Air Pollution and Health: An Integrated Agenda

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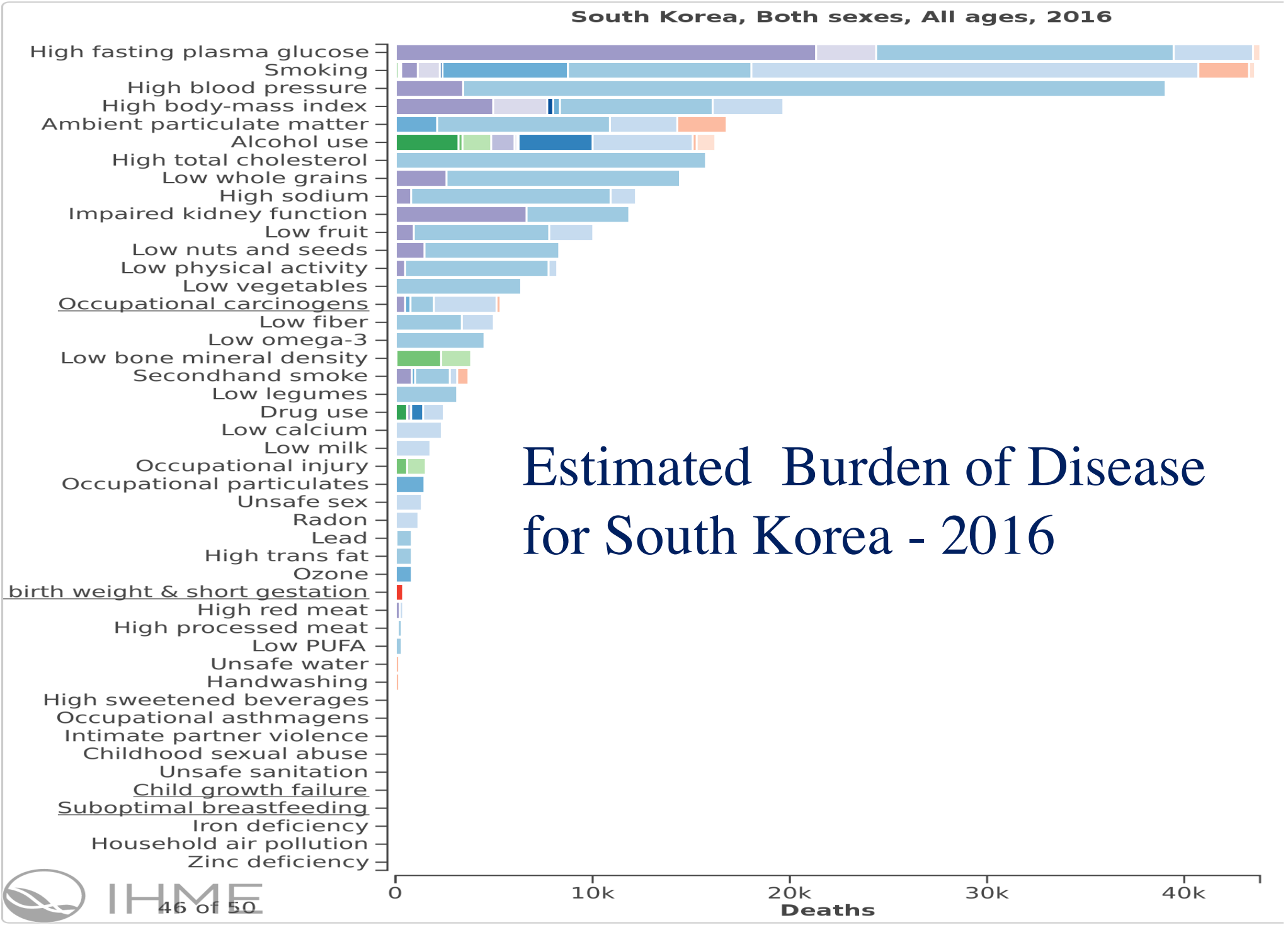
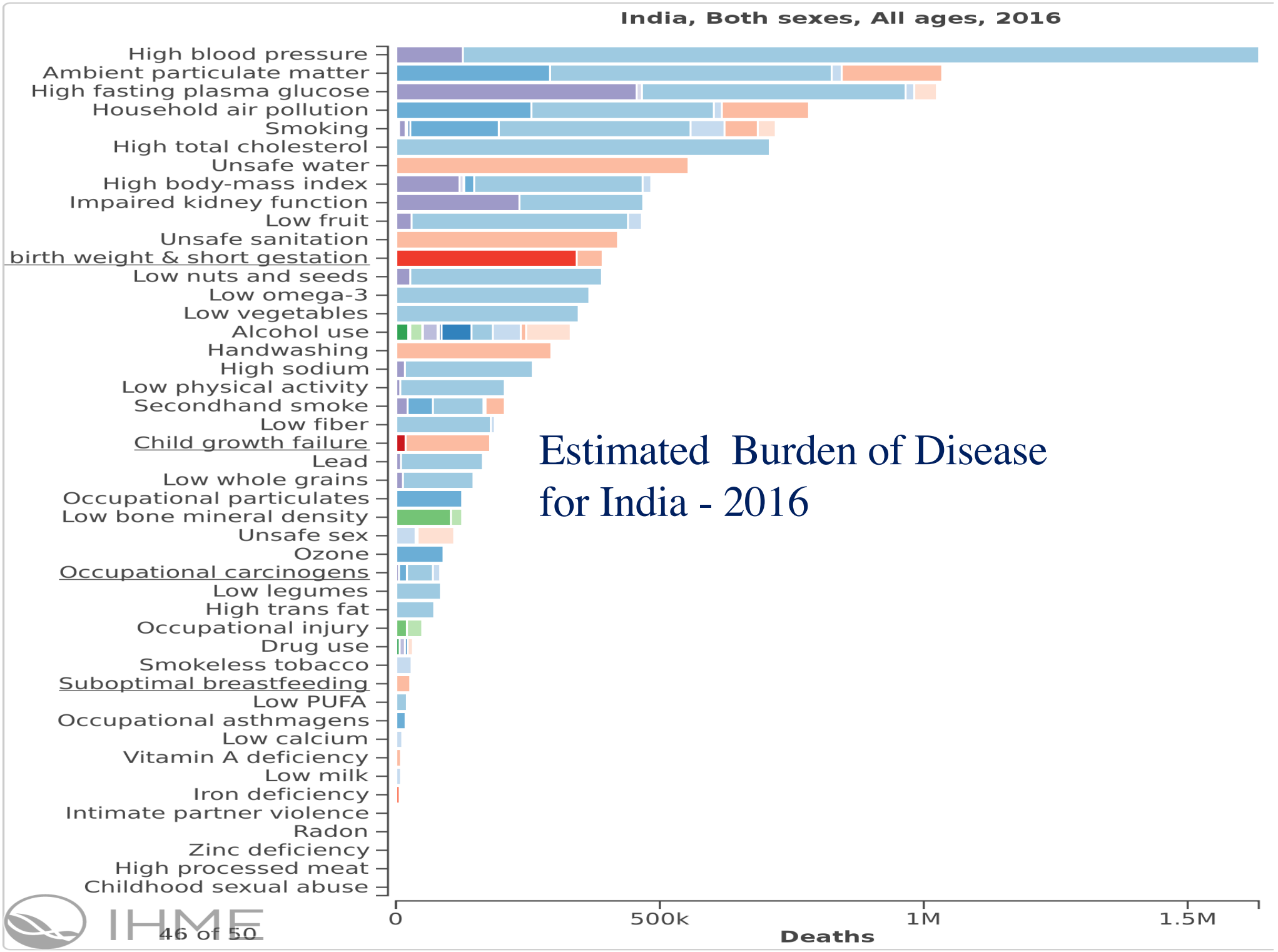
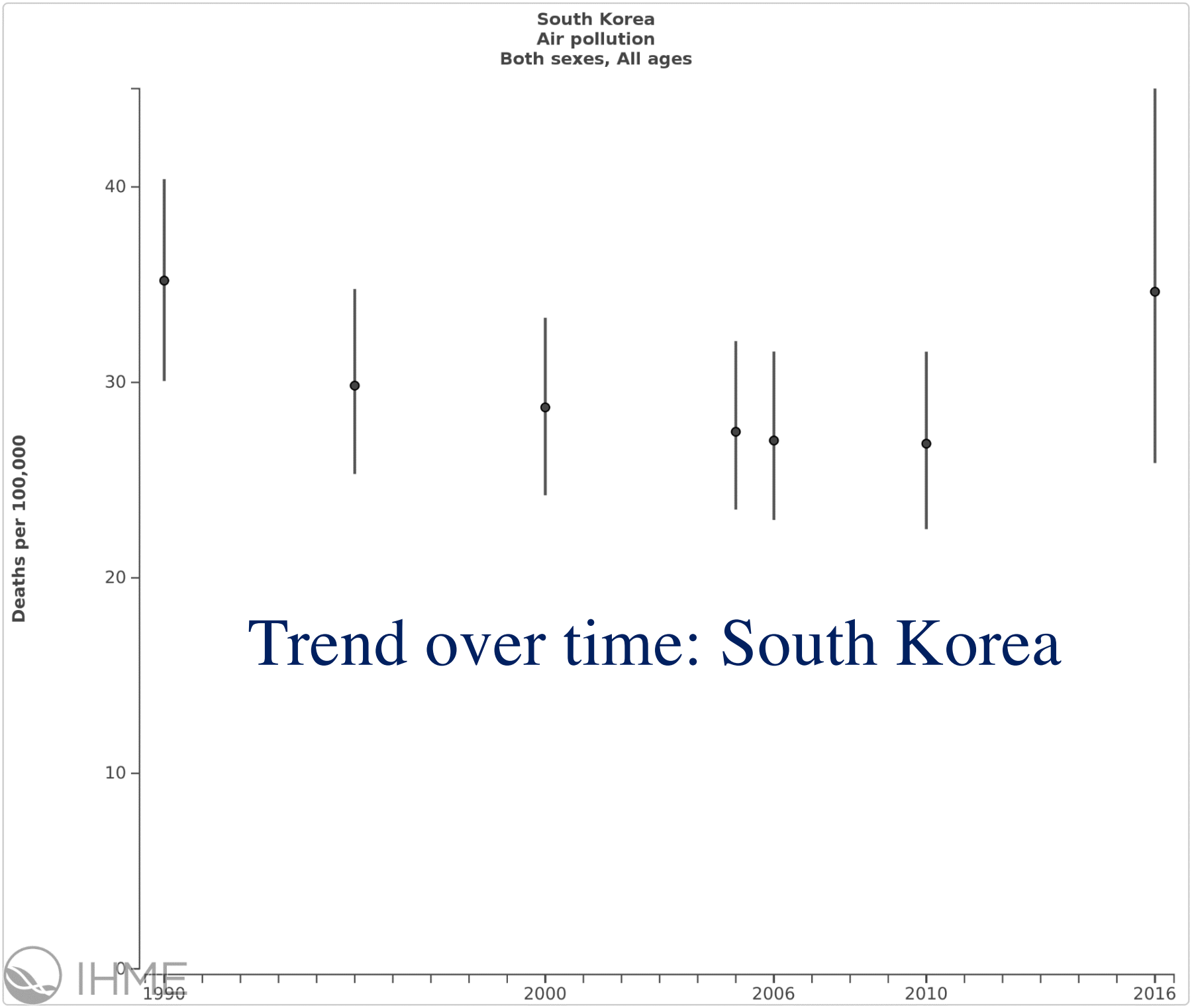
Summary

