Setting Ambient Air Quality Standards

The role of Air Pollution and Health Research in Informing Policy Action

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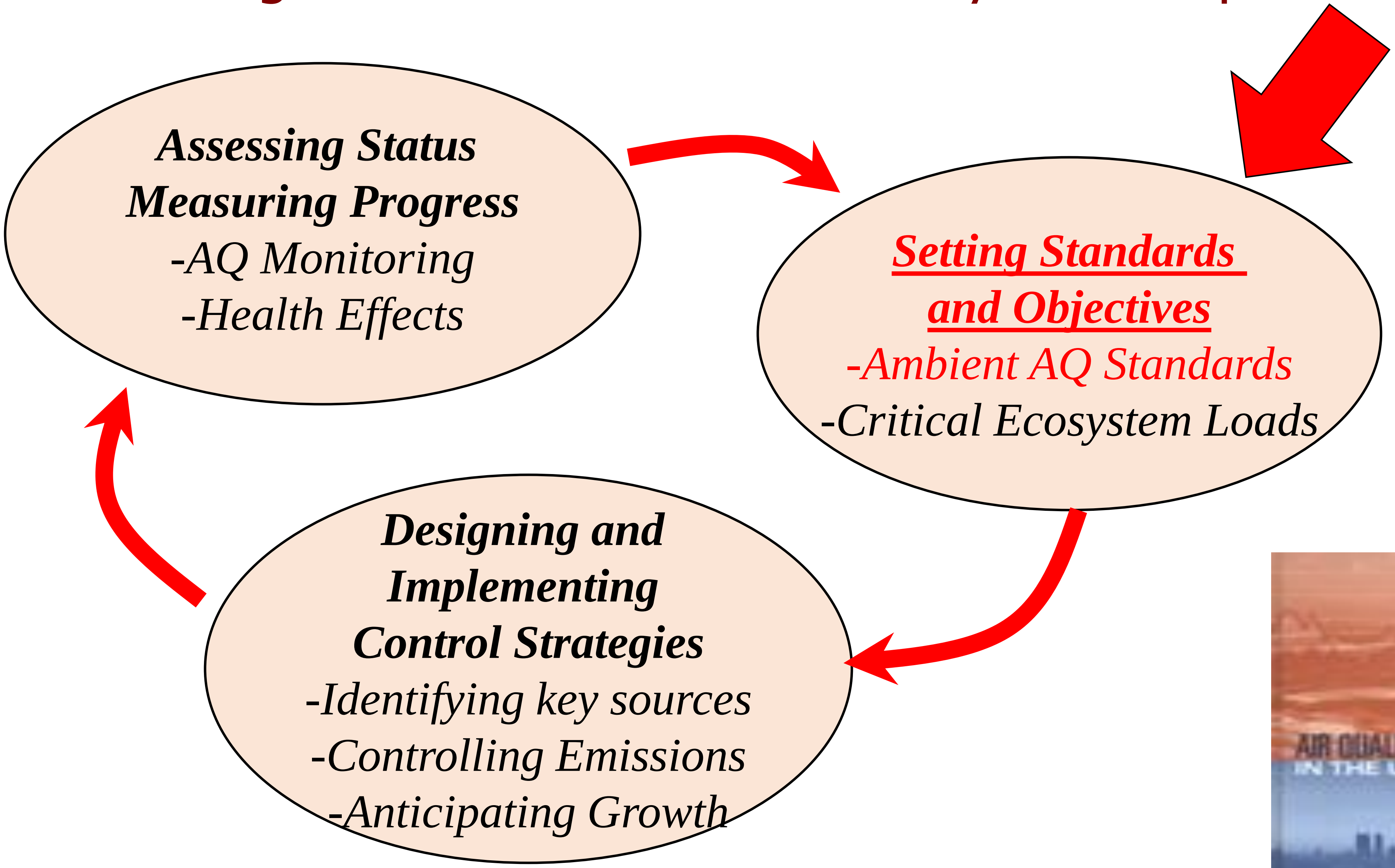
Health Effects Institute

Workshop on Air Pollution and Health in East Africa

Nairobi, Kenya

March 29, 2023

Setting Ambient Standards is a Key First Step



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US National Academy of Sciences Report Air Quality Management in the United States
http://books.nap.edu/catalog/10728.html

1. Is there a Health Hazard From Exposure to Air Pollution?

Many forms of studies can help inform this:

- *Daily population studies* examining relationship between exposures and certain health outcomes:
  - E.g., asthma hospitalization, premature birth, mortality (deaths), and more

- *Studies of Long-term Effects (e.g. cohort and panel studies)* examining how exposures do or do not affect a population of carefully selected set of participants:
  - E.g., children, pregnant mothers, older people


ELSEVIER
Science of The Total Environment
Volume 832, 1 August 2022, 154957

Early-life environmental exposures and anaemia among children under age five in Sub-Saharan Africa: An insight from the Demographic & Health Surveys

Prince M. Amegbor

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ELSEVIER
Environment International
Volume 136, March 2020, 105471

Household air pollution profiles associated with persistent childhood cough in urban Uganda

Eric Coker[a b], Achilles Katamba[c], Samuel Kizito[c], Brenda Eskenazi[b], J. Lucian Davis[d e]

