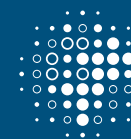


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MAX PLANCK INSTITUTE  
FOR CHEMISTRY

# Air pollution and health



Jos Lelieveld, Andrea Pozzer, Andy Haines, Thomas Münzel

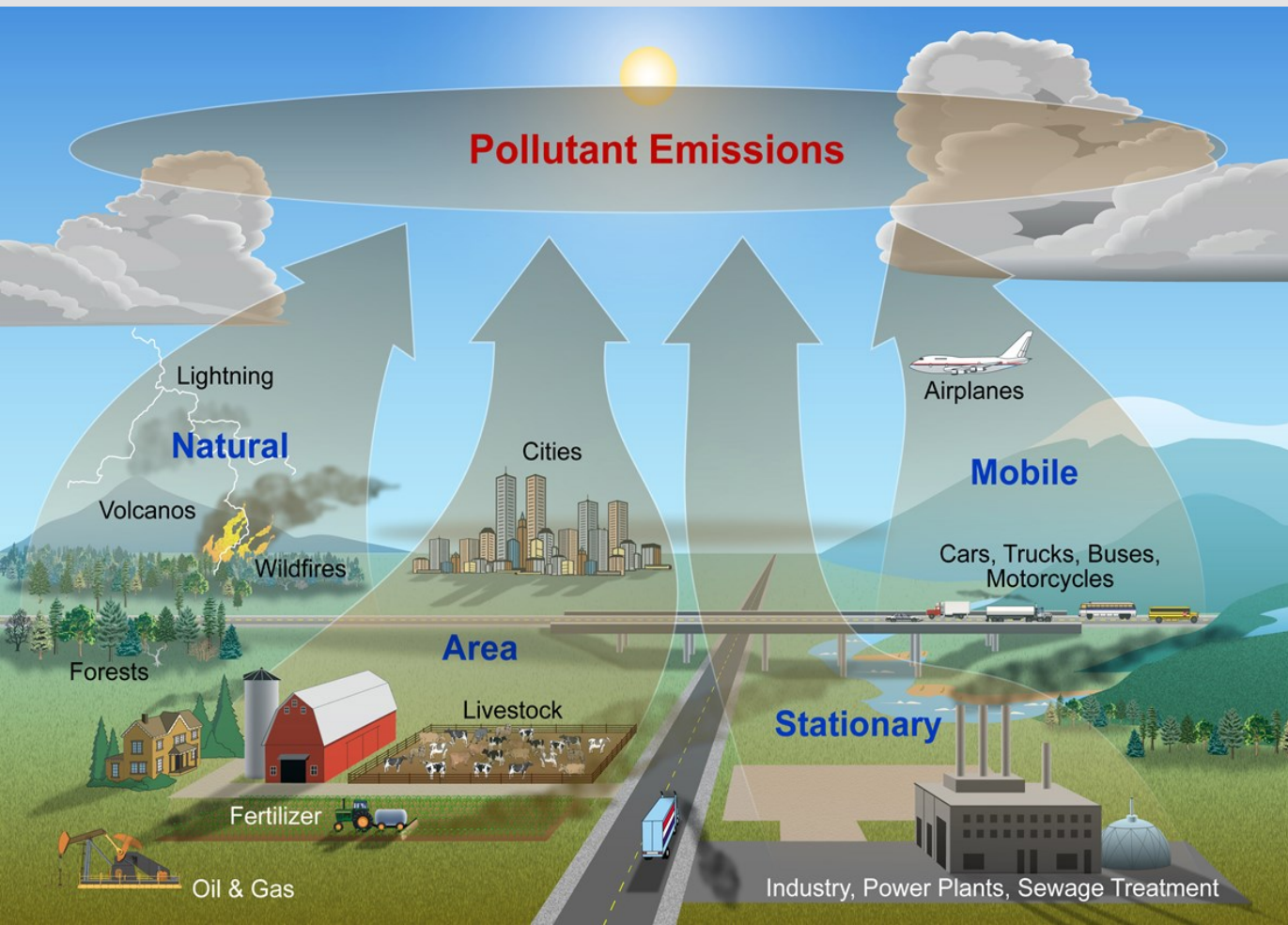
Andreas Daiber, Mohammed Fnais, Ulrich Pöschl, Rick Burnett, Klaus Klingmüller, V. Ramanathan