- How air pollution can be better controlled by taking a total exposure approach
- The example of India

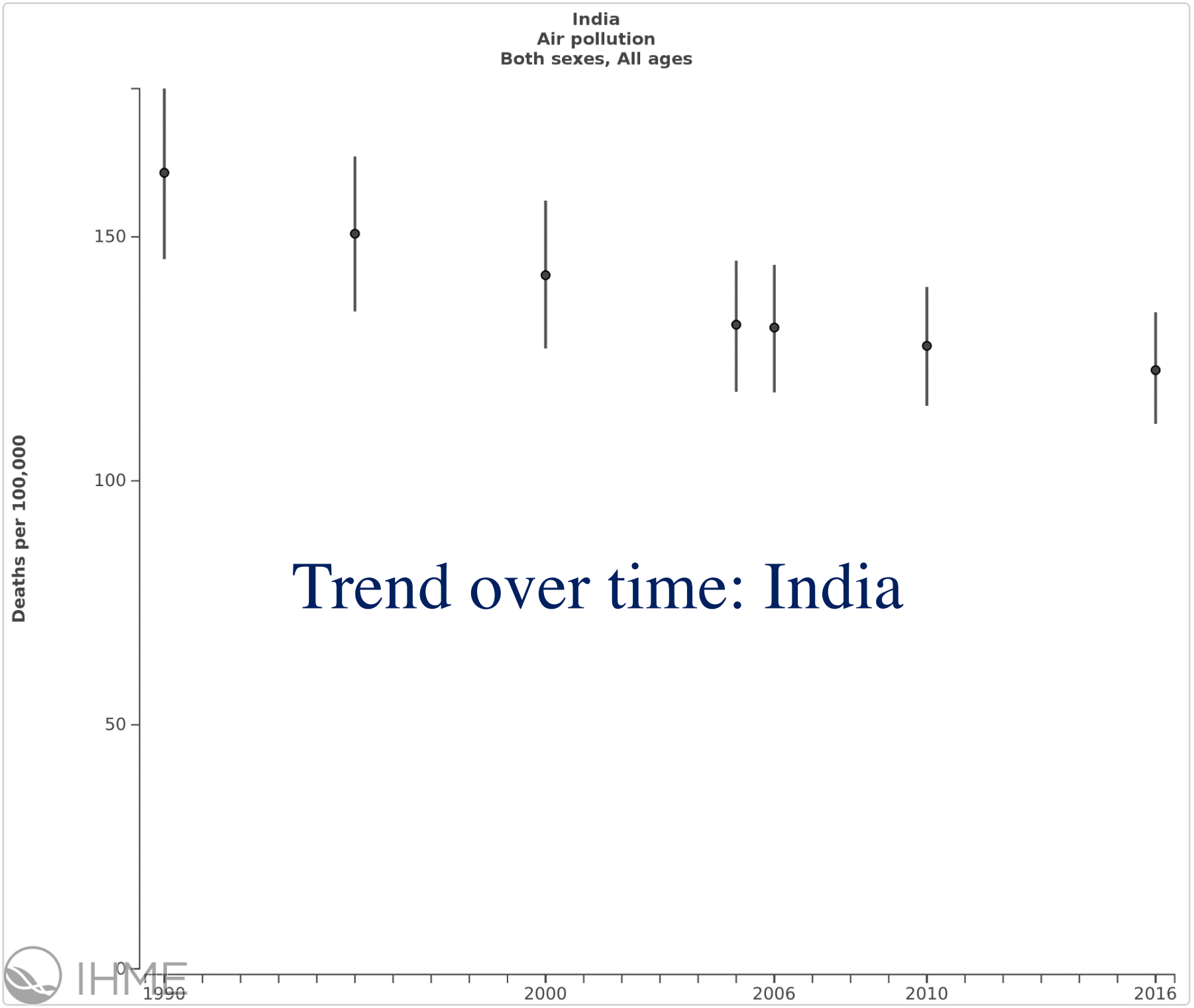


Estimated Burden of Disease for South Korea - 2016

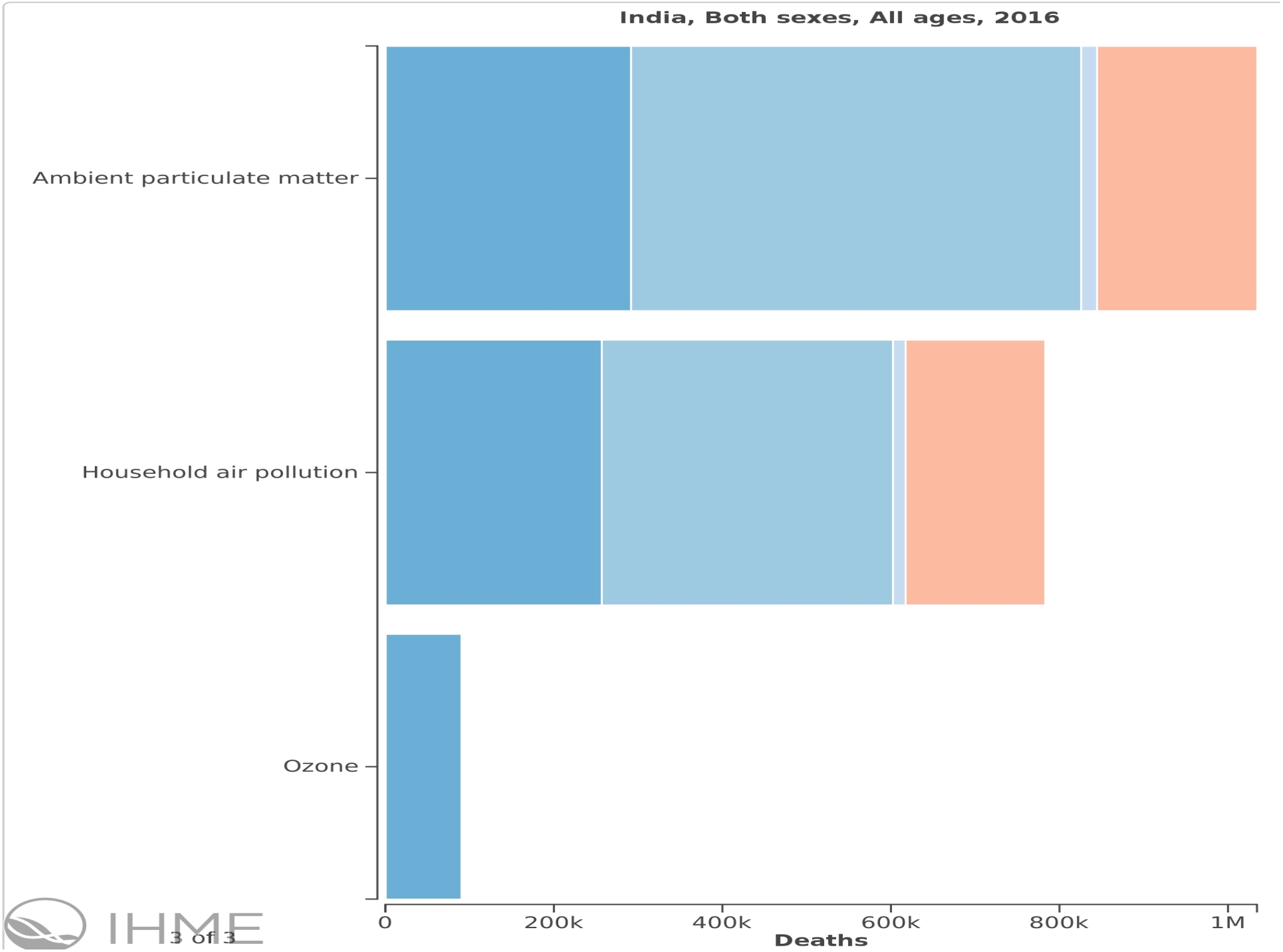

India, Both sexes, All ages, 2016
High blood pressure
Ambient particulate matter
High fasting plasma glucose
Household air pollution
Smoking
High total cholesterol
Unsafe water
High body-mass index
Impaired kidney function
Low fruit
Unsafe sanitation
birth weight & short gestation
Low nuts and seeds
Low omega-3
Low vegetables
Alcohol use
Handwashing
High sodium
Low physical activity
Secondhand smoke
Low fiber
Child growth failure
Lead
