Understanding Air Pollution - Workshop
August 23, 2021
Rajasthan
Understanding air pollution crisis, health effects and mitigation efforts
Air pollution 5th largest killer in India

RASHMIE SEHGAL
NEW DELHI, FEB. 13

ites of pulmonary
diseases in India in
2010 are listed below.

Cancer
1.2 million

Respiratory disease
2.1 million

Was it the Foullest Day Ever?
Poison in Each 493

Times View

India Gate 12.30pm

New Delhi's India Gate war memorial on 17 October 2019 and on 8 April 2020. Photograph: Anushree Fadnavis/Adnan Abidi/Reuters

World's Most Polluted City: At 145 pm, Delhi had AQI (US Scale) of 1065, Almost 7 times No. 2 Lahore's 163

Atmosfear: Delhi Victim Of Sick Choke

Capital A Gas Chamber After Light Drizzle

Worst Smog in at Least 3 Years

Delhi Current Expressway 12.30pm

935
About 70% of the country exceeded the recommended national annual average concentration level of 40 μg/m³ of PM2.5, and almost one-fifth experienced levels over 80 μg/m³.
Air quality monitoring network

• Manual ambient air quality stations: under National Air Quality Monitoring Programme (NAMP) are total 804 spread across 344 cities/towns and few villages.

• Continuous ambient air quality monitoring: 278 realtime monitoring stations are operating in 148 cities.

• Considering 6,166 urban agglomerations/cities/towns in India (Census 2011) the monitoring network is very limited -- present coverage is only about 7 per cent of cities/towns
Widespread exposure to air pollution.

- PM2.5 exposure
- Ozone concentration
## Deaths attributable to air pollution in India in 2019

<table>
<thead>
<tr>
<th>Type of Air Pollution</th>
<th>Number of deaths, in millions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air pollution</td>
<td>1.67 (1.42–1.92)</td>
</tr>
<tr>
<td>Ambient particulate matter pollution</td>
<td>0.98 (0.77–1.19)</td>
</tr>
<tr>
<td>Household air pollution</td>
<td>0.61 (0.39–0.86)</td>
</tr>
<tr>
<td>Ambient ozone pollution</td>
<td>0.17 (0.08–0.26)</td>
</tr>
</tbody>
</table>

Air pollution causes 17.8% of total deaths (9.39 million);

On an average 4,575 deaths daily across India

SOURCE: THE LANCET, VOLUME 5, ISSUE 1, E25–E38, JANUARY 01, 2021
Health and economic impact of air pollution in the states of India: the Global Burden of Disease Study 2019
Heart and pulmonary diseases are the major health outcomes leading to deaths, attributable to air pollution in India, 2019

Source: https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(20)30298-9/fulltext
### Mortality trend in states

PM causes deaths even at comparatively much lower concentration level.

Even cleaner states have high death rate.

