Source Apportionment of PM$_{2.5}$ in India

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What is the Health Effects Institute?

An independent non-profit institute providing trusted science on the health effects of air pollution for nearly 40 years

Over 350 scientific studies, reviews, re-analyses conducted around the world, including increasingly in Asia

Balanced Core Support – a public-private partnership

Partnerships- international agencies, donors, non-profits, academic institutions etc.

Independent Board and Expert Science Committees
HEI’s work in India

Public Health and Air Pollution in Asia

GBD-MAPS India

State of Global Air


https://www.healtheffects.org/publication/ghd-air-pollution-india

www.stateofglobalair.org
Approaches for source apportionment

**Bottom-up**
- Emissions inventories, chemical transport models

**Top-down**
- Ambient air quality measurements, source fingerprints
Source Apportionment using top-down approaches

Chemical Mass Balance (CMB)

Positive Matrix Factorization (PMF)

Other multivariate methods

Six City Source Apportionment Study

Real-time source apportionment

Mathematical Framework

\[ x_{ij} = \sum_{k=1}^{p} g_{ik} f_{jk} + e_{ij} \]

- \( x_{ij} \): Mass of species \( j \) in sample \( i \)
- \( g_{ik} \): Mass fraction of species \( j \) from source \( k \)
- \( f_{jk} \): Mass from source \( k \) in sample \( i \)
- \( e_{ij} \): Residual

Back of the envelope version of calculation

Want to know

Measure

tracer species \( i \) in air

total PM in air

source contribution

tracer species \( i \) from source

total PM from source

source profile or fingerprint

Credit: Dr. Mike Hannigan

GBD-MAPS India

An international collaboration

Indian leads: Dr. Chandra Venkataraman, IIT-Bombay; Kalpana Balakrishnan, Sri Ramachandran University

HEI in collaboration with IIT-Mumbai, Tsinghua University, University of British Columbia and IHME; others

Goals

Identify what sources contribute the most to poor air quality and health
Evaluate the implications of alternative control policies on future impacts
Provide a baseline against which to measure future progress

https://www.healtheffects.org/publication/gbd-air-pollution-india
GBD-MAPS approach

- Develop current and future emissions inventories
- Simulate the fraction of ambient \( \text{PM}_{2.5} \) due to each major source
- Simulate using atmospheric, chemical transport models (GEOS-CHEM, nested-south Asia version); scaled to satellite data
- Link to gridded population data
- Apply GBD exposure response functions
- Estimate source-specific burden

Emissions inventories, current and projected under alternative scenarios for 2030 and 2050

\[ \text{Total Number of Deaths (thousands)} \]
Major source contributors to baseline PM$_{2.5}$ levels and health burden at the national level

Residential biomass burning (24.4%) is the largest individual contributor to the burden of disease in India, followed by coal combustion (15.5%) and open burning of agricultural residue.

2015

https://www.healtheffects.org/publication/gbd-air-pollution-india
But this isn’t the only study—how do the different estimates compare?

National estimates: bottom-up modelling

City-level estimates: bottom-up/top-down

No single sector - silver bullet that will solve our air pollution problem

Need coordinated multi-sectoral regional action, as well as the city-level action as mandated by NCAP

Improved data access as well as data transparency

Ongoing assessment – convergence of results from various approaches
CLEARING THE AIR WITH DATA

Supporting long-term policy making by establishing baselines for air pollution in a city.

1. Complete emissions inventories for each city and sub-regions and national background levels.
2. Create a spatial map of emissions for each pollutant, specifying source category, inventory and GHG potential.
3. Use satellite data and ground measurements for air quality.
4. Use a dispersion model to calculate concentrations of pollutants.

APnA cities

AHMEDABAD

January

2018

PM2.5 - ug/m³

0 to 10
10 to 20
20 to 40
40 to 60
60 to 100
100 to 150
150 to 200

Ahmedabad

boundaries

veh-exh

cook-light

heating

industry

waste-burn

dust

dg-sets

14%
4%
9%
12%
8%
17%
6%

50 cities
Questions for discussion

Per NCAP, cities will be required to conduct source apportionment analysis.

Are there common protocols/methodologies to be used?

How will source apportionment analyses be used?

Who will do this? How?

Standard Operating Procedures
QA/QC Processes

Prioritize sources to control?
Seasonal contributions?
Measurement of progress?
Thank you!

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