Low whole grains
Occupational particulates
Low bone mineral density
Unsafe sex
Ozone
Occupational carcinogens
Low legumes
High trans fat
Occupational injury
Drug use
Smokeless tobacco
Suboptimal breastfeeding
Low PUFA
Occupational asthmagens
Low calcium
Vitamin A deficiency
Low milk
Iron deficiency
Intimate partner violence
Radon
Zinc deficiency
High processed meat
Childhood sexual abuse
0
500k
1M
1.5M
Deaths
Estimated Burden of Disease
for India - 2016



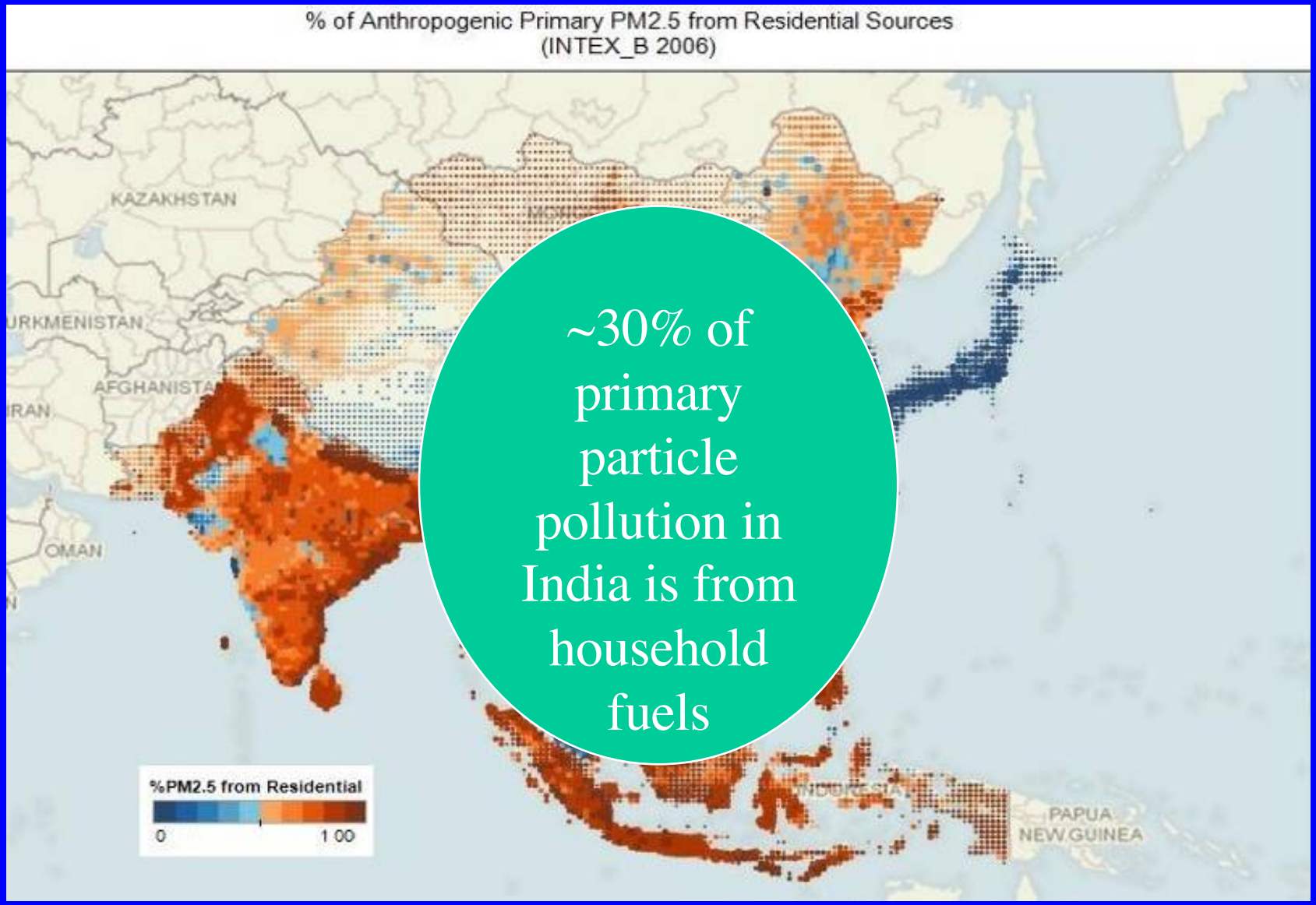
Trend over time: South Korea



Trend over time: India


India, Both sexes, All ages, 2016
Ambient particulate matter
Household air pollution
Ozone
0
200k
400k
600k
800k
1M
Deaths