<table>
<thead>
<tr>
<th>State</th>
<th>Number of deaths attributable to air pollution: 2017</th>
<th>Death rate/100,000 population attributable to air pollution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uttar Pradesh</td>
<td>200,028</td>
<td>111.1</td>
</tr>
<tr>
<td>Maharashtra</td>
<td>108,038</td>
<td>86.9</td>
</tr>
<tr>
<td>Bihar</td>
<td>96,967</td>
<td>79</td>
</tr>
<tr>
<td>West Bengal</td>
<td>94,534</td>
<td>93.3</td>
</tr>
<tr>
<td>Rajasthan</td>
<td>90,499</td>
<td>112.5</td>
</tr>
<tr>
<td>Madhya Pradesh</td>
<td>83,045</td>
<td>97</td>
</tr>
<tr>
<td>Karnataka</td>
<td>64,333</td>
<td>94.8</td>
</tr>
<tr>
<td>Tamil Nadu</td>
<td>61,205</td>
<td>75.9</td>
</tr>
<tr>
<td>Gujarat</td>
<td>58,696</td>
<td>84.9</td>
</tr>
<tr>
<td>Andhra Pradesh</td>
<td>45,525</td>
<td>83.7</td>
</tr>
<tr>
<td>Odisha</td>
<td>31,118</td>
<td>65.3</td>
</tr>
<tr>
<td>Chattisgarh</td>
<td>29,841</td>
<td>98.9</td>
</tr>
<tr>
<td>Haryana</td>
<td>28,985</td>
<td>100.1</td>
</tr>
<tr>
<td>Kerala</td>
<td>28,051</td>
<td>79.3</td>
</tr>
<tr>
<td>Punjab</td>
<td>26,594</td>
<td>86.3</td>
</tr>
<tr>
<td>Jharkhand</td>
<td>26,486</td>
<td>69</td>
</tr>
<tr>
<td>Telengana</td>
<td>26,000</td>
<td>65.8</td>
</tr>
<tr>
<td>Assam</td>
<td>25,888</td>
<td>72.3</td>
</tr>
<tr>
<td>NCT of Delhi</td>
<td>12,322</td>
<td>65.3</td>
</tr>
<tr>
<td>Uttarakhand</td>
<td>12,000</td>
<td>106.4</td>
</tr>
<tr>
<td>Jammu and Kashmir</td>
<td>10,476</td>
<td>75.4</td>
</tr>
<tr>
<td>Himachal Pradesh</td>
<td>7,485</td>
<td>99.7</td>
</tr>
<tr>
<td>Tripura</td>
<td>3,711</td>
<td>91.1</td>
</tr>
<tr>
<td>Manipur</td>
<td>1,949</td>
<td>57.2</td>
</tr>
<tr>
<td>Meghalaya</td>
<td>1,440</td>
<td>42.7</td>
</tr>
<tr>
<td>Nagaland</td>
<td>958</td>
<td>48.8</td>
</tr>
<tr>
<td>Goa</td>
<td>892</td>
<td>58.2</td>
</tr>
<tr>
<td>Mizoram</td>
<td>652</td>
<td>52.9</td>
</tr>
<tr>
<td>Arunachal pradesh</td>
<td>608</td>
<td>36</td>
</tr>
<tr>
<td>Sikkim</td>
<td>413</td>
<td>61.1</td>
</tr>
</tbody>
</table>

Source: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6358127/
Death rate due to outdoor air pollution has surpassed household air pollution

Trend in death rate attributable to ambient PM pollution, household air pollution, and ambient ozone pollution per 100,000 population in India, 1990–2019

Source: The Lancet Planetary Health 2021 5e25-e38DOI: (10.1016/S2542-5196(20)30298-9)
Health of children compromised..

2012 epidemiological study on children in Delhi (CPCB and Chittaranjan National Cancer Institute of Kolkata):

-- Every third child has reduced lung function.

-- Sputum of Delhi’s children contains four times more iron-laden macrophages than those from cleaner environs, indicating pulmonary hemorrhage.

-- The levels of these biomarkers in children have been found to be higher in areas with high PM10 levels.
Himachal lung

Actually a shocking tale!

Look at the spotless lung below. The fortunate owner comes from a relatively cleaner place.

Delhi lung
Capital punishment

Look at these black spots on the lung. The unfortunate owner lives in Delhi and has been breathing polluted air. Air full of carbon particles which accumulate in the lungs (black spots). What you can’t see is a cocktail of gases and tiny particles even smaller than carbon that get into our bodies. Actually, you are getting polluted.
Emerging evidences of health impacts in India……

Alveolar macrophage - biomarker of air pollution

Exposed group; Kolkata taxi driver
Increase in AM number

Control area: Sundarbans

Larger AM – particle laden

Sputum cytology of a 14-year old girl, showing abundance of particle laden AM

Source: CNCI
National Clean Air Programme

• **GOAL:** to meet annual average ambient air quality standards

• **MID TERM:** Reducing air pollution by 20-30% by 2024, taking 2017 as base year

• **PLAN:** City specific air pollution abatement action plan (122 non-attainment cities)

• **PROCESS:** National emission inventory, air quality information, source apportionment studies, guidelines for indoor air pollution, rural monitoring stations
Reduction targets for annual PM2.5 concentration in six major cities of Delhi-NCR

Note: Mean of 3-yr average of all CAAQM stations that have been working in the city since 2018. Data upto 31 Dec 2020.
Source: CSE analysis based on CPCB data
Winter air pollution

Source: IIT Kanpur
How much pollution we breathe while travelling?