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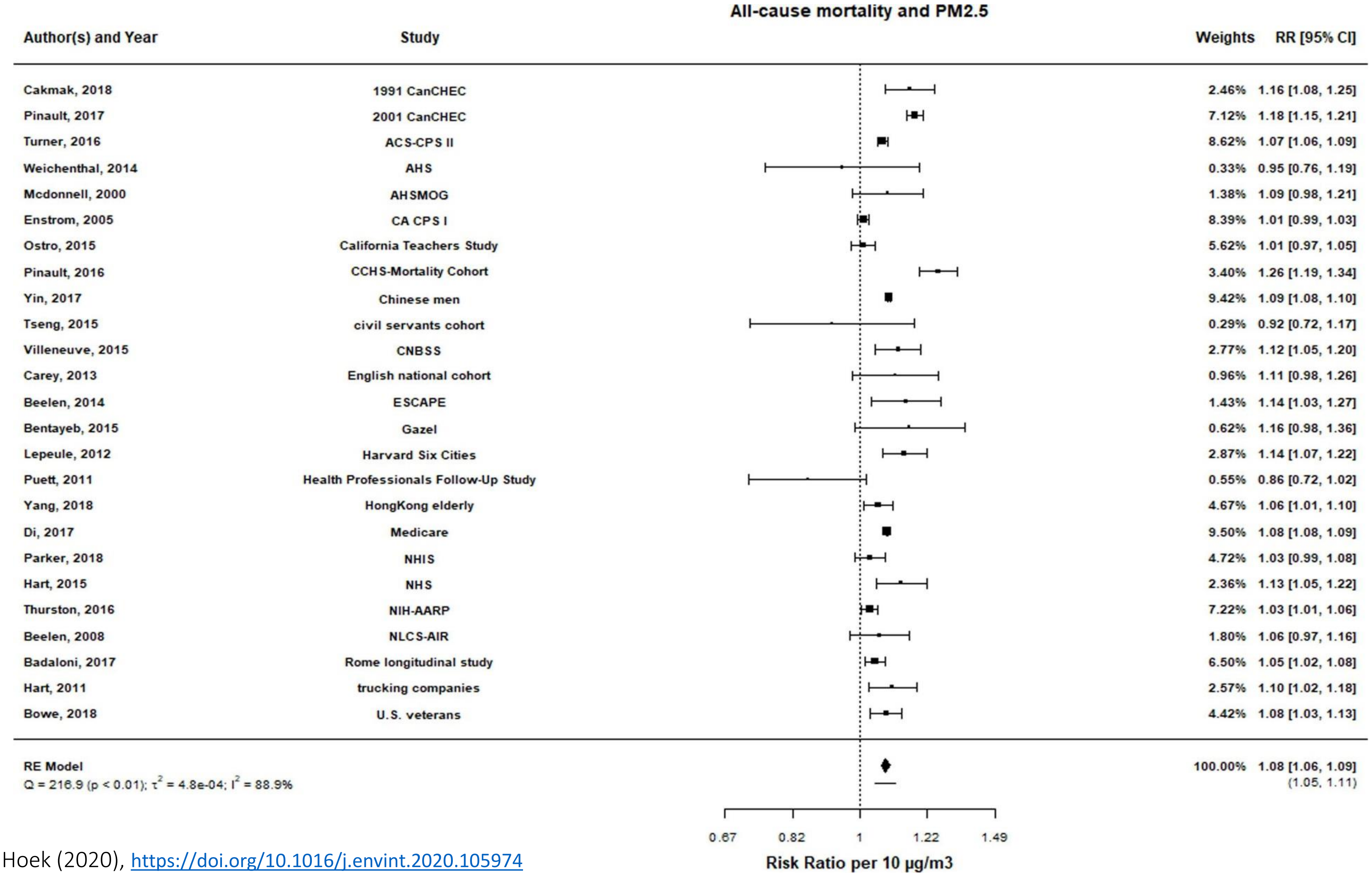
Example: Recent Global Mortality Studies Provide Consistent Evidence of Long -Term Effects



Chen and Hoek (2020), https://doi.org/10.1016/j.envint.2020.105974

2. At what **exposure level** do effects occur?

This requires evidence of the *Concentration Response (C-R) relationship:*

- *Detailed estimates of:*
  - *Exposures across an entire population*
  - *Health status and outcomes*
    - *E.g., mortality, lung cancer incidence*

Draws on a large worldwide data set, but gaps remain in Africa

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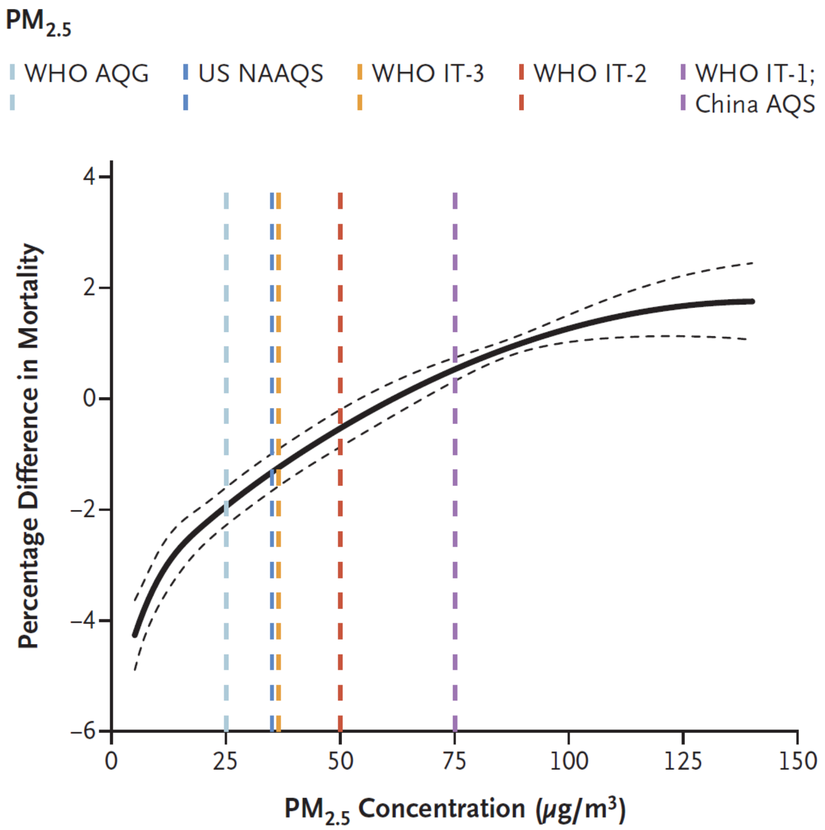
One example of the "Concentration Response Relationship"

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 AUGUST 22, 2019 VOL. 381 NO. 8

Ambient Particulate Air Pollution and Daily Mortality in 652 Cities



- Recent paper from Liu et al in the New England Journal of Medicine
- Times series studies in 652 cities in 24 countries
  - including China, Africa, Latin America
- Strong PM2.5 associations below US NAAQS, WHO AQG
  - Steeper curve at lowest levels

Using Evidence to Set Air Quality Standards and Guidelines

US, WHO, India, and Much of the Rest of the World, has set PM and Ozone Ambient Air Quality Standards (in µg/m^3)

Pollutant	WHO AQG (Interim Targets)	US EPA	EU	China Revised 2016	India Revised 2009
PM10 Annual	**10** (70-50-30-20)	---	40	70	60
PM10 Daily	**45** (150-100-75-50)	150	50	150	\
PM2.5 Annual	**5** (35-25-15-10)	12\8-10?	25\10	35	40\?
PM2.5 Daily	**15** (75-50-37.5-25)	35	---	7	60
Ozone 8-hour	**100** (**160-120)	~140 (70ppb)	100***	160	100

***target value, not limit value

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WHO Global Air Quality Guidelines