%$PM_{2.5}$ from "Residential" Emissions : NASA



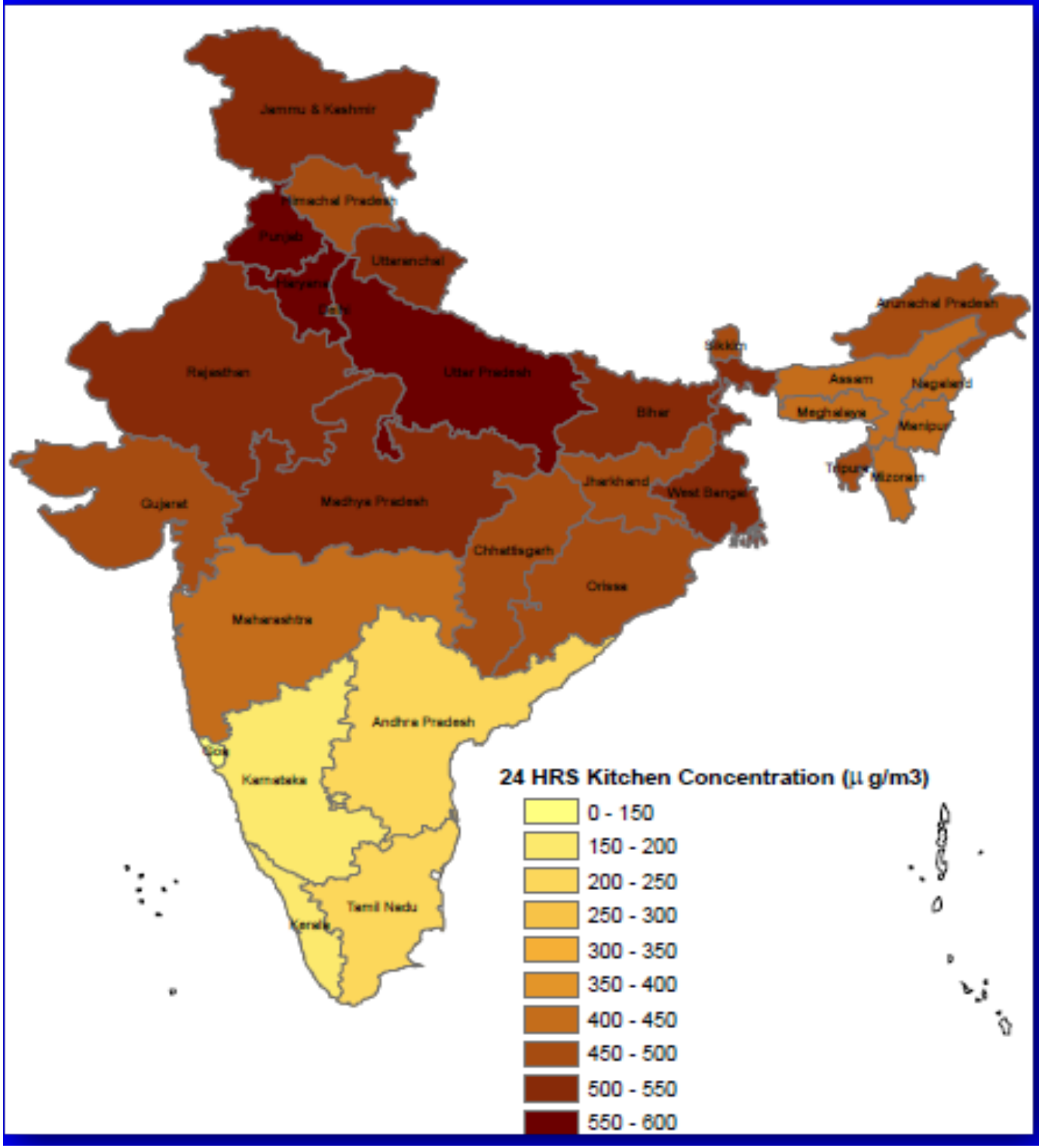
~30% of primary particle pollution in India is from household fuels

Source: Asian Emission Inventory for NASA INTEX_B 2006 (accessed 2010)

Chafe, 2010

Household Air Pollution from Solid Cooking Fuels in India

- Biggest impact in adults ~0.6-1.0 million premature deaths (two-thirds the DALYs)
- Still important for children ~40-60 thousand deaths (one-third the DALYs)
- Biggest single risk factor of any examined for Indian women and girls
- Important source of outdoor air pollution - ~30% in India