Lancet Planetary Health, 2, e292, 2018

European Heart Journal, 40, 1590, 2019

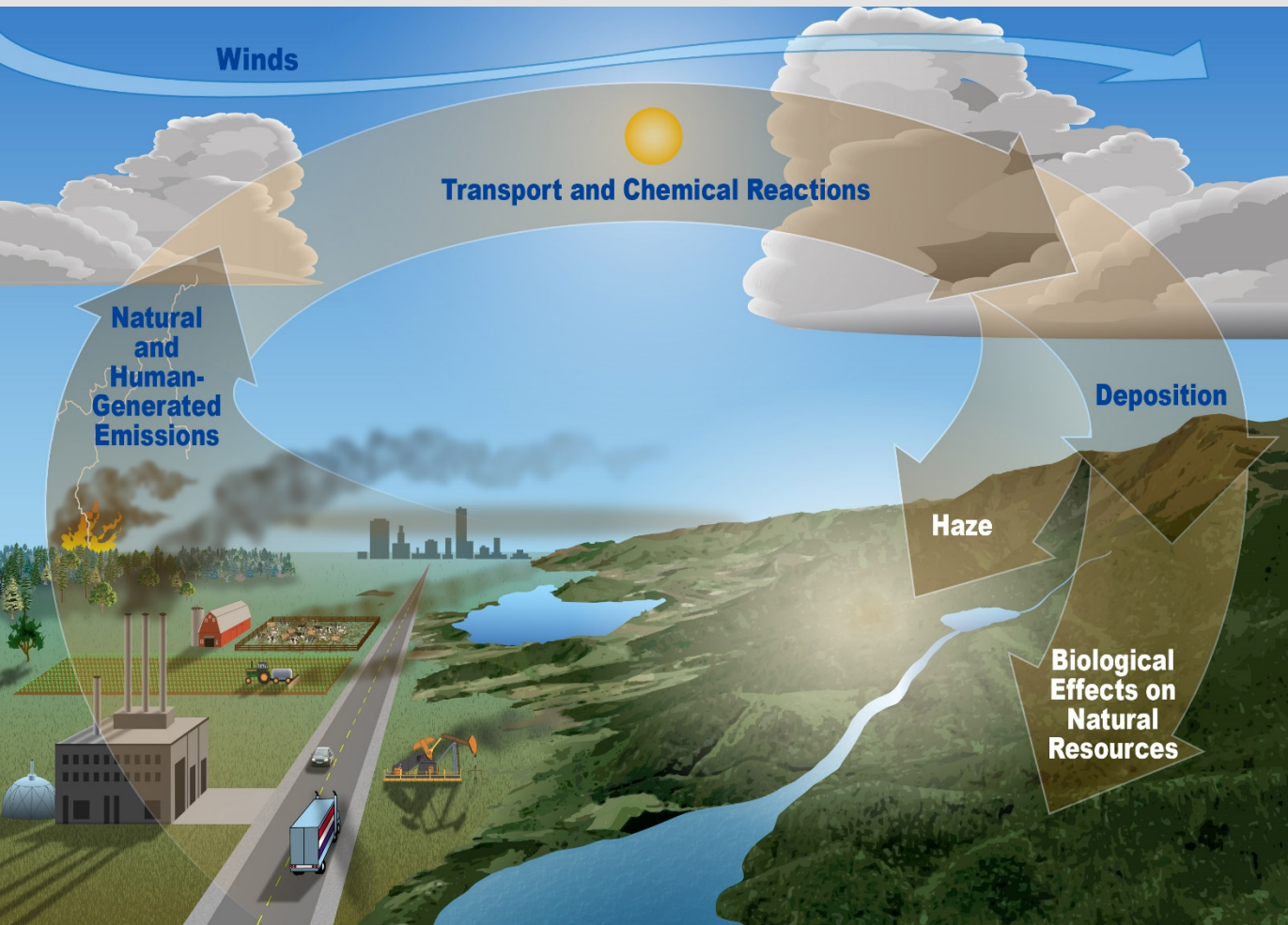
Proc. Natl. Acad. Sci. U.S.A., 116, 7192, 2019

