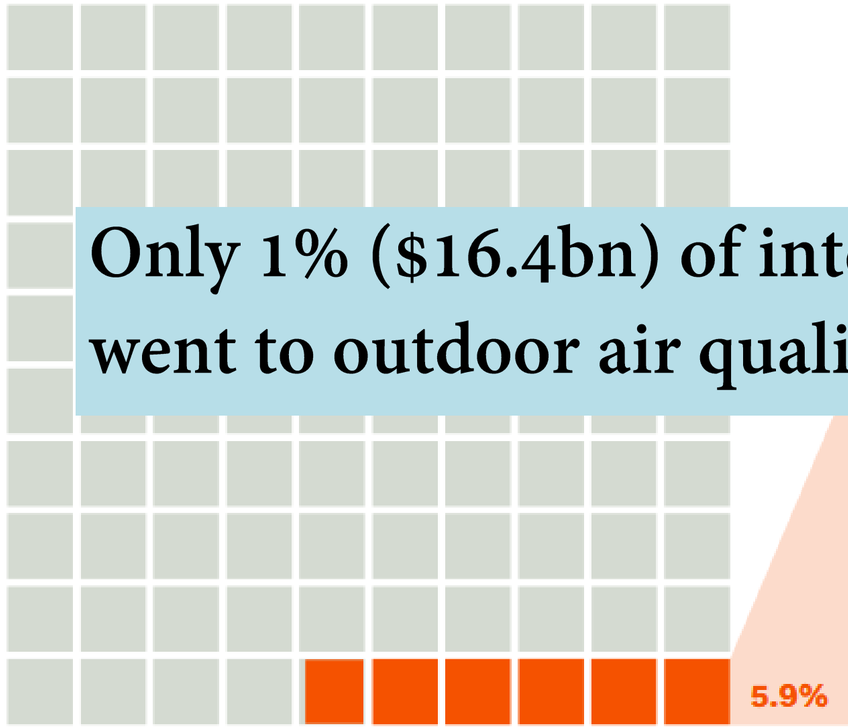

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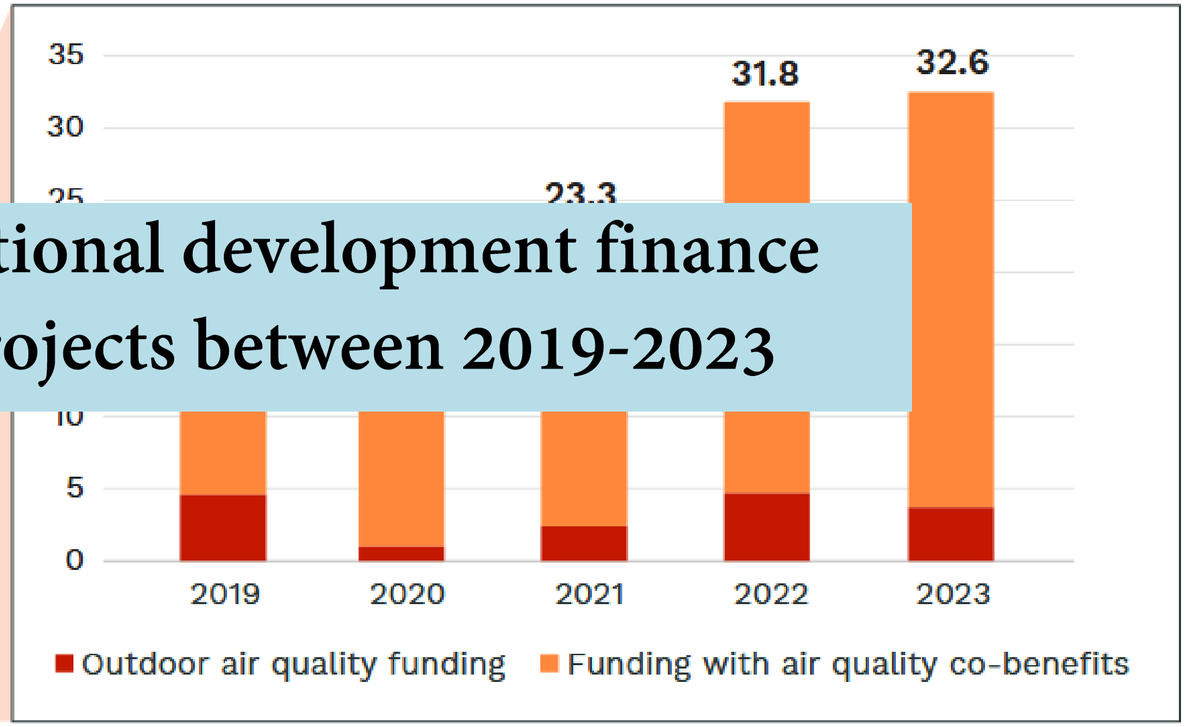


Only 1% ($16.4bn) of international development finance went to outdoor air quality projects between 2019-2023

https://www.cleanairfund.org/resource/air-quality-funding-2025

Signs of progress

2024 *UNEA Resolution* to bolster regional cooperation on air quality

2025 *WHO Roadmap* adopted; includes a voluntary target to halve premature deaths caused by anthropogenic air pollution by 2040

Nearly every low- and middle-income country mentions air pollution in their Nationally Determined Contributions (NDCs)

2020 *West African* countries adopted a comprehensive set of regulations for introducing cleaner fuels and vehicles

2022 *China* sees steep reductions in levels of $PM_{2.5}$ across major cities

2024 *Uganda* introduced the first National Environment (Air Quality Standards) Regulation