State-wise estimates of 24-h kitchen concentrations of PM2.5 in India

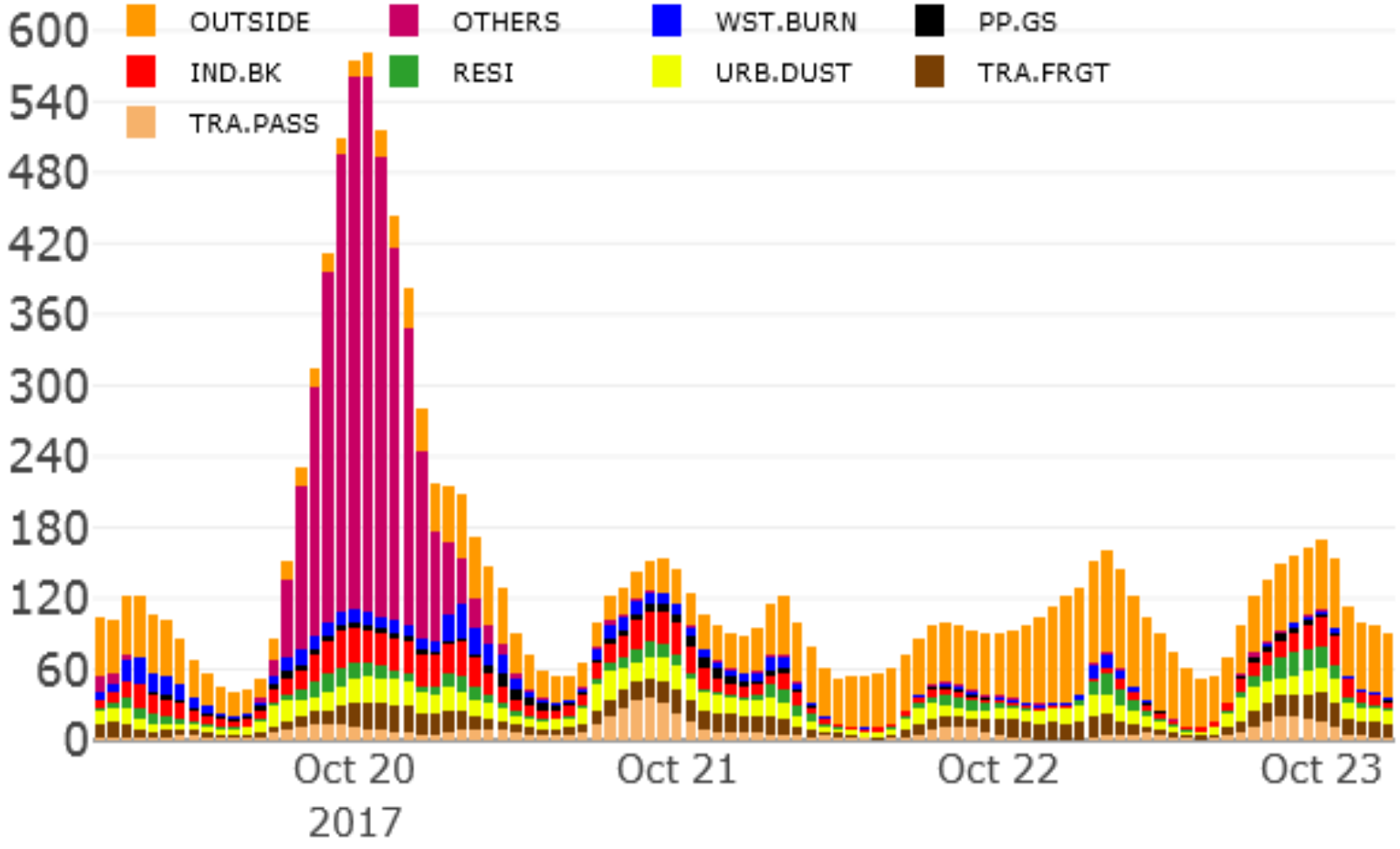
Solid-fuel using households

GBD

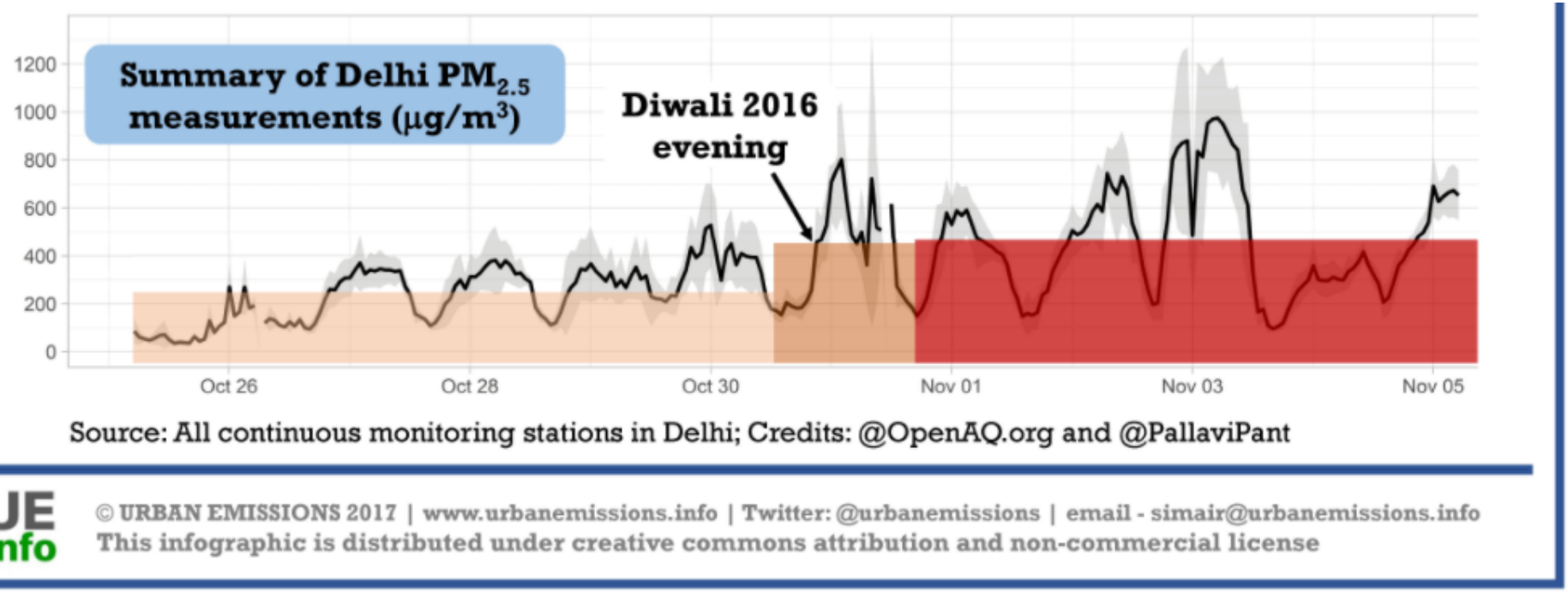
Ambient Air Pollution in India

- Largest environmental risk factor: 0.8-1.2 million deaths
- Largest health impact per capita in the world
- Many sources, both traditional and modern
- Many polluted cities, but rural areas also dirty

REGION: Urban Built-up Area of NCR Delhi
Modeled PM2.5 Source Contributions in µg/m3



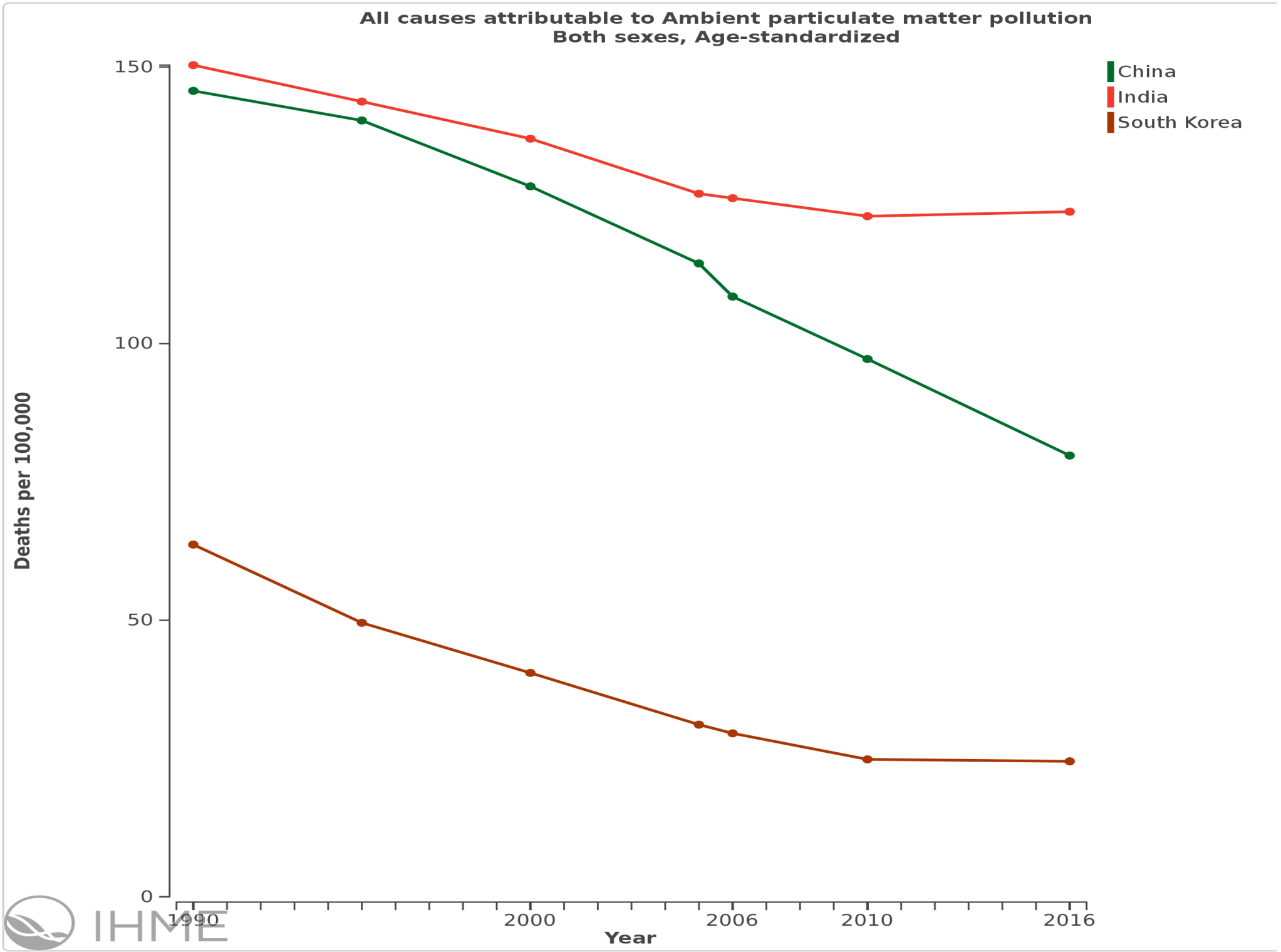
WRF-CAMx forecasts; average of ~1600 1kmx1km urban grids of NCR. System details @ http://www.delhiairquality.info



Delhi's pollution in 2016 – note effects of

1) the holiday (Diwali) and

2) crop residue burning


All causes attributable to Ambient particulate matter pollution
Both sexes, Age-standardized
China
India
South Korea
150
100
50
0
Deaths per 100,000
1990
2000
2006
2010
2016
Year
IHME

Ministry of Health and Family Welfare Air Pollution Task Force

- First Ministry of Health in world to treat AP as one of its major priorities and consider along with other risk factors in its mission
- First government agency in the world not to address AP by location, but by total exposure – a true health focus
- Thus, not indoor/household, not outdoor, but by what will give the most health benefit

MoHFW AP Task Force

- One way of utilizing the total exposure approach is to estimate intake fraction by source category.
- Broken into “near field” and “ambient” intake fractions
- Emissions weighted essentially by proximity to population
- Goal is to change source apportionment to exposure apportionment