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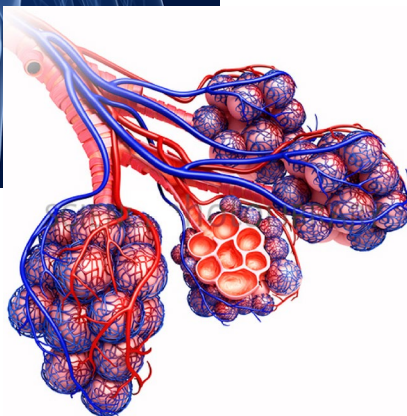
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## Secondary pollutants: O<sub>3</sub> and fine particulates



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## Health impacts of ambient air pollution



Per day you take 20,000 – 25,000 breaths

You inhale 7 – 8 liters of air per minute

Totals about 11,000 liters of air per day

## Health impacts fine particles ( $\text{PM}_{2.5}$ ) and ozone ( $\text{O}_3$ )

### Short term impacts

Coughing, difficulty breathing, asthma, irregular heartbeat

### Long term impacts

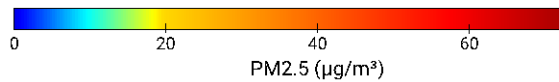
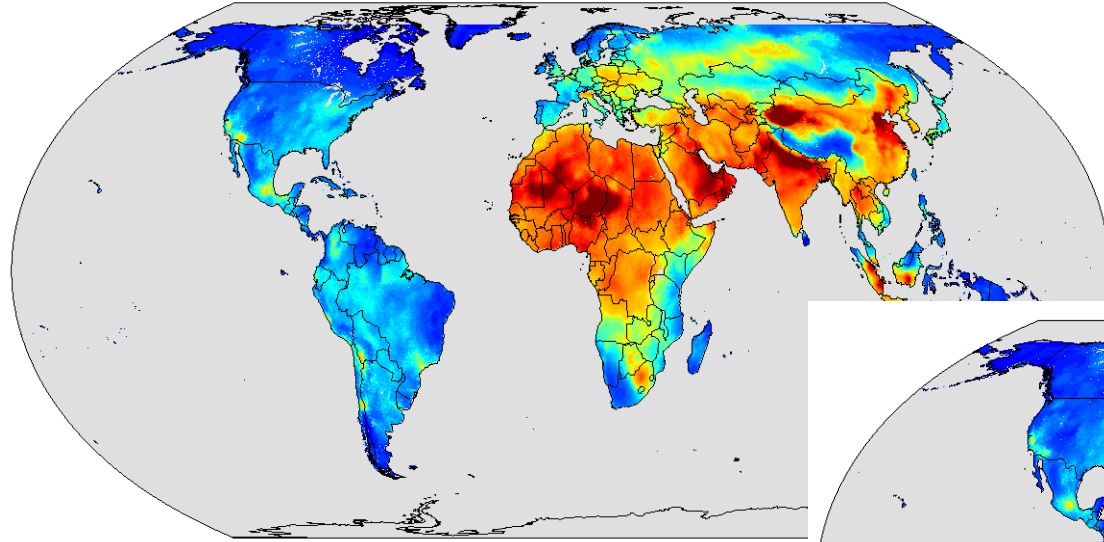
Lower respiratory tract infections (pneumonia), chronic obstructive pulmonary disease (bronchitis), ischemic heart disease (heart attack), cerebrovascular disease (stroke), lung cancer, and other non-communicable diseases