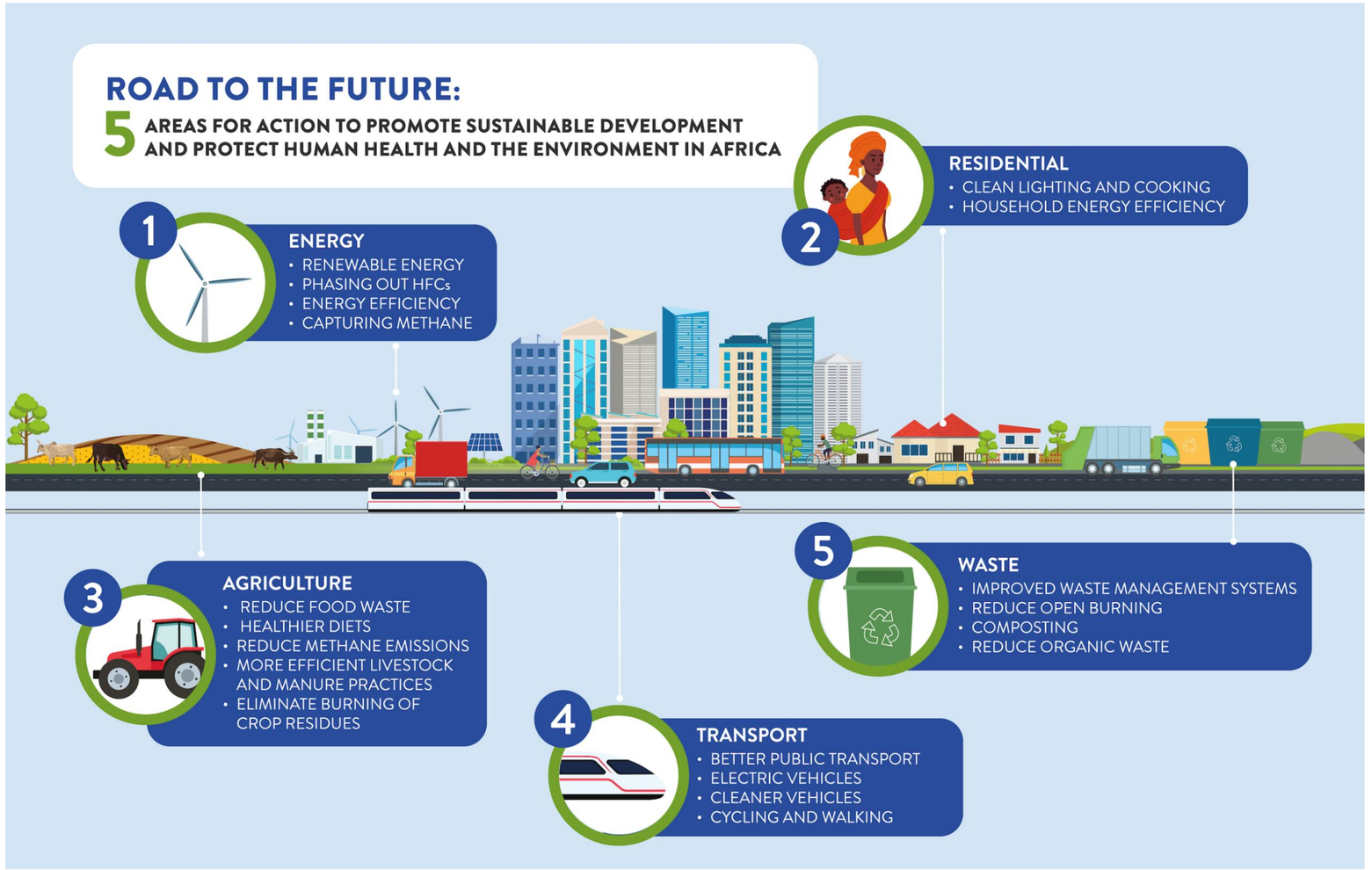
2024 *Brazil* approved the National Air Quality Management System (MonitoAr) to provide real-time access to air quality data

2024 *Bangladesh* introduced the National Air Quality Management Plan

2025 *Ghana* passed the Air Quality Management Regulation into law

https://apps.who.int/gb/ebwha/pdf_files/EB156/B156_24-en.pdf ; https://www.ccacoalition.org/news/unpacking-newly-adopted-unea-6-resolution-promoting-regional-cooperation-air-pollution-improve-air-quality-globally
https://www.ccacoalition.org/news/west-african-ministers-adopt-cleaner-fuels-and-vehicles-standards ; https://media.ulii.org/media/legislation/109237/source_file/a531145514695d0d/ug-act-2024-22-publication-document.pdf ;
https://www.ccacoalition.org/news/brazil-approves-national-air-quality-management-system-monitoar; https://doe.portal.gov.bd/sites/default/files/files/doe.portal.gov.bd/publications/dca40e57_68bb_4b2b_9793_02cd755914e8/2024-11-11-04-59-fa4c99872dfa5bd0c14dcae20af8809f.pdf ; https://english.www.gov.cn/news/topnews/202208/13/content_WS62f7a611c6d02e533532f21f.html

Collaborative action can help accelerate progress towards Agenda 2063



"prevent 200,000 premature deaths per year by 2030, reduce carbon dioxide and methane emissions, and improve food security" (Africa Integrated Assessment)

"precent 109,000 lives and save $20bn in economic costs by reduced air pollution in six cities in Africa" (Clean Air Fund)

Food for thought

What was the most surprising fact that you learnt today?

Resources

- AQMx
- Atmospheric Tales
- A chronology of global air quality

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