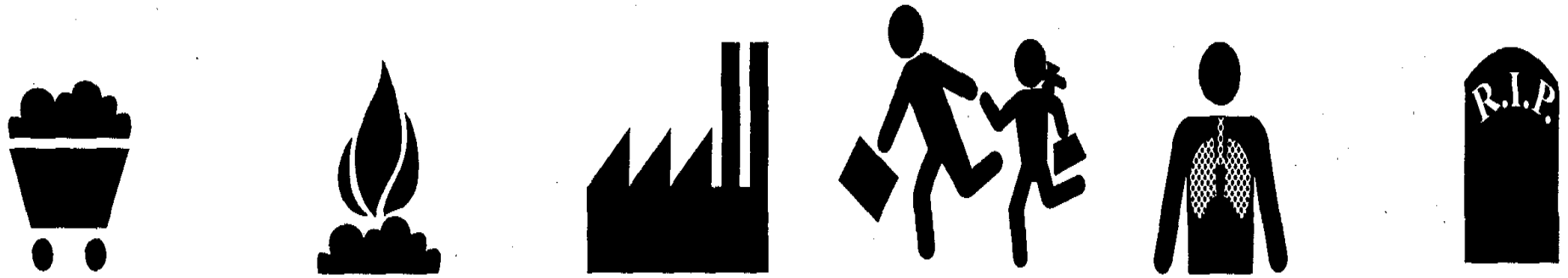
Introduction to Intake Fraction:

The quantification for policy of total exposure assessment

The Environmental Health Pathway

Environmental Pathway is different for different emission sources

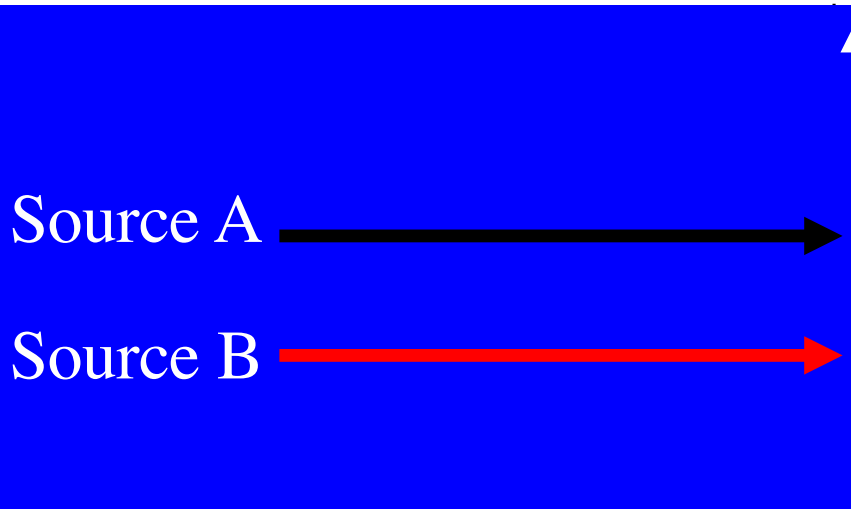
SOURCE → EMISSIONS → CONCENTRATION → EXPOSURE → DOSE → HEALTH EFFECTS



Where are the people?

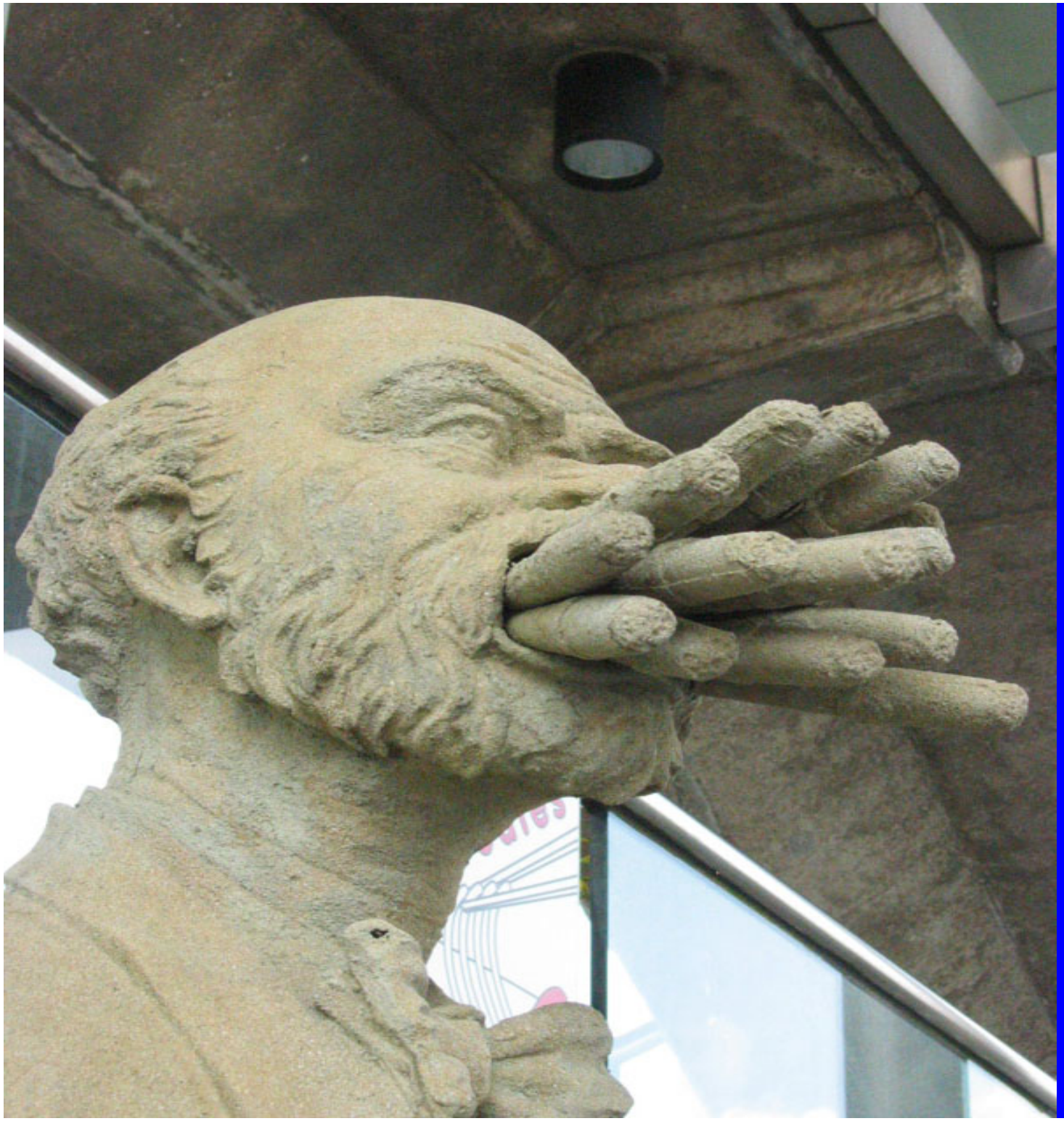
- **How many, where, when, and for how long?**
- **Which kind of people (age, sex, health status) doing what (resting, working)**