Contribute to hospitalization and loss of life expectancy

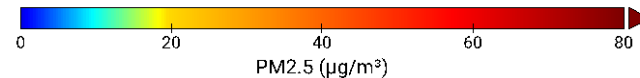
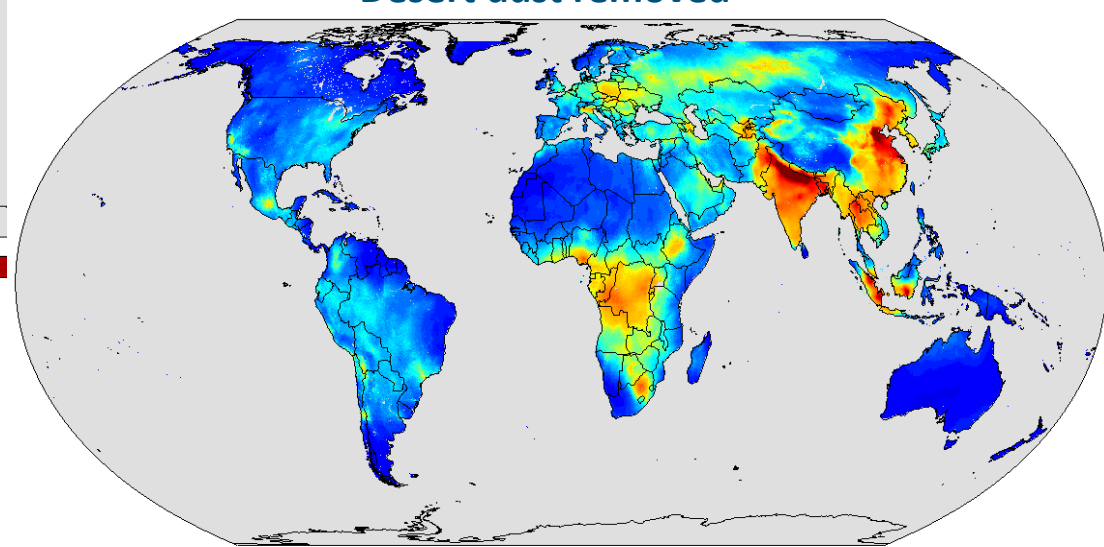
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## Global mean PM<sub>2.5</sub> derived from satellite observations

More than 90% of people (~7 billion) exposed to PM<sub>2.5</sub> levels higher than the WHO air quality guideline of 10  $\mu\text{g}/\text{m}^3$



Desert dust removed



# GBD method to compute excess mortality rates from long-term exposure to air pollution

$$\Delta M = M_o \times AF \times Pop$$

$\Delta M$  = excess mortality rate for different disease categories

$M_o$  = baseline mortality rates related to different disease categories (WHO)