Scientific evidence and decision-making process

Dr Dorota Jarosinska, WHO European Centre for Environment and Health

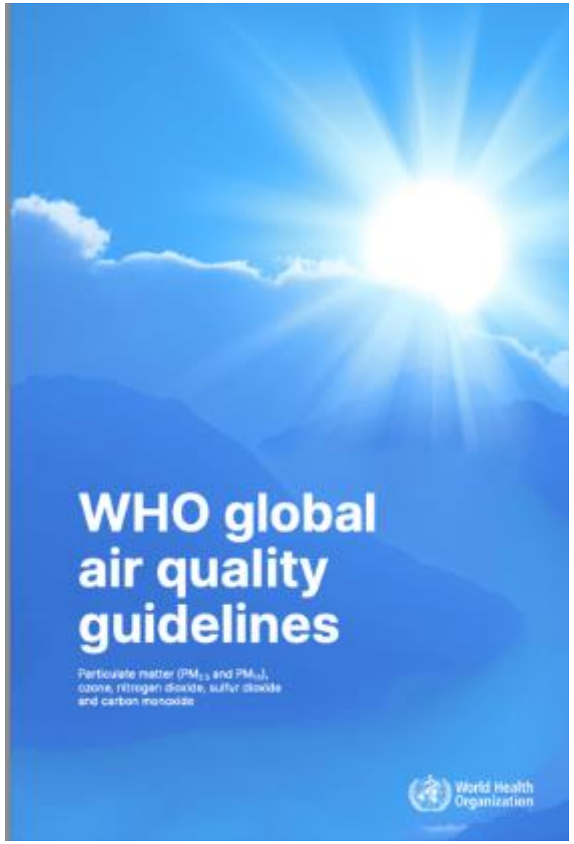
HEI Annual Conference, 26-28 June 2022

World Health Organization

European Region

www.who.int/europe

What are the WHO Global AQGs



- Based on extensive scientific evidence, the AQGs identify the levels of air quality necessary to **protect public health worldwide.**
- Provide recommendations on **air quality guideline levels** (and interim targets) for **$PM_{2.5}$, PM_{10}, O_3, NO_2, SO_2** and **CO,** and qualitative good practice statements for certain types of particulate matter.
- Guideline levels can be used as an **evidence-informed reference** to help decision-makers in setting legally binding standards and goals for air quality management.
- They are an **instrument to design effective measures** to achieve reduction of air pollution and, therefore, protect human health.
- ***Different Countries have taken different approaches to setting standards***

China chose an interim target

China's Class 2 Annual AQ Standard

Summary of recommended AQG levels and interim targets

Pollutant	Averaging time	IT1	IT2	IT3	IT4	AQG level
$PM_{2.5}$, µg/m³	Annual	35	25	15	*10*	5
$PM_{2.5}$, µg/m³	24-hour[a]	75	50	37.5	*25*	15
PM_{10}, µg/m³	Annual	70	50	30	*20*	15
PM_{10}, µg/m³	24-hour[a]	150	100	75	*50*	45
O_3, µg/m³	Peak season[b]	100	70	–	–	60
O_3, µg/m³	8-hour[a]	160	120	–	–	100
NO_2, µg/m³	Annual	*40*	30	20	–	10
NO_2, µg/m³	24-hour[a]	120	50	–	–	25
SO_2, µg/m³	24-hour[a]	125	50	–	–	40
CO, mg/m³	24-hour[a]	7	–	–	–	4

Air quality guideline levels for both long- and short-term exposure in relation to critical health outcomes

Interim targets to guide reduction efforts for the achievement of the air quality guideline levels

Good practice statements on the management of certain types of particulate matter for which evidence is insufficient to derive quantitative air quality guideline levels, but points to their health relevance

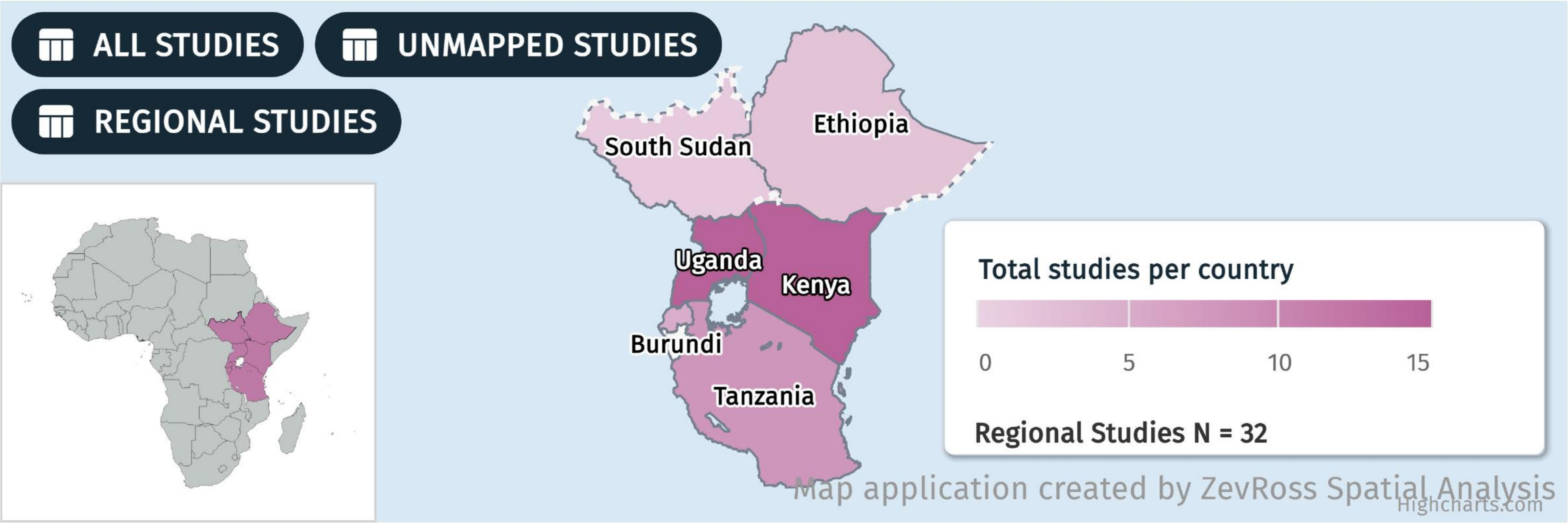
Different uptake of AQGs in AAQS across the world

WHO REGION	COUNTRIES IN THE REGION (N)	COUNTRIES WITH STANDARDS FOR AT LEAST ONE POLLUTANT AND AVERAGING TIME		COUNTRIES WITHOUT STANDARDS		COUNTRIES WITH NO INFORMATION	
		n	%	n	%	n	%
African Region	47	17	36	21	45	9	19
Region of the Americas	35	20	57	13	37	2	6
South-East Asian Region	11	7	64	3	27	1	9
European Region	**53**	**50**	**94**	**2**	**4**	**1**	**2**
Eastern Mediterranean Region	21	11	52	1	5	9	43
Western Pacific Region	27	12	44	13	48	2	7
Total	194	117	60	53	27	24	12

Kutlar Joss et al., 2017

Growing Evidence of Air Pollution and Health in East Africa

Over 80 studies in HEI's new interactive data base



https://www.healtheffects.org/global/interactive-database/east-africa

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3. How can we test which **sources** contribute to health hazards?

- Requires source-specific estimates of emissions
- And populations that are, *and are not,* exposed to the source
- May be challenging in high pollution environments where there are *many* sources, and everyone is exposed

But ultimately such studies can play a key role in targeting source controls.