Environmental Pathway



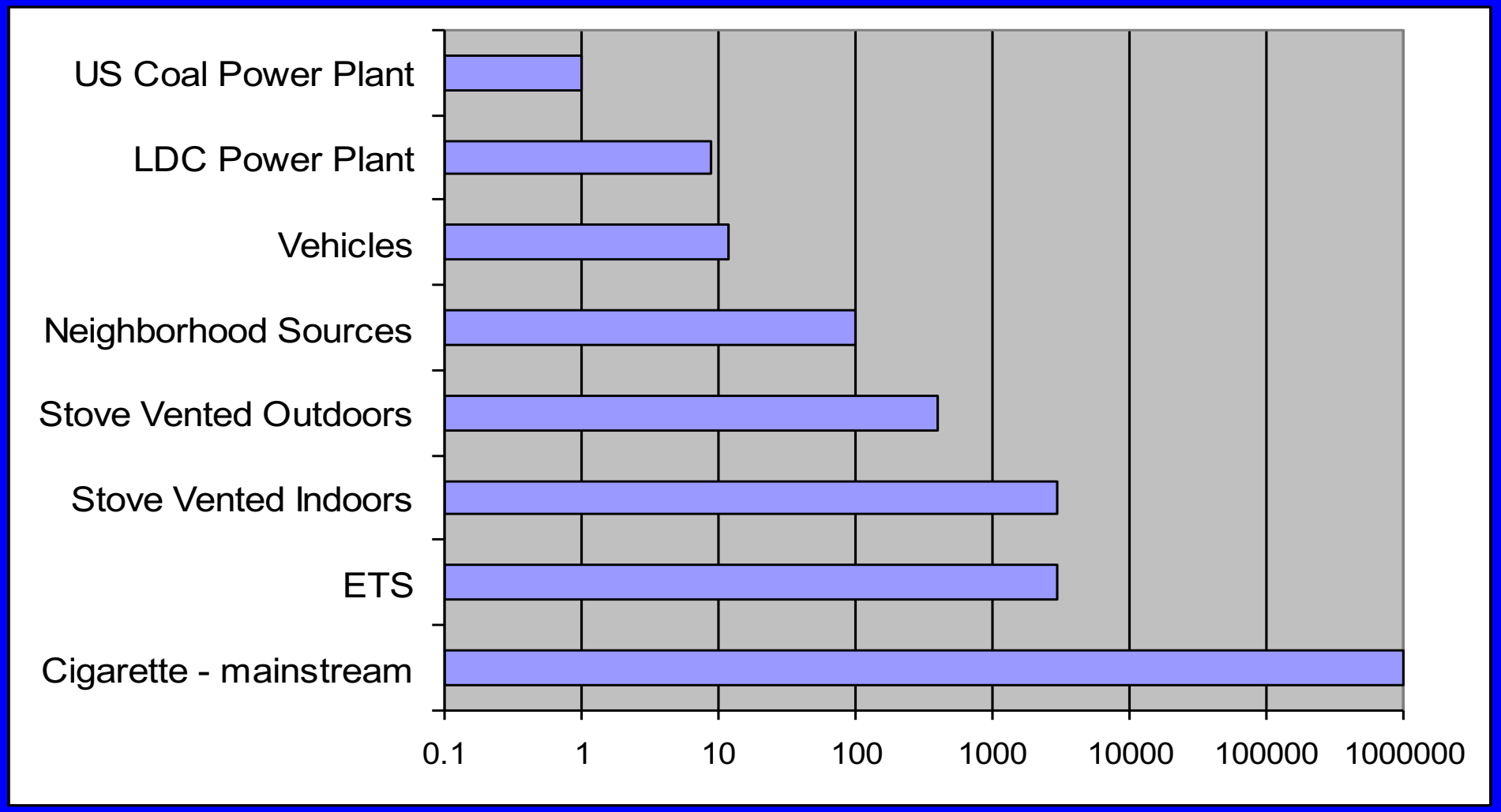
Much of the essence of exposure assessment can be captured by the concept of *Intake Fraction (IF)*

- *IF* is the fraction of material emitted that crosses some person's physiological barriers (skin, GI tract, Resp. tract, etc.)
- For air pollution, *IF* is the fraction breathed in by the exposed population.



IF = 1.0

Intake Fraction Varies as Much as Toxicity (these are rough calculations for typical examples of sources in each class)



Smith, 1993

Grams Inhaled per Tonne Emitted

Power of Intake Fraction

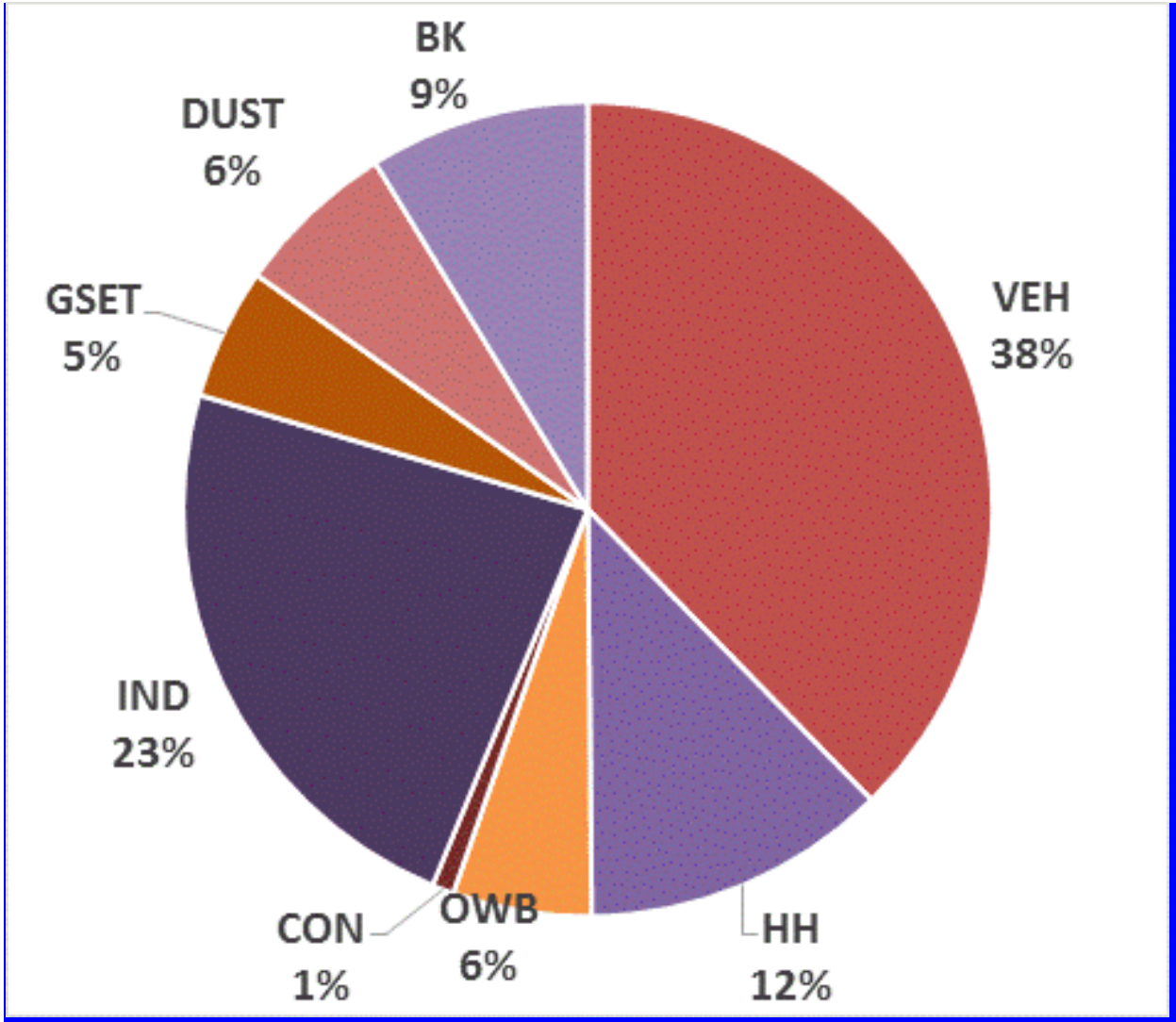
- "Rule of One Thousand" = Pollutants released indoors are 1000 times more likely to reach someone's lungs than if released outdoors.
- Sample comparison: U.S. power plant versus cigarettes
  - Source:
    - 1 ton coal = 1 million cigarettes (1 g each)
  - Emissions of particles
    - 1 ton coal = 24,000 cigarettes
  - Approximate particle intake equivalence
    - 1 ton coal = 24 cigarettes (ETS)
- Thus, even though there are more than 40 times more primary particles released from coal power plants in the US than from cigarettes, less than a 2-5% reduction in passive smoking (ETS exposures) would be equivalent to eliminating all the power plants in the country in terms of particle exposure.