$Pop$  = population exposed to pollutants

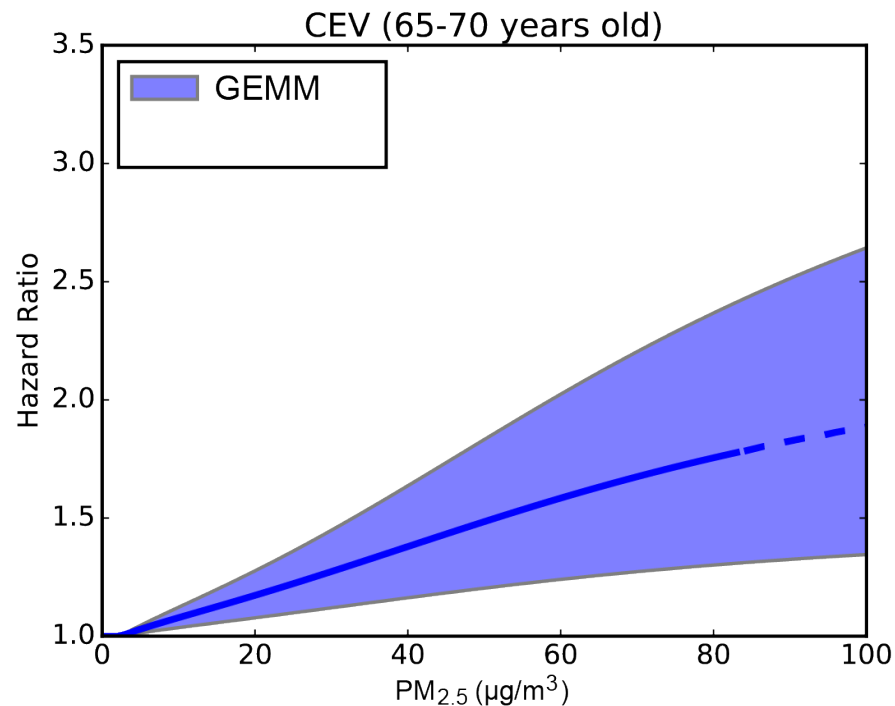
$AF$  =  $[R(z)-1]/R(z)$  is attributable fraction

$R(z)$  = hazard ratio, dependent on concentration  $z$  (Burnett et al., 2018)

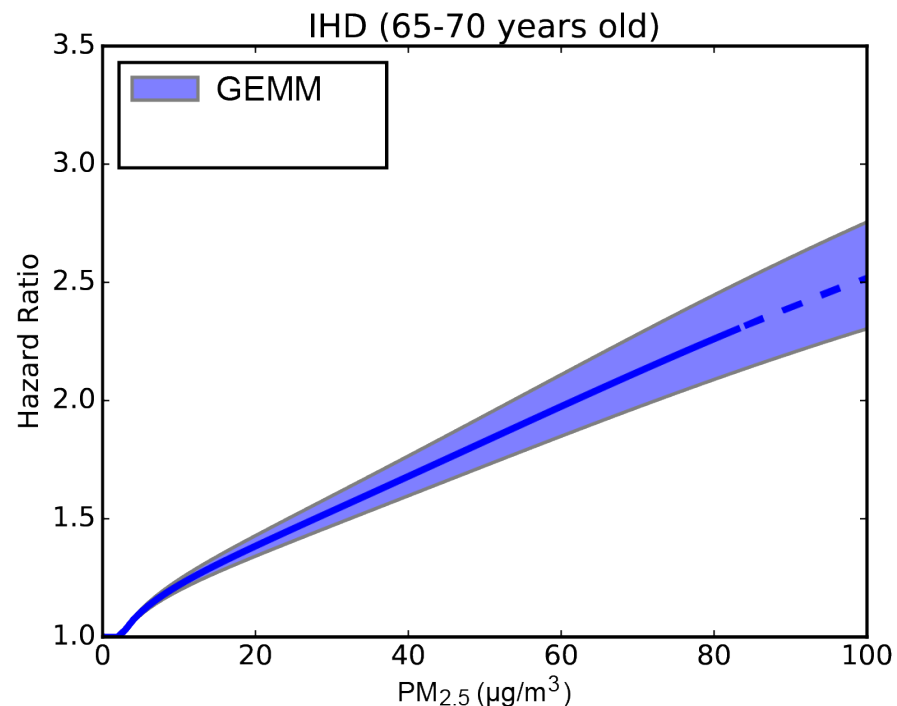
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## New global exposure – mortality model (GEMM)

from 41 cohort studies in 16 countries (Burnett et al., PNAS, 2018)



CEV is cerebrovascular disease (stroke)