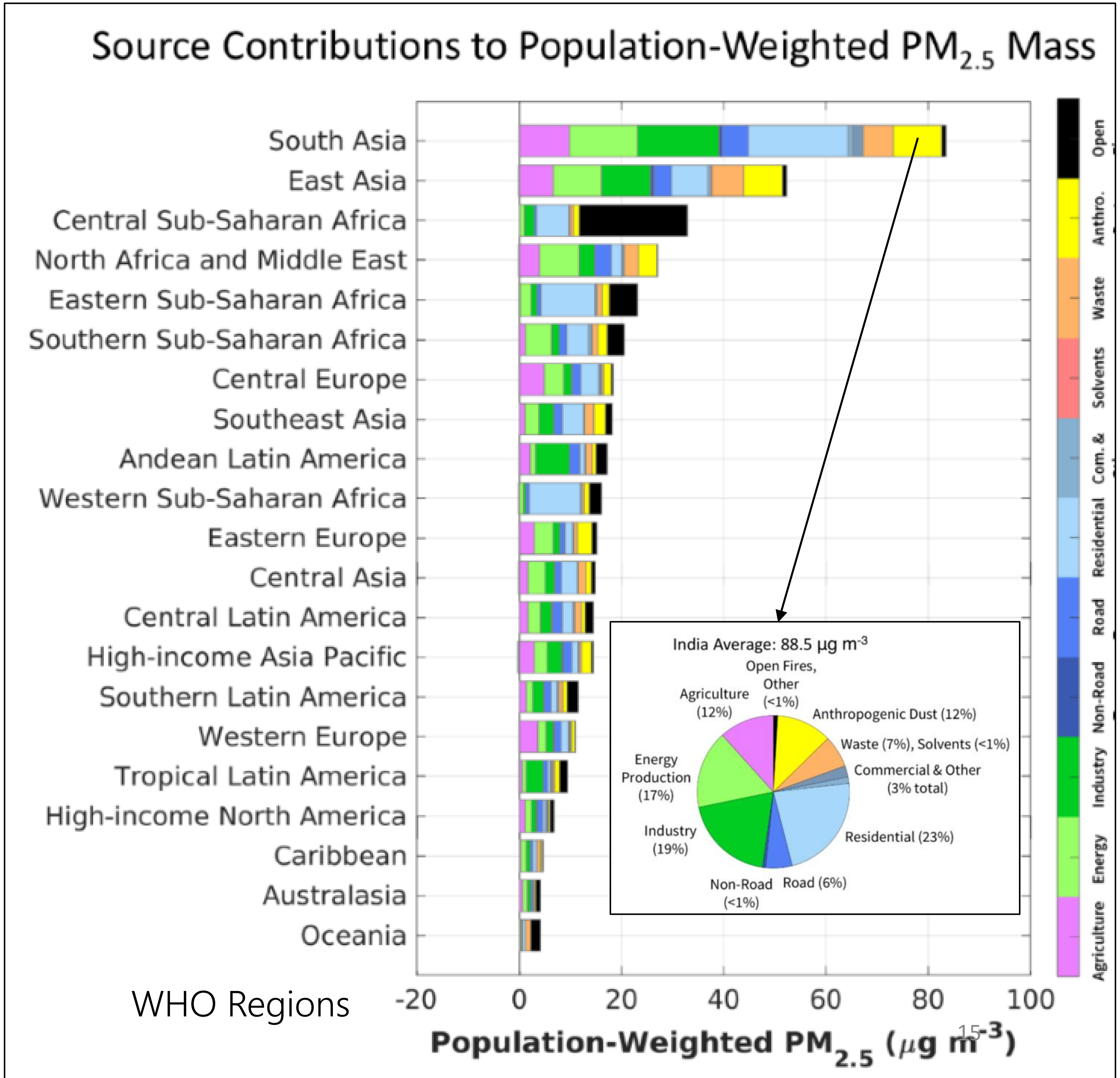
Informing Solutions: Global Burden of Disease from Major Air Pollution Sources (GBD MAPS)

GBD-MAPS Global is identifying which sources/sectors contribute most to air pollution and health in 195 countries

Relies on AQ monitors, satellite data and models

Local data is key to informed air quality management

Full Data Available through State of Global Air 2021



Setting Standards Sets the Stage for the Next Step:

Assessing Status
Measuring Progress
-AQ Monitoring
-Health Effects

Setting Standards and Objectives
-Ambient AQ Standards
-Critical Ecosystem Loads

Designing and Implementing Control Strategies
-Identifying key sources
-Controlling Emissions
-Anticipating Growth

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Health impact of China's Air Pollution Prevention and Control Action Plan: an analysis of national air quality monitoring and mortality data

Jing Huang, Xiaochuan Pan, Xinbiao Guo, Guoxing Li

- China took action starting in 2013
- Air Pollution went Down
- Deaths declined and Years of life were saved

Lancet Planetary Health July 2018

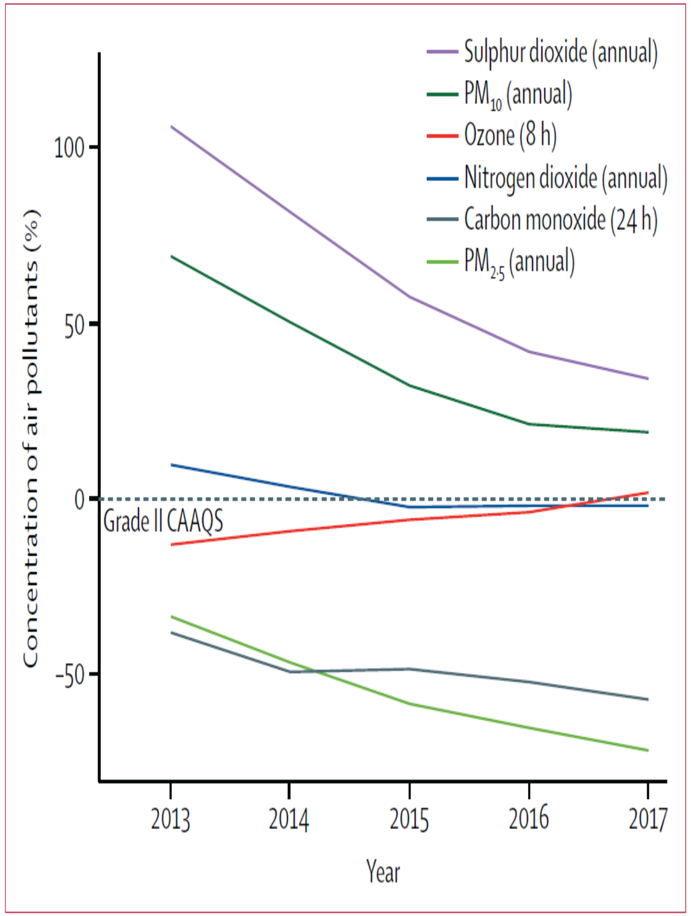

Figure 3: Average concentrations of the six criteria air pollutants in the 74 key cities, as percentages of the grade II levels set by the CAAQS, 2013-17