Smith, 1988

Comparisons of Annual Population Intakes in California Based on IF Calculations

- Vehicles
  - 140 t CO
  - 12-40 kg benzene
  - 400 kg PM
- ETS
  - 8 t CO
  - 35 kg benzene
  - 1300 kg PM

Nazaroff & Lai, 2000



Hyderabad-2012

Emissions – $PM_{2.5}$

Draft MOHFW Report
estimates by Guttikunda

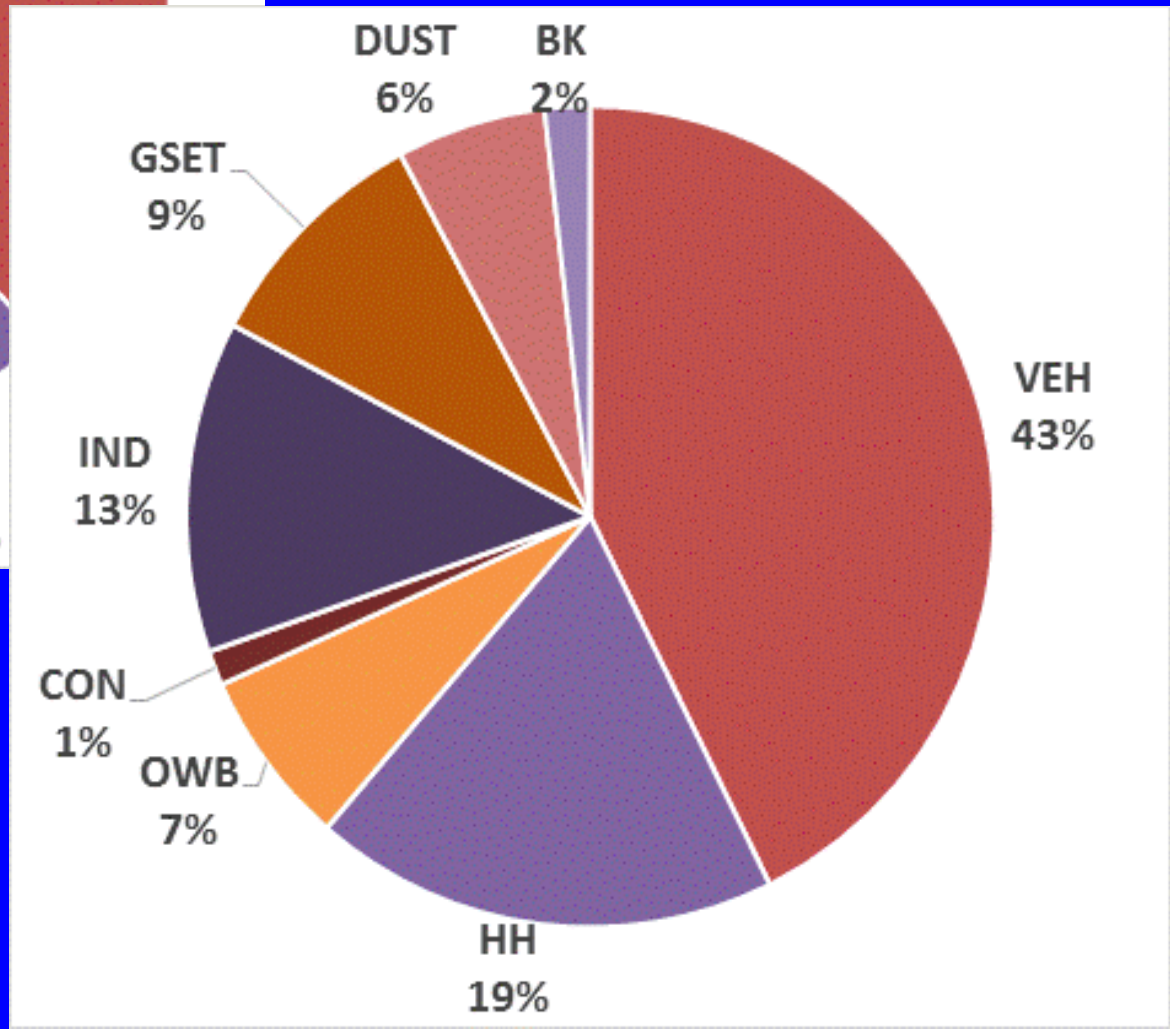
Ambient Intake Fractions in Hyderabad

ppm – grams inhaled per tonne emitted

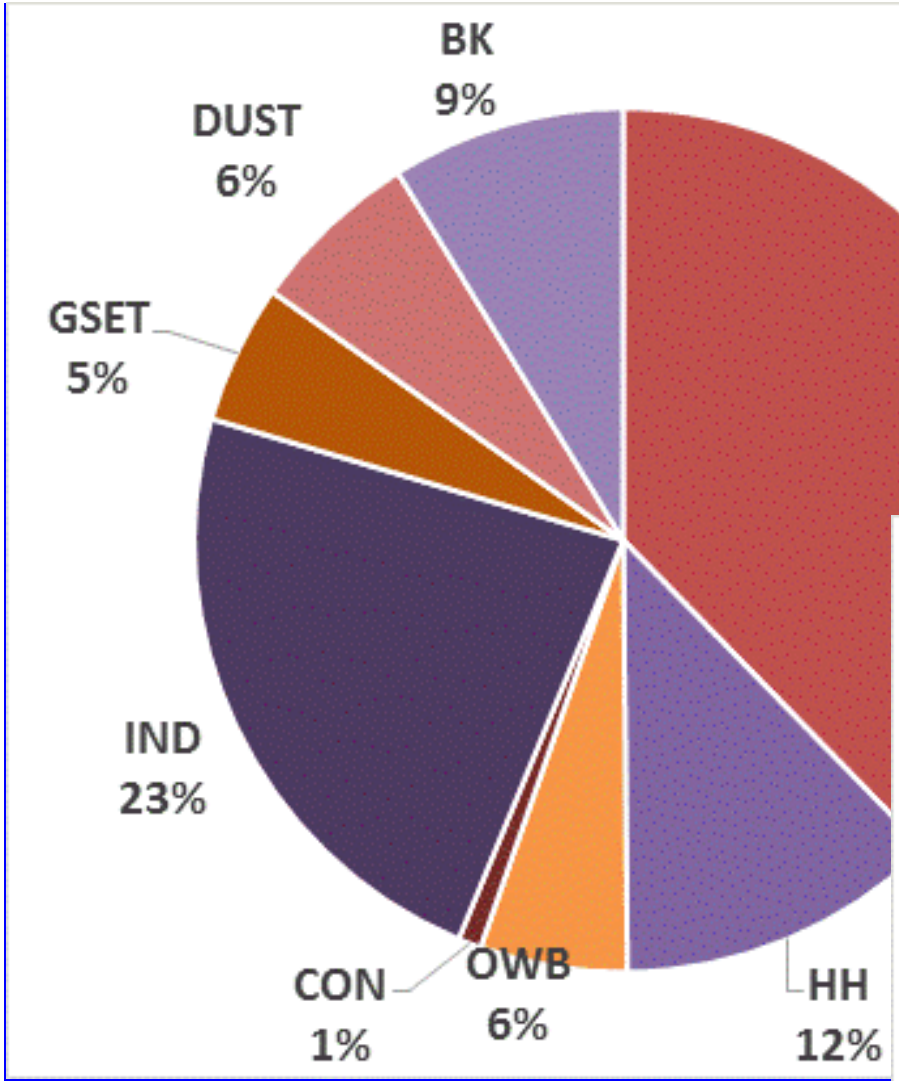
	Average	SD
Households	175	97
Construction	175	93
Waste.burn	140	74
Veh.exhaust	130	64
Gen.sets	123	53
Industries	65	17
Dust	18	4
Power plants	7.4	7.0
Brick.kilns	6.8	1.9

Hyderabad-2012

Ambient Exposures– $PM_{2.5}$



Emissions – $PM_{2.5}$



Draft MOHFW Report
estimates by Guttikunda

MoHFW AP Task Force, cont.

- Nearfield intake fractions not as well developed but important for local sources
  - Vehicles
  - Neighborhood waste burning
  - Gen sets
  - Households
- Preliminary estimates of household nearfield intake fractions are about 5x those from ambient (downwind exposures) in Hyderabad (850 vrs 175 ppm)

MoHFW AP Task Force, cont.

- There are other ways of using total exposure in policy: without intake fraction
- Monitoring of carefully selected and representative populations using small personal monitors, e.g. on cell phones
- Measuring carefully selected microenvironments and combine with regular surveys of time use
- Others also

Heath versus Environment

- Health sector has vast resources not available to environment ministries
- In India, 1 million local health workers
- Hospitals, public health clinics, health science schools, professional associations,
- Also much public credibility
- And a focus on health, not environmental quality.

Collaborative Clean Air Policy Centre

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Collaborative Clean Air Policy Centre

Many thanks

Publications and
presentations on website
– easiest to just
"google" Kirk R. Smith

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http://ccapc.org.in/

Paracelsus Updated

- Not only does

  The Dose Make the Poison

- But also,

  The Place Makes the Dose

And thus,

The Place Makes the Poison