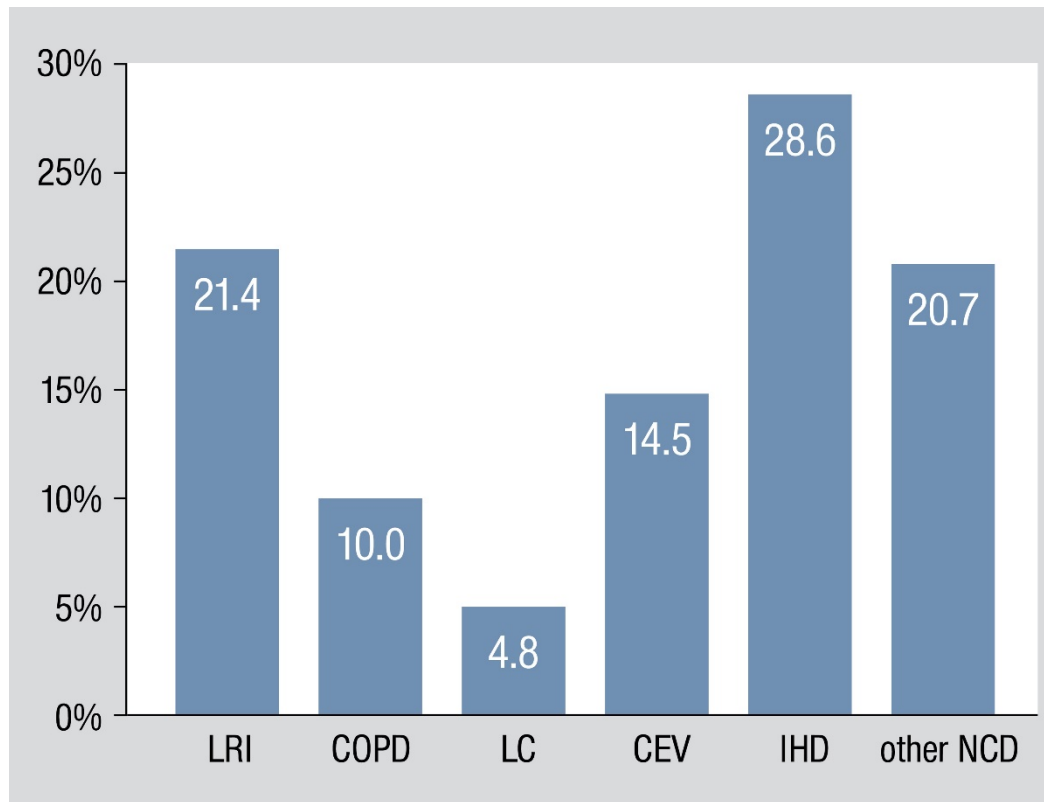
IHD is ischemic heart disease



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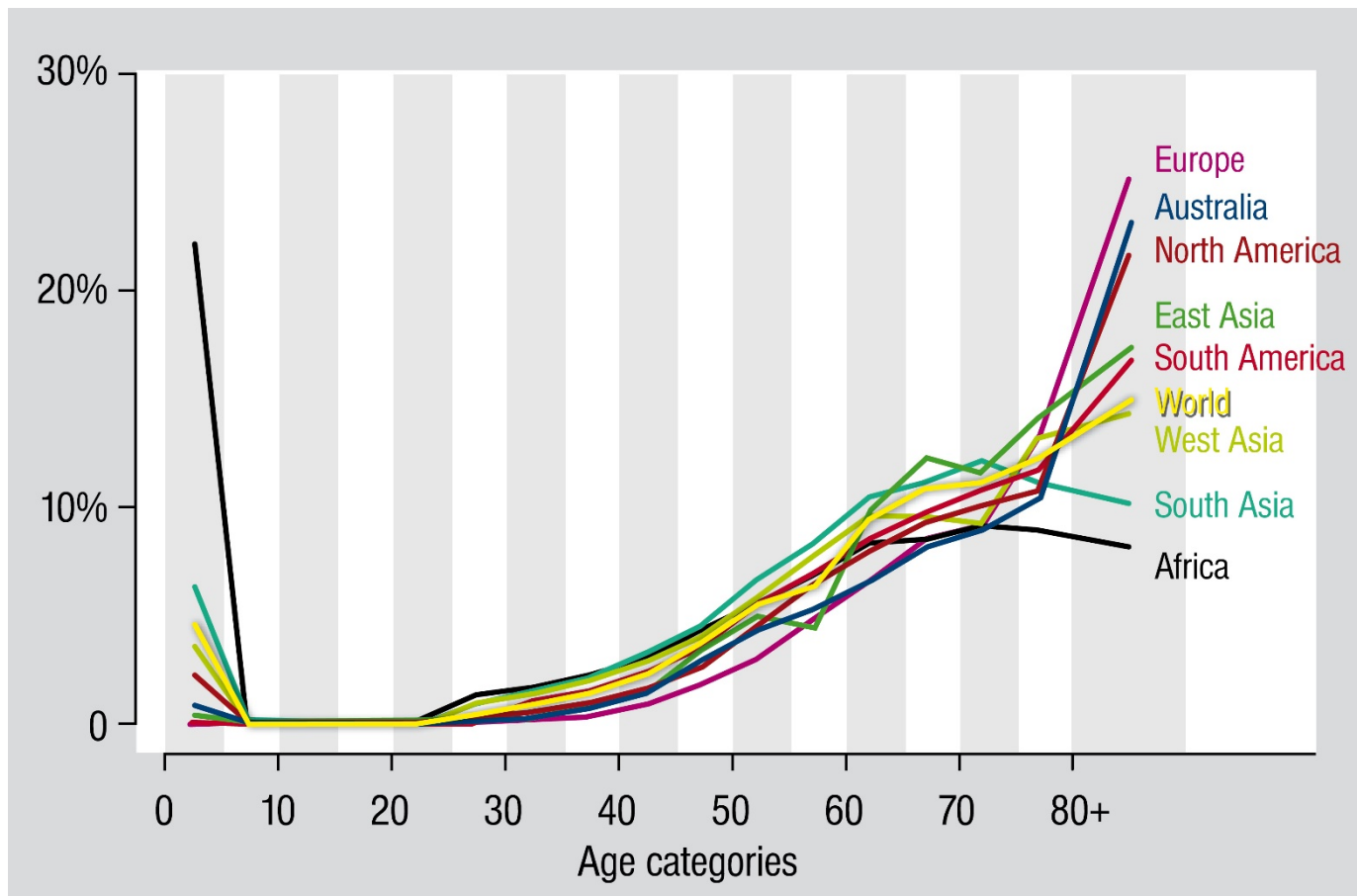
## Global mortality rates from ambient air pollution

Total is **8.8 million/year** (Global Burden of Disease 2015 – **4.5 million/year**)



Lower respiratory tract infections (LRI), Chronic obstructive pulmonary disease (COPD), Lung cancer (LC), Cerebrovascular disease, stroke (CEV), Ischaemic heart disease (IHD), Other non-communicable diseases (NCD)