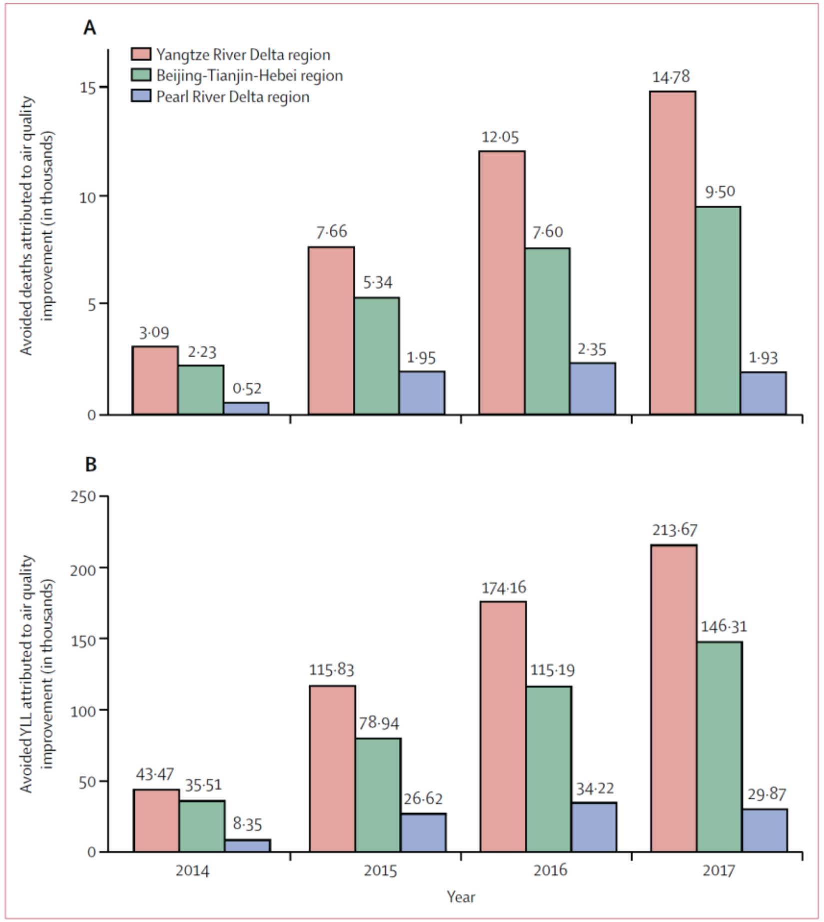

Figure 5: Number of avoided deaths and YLL attributable to air quality improvements in the three key regions in China from 2014 to 2017 compared with 2013

Conclusions

- Achieving Clean Air Through Effective Air Quality Management is a Long-term Commitment
- Setting AQ Standards relies on a combination of global and local studies and international assessments (WHO AQG's, Euro limit values, US EPA NAAQS)
- Understanding emissions and population exposures at the regional and local levels key to targeting sources of greatest concern to public health
- Assessing progress over time is key to ensuring that regulatory and other interventions are working to protect public health
- Enhanced air quality monitoring needed to inform better health studies, exposure assessment, source contributions and track progress.

THANK YOU!

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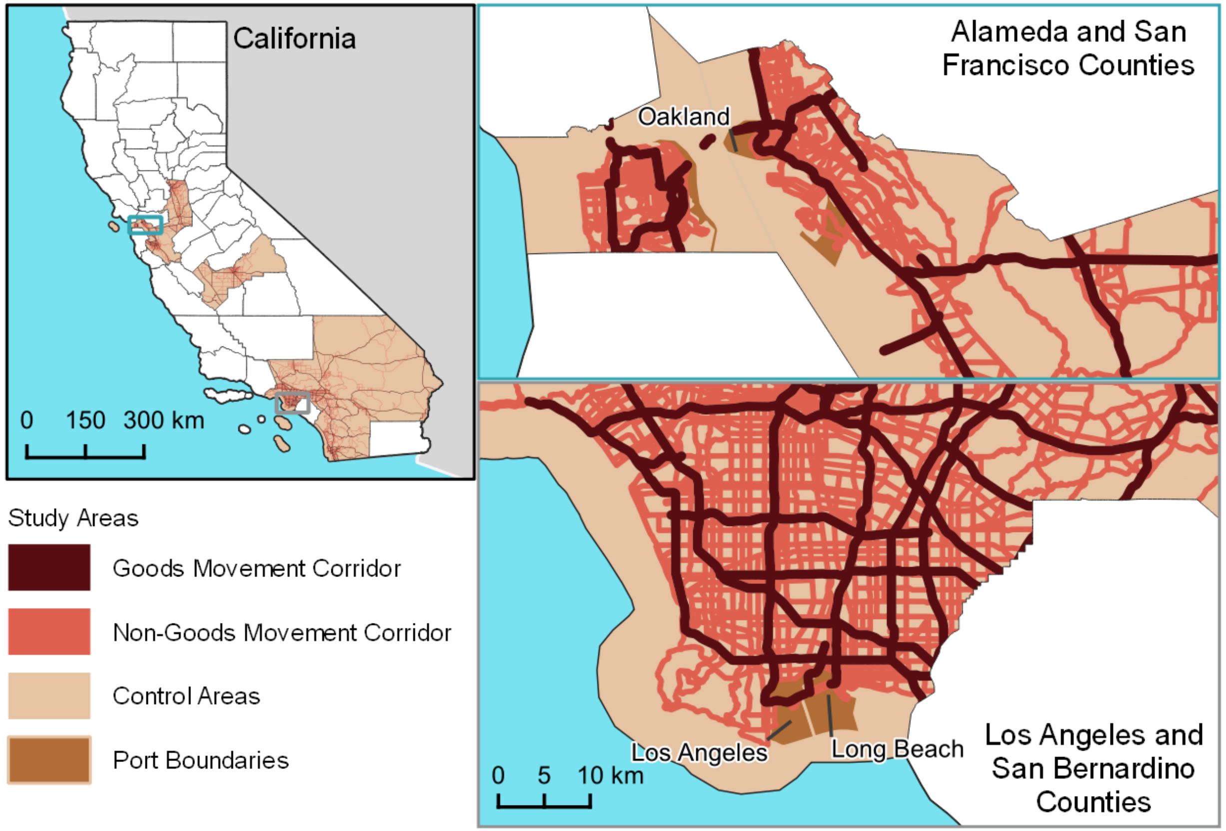
A Recent Example:
HEI's Report on CA Goods Movement (Meng et al May 2021)

Compare changes in 10 California counties from pre-policy to post-policy comparing:

- *Goods Movement Corridors* to *Non-Goods Movement Corridors*
- *NO2 Exposures went down*
- *Hospitalizations Went Down*



Commentary Figure 1

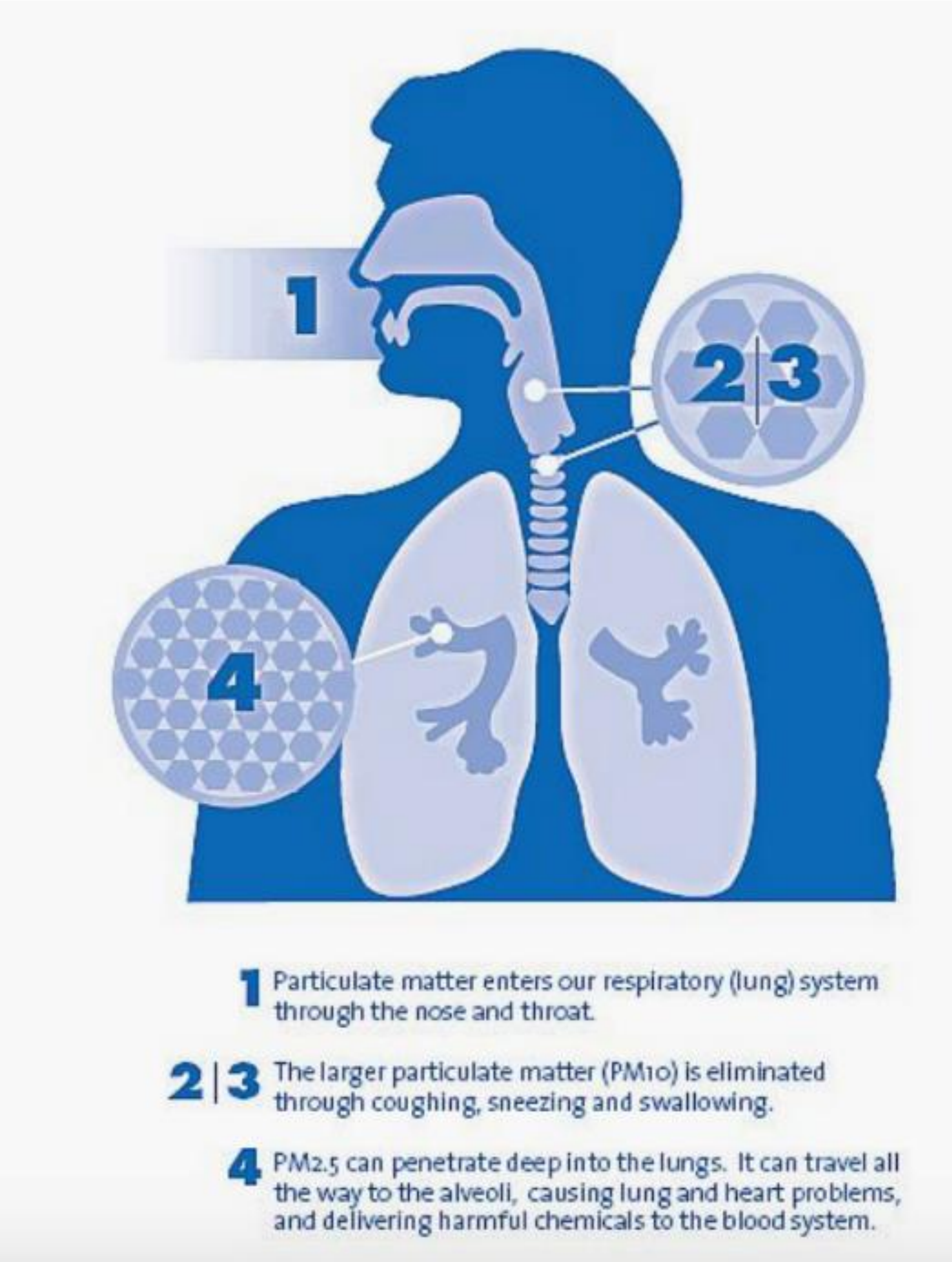
https://www.healtheffects.org/publication/improvements-air-quality-and-health-outcomes-among-california-medicaid-enrollees-due

Health Effects of exposure to $PM_{2.5}$

Longstanding concern about effects on the lung

But strong evidence of an association between long- and short-term exposure to $PM_{2.5}$ and heart disease, stroke, brain disease, birth outcomes

Growing evidence from India, China, elsewhere in Asia



State of Global Air 2020

www.stateofglobalair.org

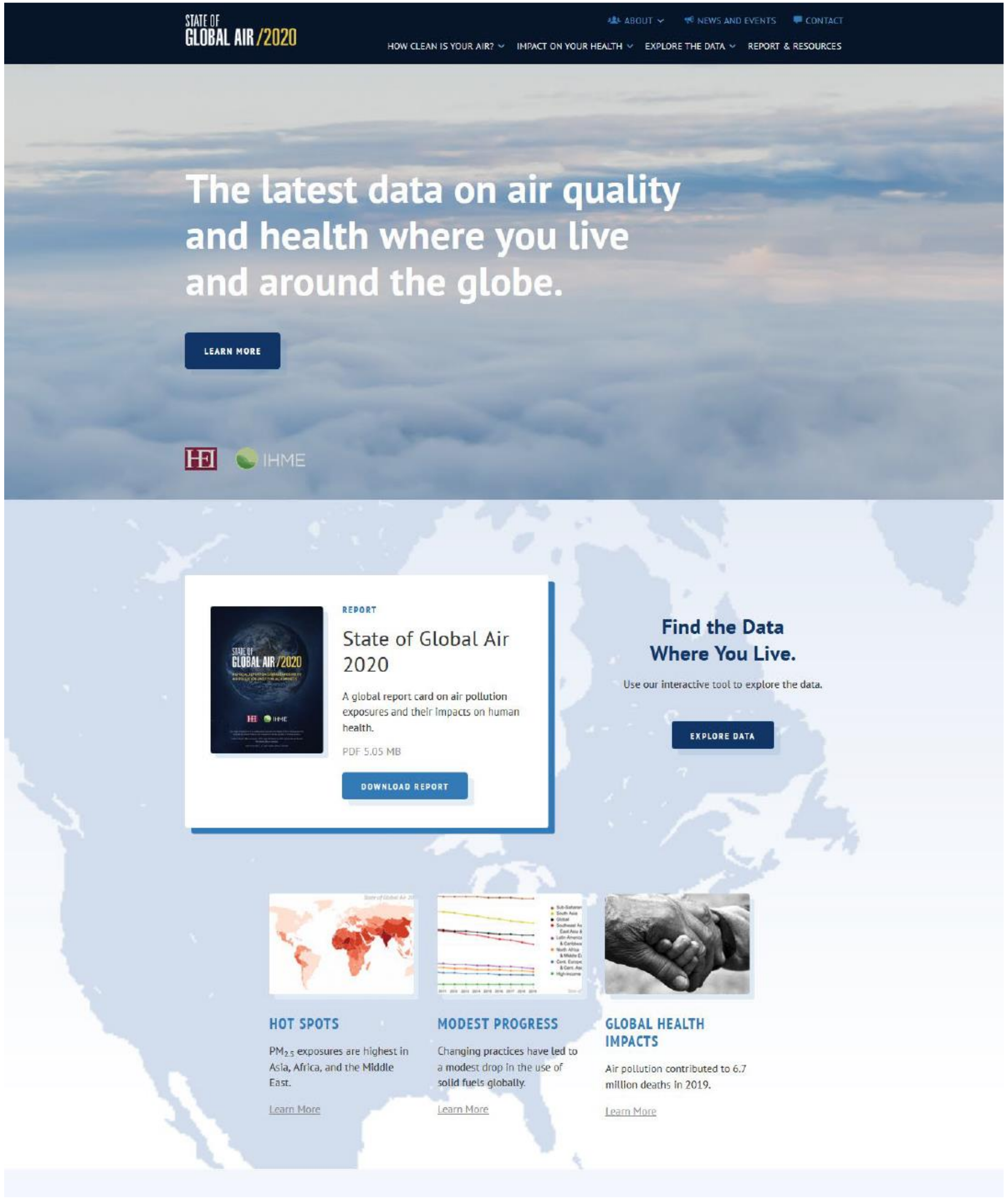
Based on the Annual Global Burden of Disease 2019*