## Relative contributions to excess mortality from air pollution for 5-year age categories

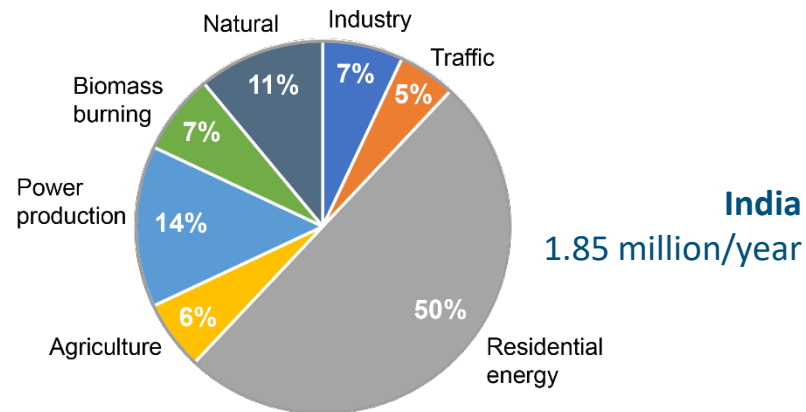
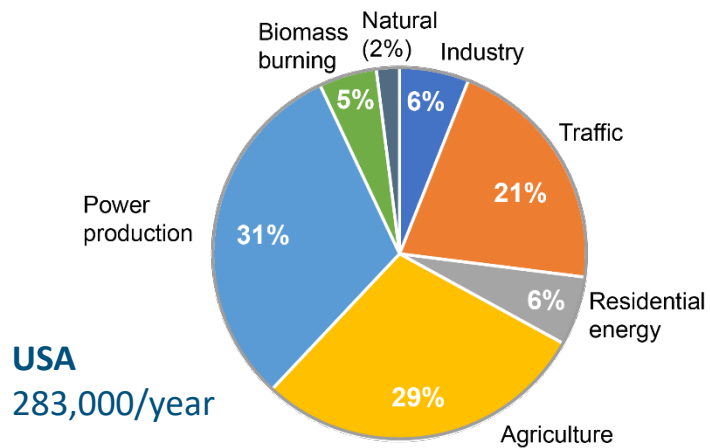
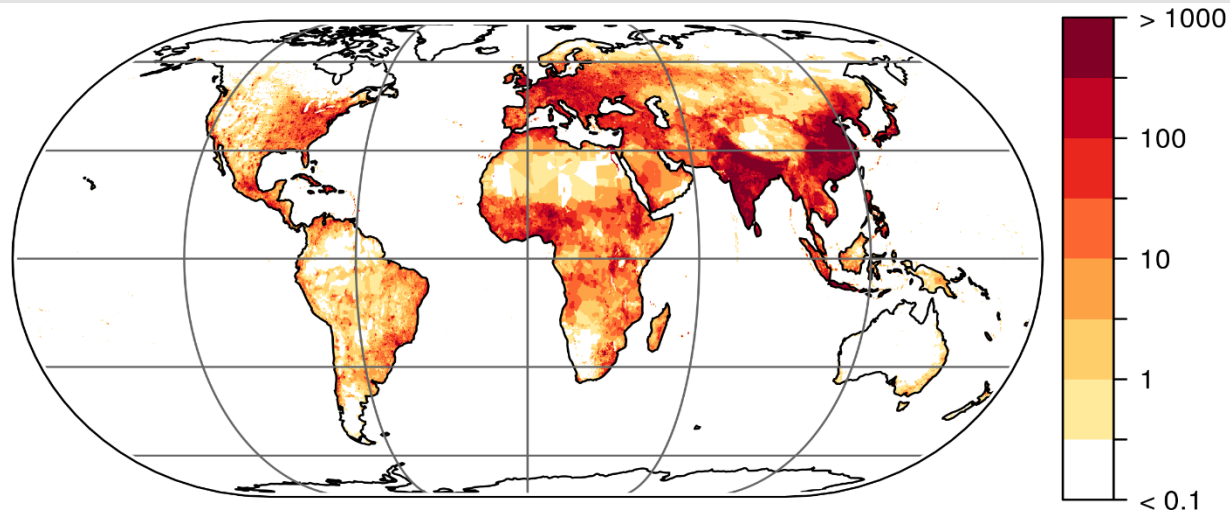


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# Global mortality rates from ambient air pollution

Units: Individuals per area of 1,000 km<sup>2</sup>/year

Global total is about **8.8 million/year**



## Summary

Mortality rate attributable to ambient air pollution is about **8.8** million/year, in France **67,300**/year

Is the main global environmental health risk, and one of the “top five” overall (with hypertension, tobacco smoking, diabetes and high cholesterol)

The global life expectancy reduction from air pollution is **2.9** years, and in France **1.6** years

For comparison: The excess death rate from tobacco smoking is **7.2** million/year, from HIV/AIDS 940,000/year, and malaria 440,000/year