Making data available on air pollution and health

For every country in the world

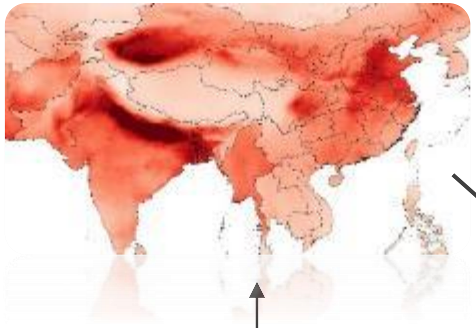
From 1970 to 2019

* Published in *The Lancet October 15, 2020*

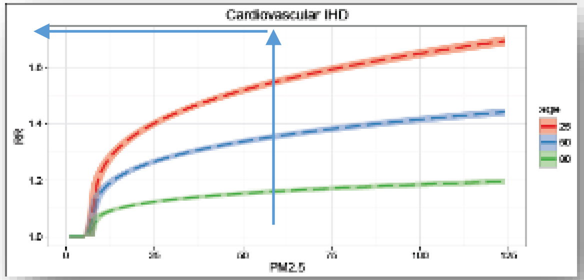


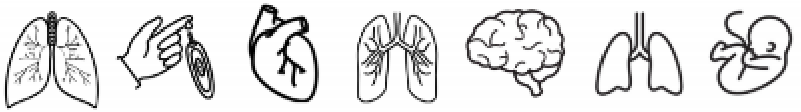
Estimating burden of disease from air pollution

Global population exposures



Exposure-response relationships

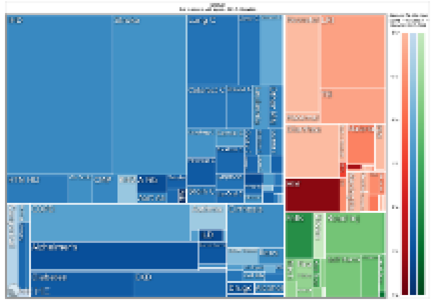




Minimum risk exposure level

Population-attributable fraction due to air pollution

Burden of Disease attributable to Air Pollution

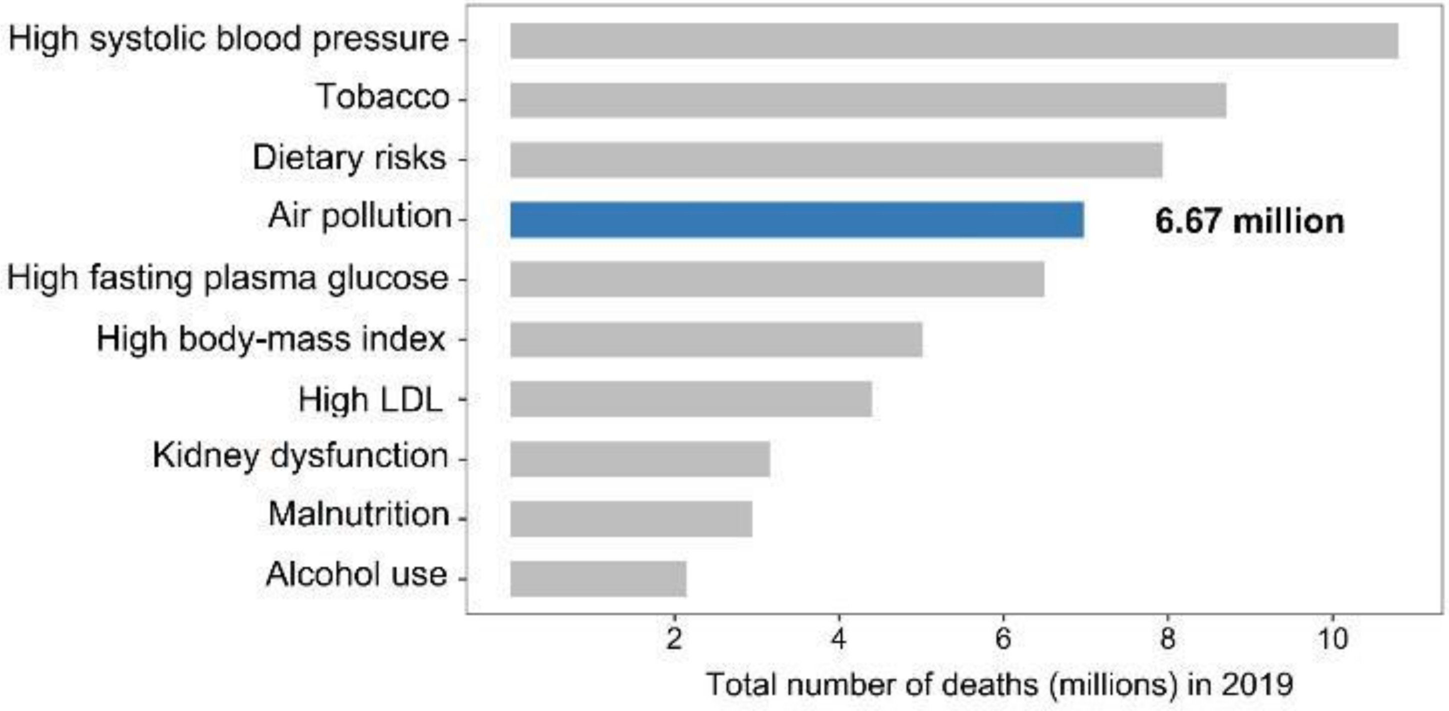


Disease-specific burden

Putting air pollution in perspective
How does it compare to other risks

Air pollution is the 4th leading risk factor for premature death and disability;

In 2019, it accounted for **12% of global deaths**.

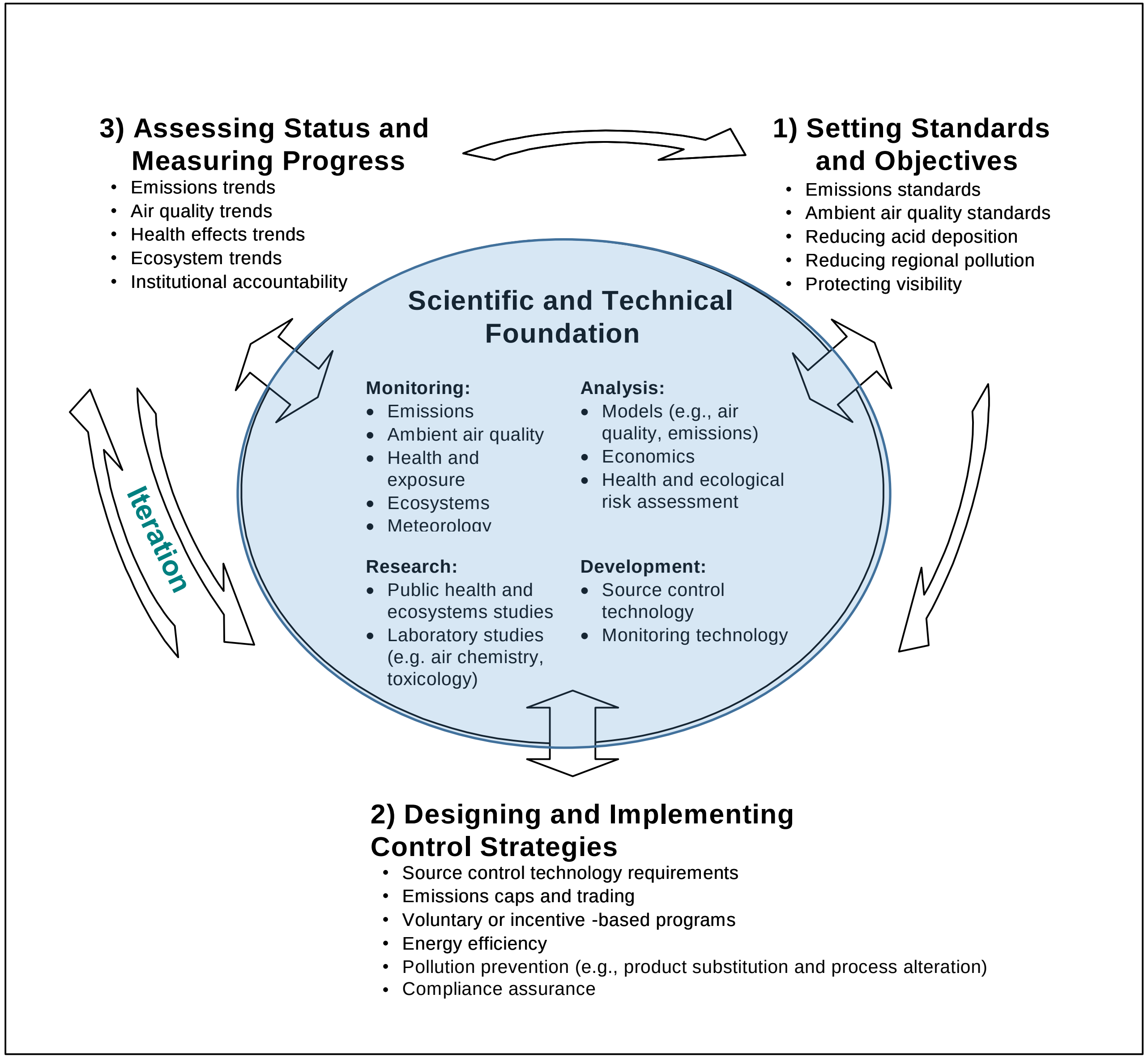


Global ranking of risk factors by total number of deaths from all causes in 2019.

STATE OF GLOBAL AIR /2020

www.stateofglobalair.org

Science Plays an Important Role in Setting Standards



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Many Sources of PM

COAL-FIRED POWER PLANT EMISSIONS

HOUSEHOLD BURNING

VEHICLE EXHAUST

FACTORYEMISSIONS

REFUSE BURNING

SMELTERS

CROP BURNING

FOREST FIRES

India set a standard in 2009; now under review

TABLE 2: NATIONAL AMBIENT AIR QUALITY STANDARDS (NAAQS)

Sr. No	Pollutants	Time Weighted Average	Concentration in Ambient Air	
			Industrial, Residential, Rural, and Other Areas	Ecologically Sensitive Area
1	Sulphur dioxide (SO_2), µg/m³	Annual*	50	20
		24 hours**	80	80
2	Nitrogen dioxide (NO_2), µg/m³	Annual*	40	30
		24 hours**	80	80
3	Particulate matter (Size <10 µm) or PM_{10} µg/m³	Annual*	60	60
		24 hours**	100	100
4	Particulate matter (Size<2.5 µm) or $PM_{2.5}$ µg/m³	Annual*	40	40
		24 hours**	60	60
5	Ozone (O_3), µg/m³	8 hours**	100	100
		1 hours **	180	180
6	Lead (Pb), µg/m³	Annual*	0.50	0.50
		24 hours**	1.0	1.0
7	Carbon monoxide (CO), mg/m³	8 hours**	02	02
		1 hours **	04	04
8	Ammonia (NH_3), µg/m³	Annual*	100	100
		24 hours**	400	400
9	Benzene (C6 H6) , µg/m³	Annual*	05	05
10	Benzo(a) pyrene (BaP)- particulate phase only, ng/m³	Annual*	01	01
11	Arsenic (As), ng/m³	Annual*	06	06
12	Nickel (Ni), ng/m³	Annual*	20	20

* Annual arithematic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals

** 24 hourly or 08 hourly or 01 hourly monitored values,as applicable shall be complied with 98% of the time in a year. 2 % of the time may exceed the limits but not on two consecutive days of monitoring.

Setting Ambient Air Quality Standards

- Their key role in making progress on clean air
  - Studies Used to Set Standards Around the World
  - The Most Recent World Health Organization Air Quality Guidelines
  - Source Emissions, Impacts and use in Air Quality Management
  - Assessing Progress

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4. Assessing whether AQ interventions have actually reduced health impacts:?

"Accountability" studies

- To better test and quantify the consequences of policy actions on air quality and health
- Can help inform whether air quality interventions actually reduced exposures and health impacts
- Potential to improve cost-benefit analyses of future actions
- Challenging to account for other changes in exposures and effects over long periods of time and specific source health impacts