Source: Based on CSE exposure monitoring and DPCC data for ambient levels
Source: Industrial emissions

Action status:

• Industries shift out of Delhi to neighboring NCR while continuing to pollute in the common airshed.

• Delhi has also taken more active steps to scale up access to PNG in its industrial areas and taken the more ambitious decision of banning coal and other dirty fuels including petcoke and furnace oil.

• Challenge of regulating and monitoring large numbers of informal small scale units outside the designated industrial areas. Enforcement of clean fuel notification --a challenge.

• Controlling pollution in the industrial areas includes improving stack emissions and access to clean fuels,

• Control of fugitive emissions from material handling and movement of heavy duty trucks, and reduction in open burning of industrial waste.

• Need to expand PNG in industrial clusters of NCR and ensure connectivity with units to replace coal.

• Ensure implementation of SO2 and NOx emissions standards notified by MoEFCC on 29 January 2018 for 16 categories of industries
Source: Industrial emissions
What more needs to be done…

• Till the time full transition to gas and electricity as industrial fuel becomes possible, it may be useful to assess the use of intermediary fuels like agro-residue for industrial combustion.

• Promote smart monitoring of industrial stacks emissions with continuous emissions monitoring system and with strong quality control. CEMS has to be installed and operated properly for credible and accessible data. The emissions data should be available in the public domain for transparency.

• Implement industrial waste management plan to prevent open dumping and burning. In Delhi large scale burning of industrial waste was noticed during field survey in Mundka and Bawana areas where non-usable plastic and rubber waste from the recycling plants was found dumped for open burning.

• Mandate all industrial units to prominently display details of the Consent to Operate within their premises to prevent illegal operations: This is urgently needed to stop illegal operations of industries.

• Implement siting plan for industrial units outside the industrial zones for regulations and monitoring: There are large numbers of illegal units operating in non-conforming areas.
CPCB has identified eleven coal based power plants that are within 300 km of Delhi and are part of the common airshed. These plants will require stringent time-bound action to meet the emissions standards. Delhi has closed down all coal power plants.

MoEFCC introduced stricter environmental standards for coal-based thermal power plants (TPPs).

First deadline to meet the norms was 2017; this was extended to 2022. However norms were also diluted.

Govt has now given a deadline in phased manner which will be implemented during 2022 to 2024 for different category power plants considering population criteria of cities.

Estimations of penalty indicates that cost of non-compliance is lower than that of compliance—no deterrance.

To incentivize implementation of the new norms, preferential scheduling of electricity from cleaner power stations has to be adopted. Along with renewable energy or must-run plants, a new category of clean coal power plants need to be included as first-run or priority-run plants.

Source: Power Plants

Action points:

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Source: Vehicles

Action strategy

New vehicle Standards

- Technology neutral (but technology-forcing…) emissions standards for new vehicles.
- Must consider emissions from all mobile sources: on-road, offroad, marine, locomotives, aviation…
- Limit values only as good as: - Compliance and enforcement - Real-world performance

Fuel quality standards

- High fuel quality (especially low sulfur levels) enables advanced emission control technologies to be deployed in the fleet.
- Fuel quality compliance programs critical to prevent damage to engines and prevent mis-fueling

In-use vehicle emission control

- In-use vehicle emission control
- Clean up legacy vehicles on the roads
- Comprehensive program includes:
  - Catching gross-emitters (I/M, remote sensing, maintenance, etc.)
  - Cleaner fuels
  - Scrap-page
  - replacement programs
  - Retrofit programs
  - Low emission zones
Action taken on vehicles— emission norms

**Source:** Vehicles

**Action Taken:**

• It was in April 1999 that the Supreme Court had directed that all vehicles in India would have to meet BS I norms by the June of that year. It also directed that BS II would be mandatory in the NCR by April 1, 2000.

• The government set up Auto Fuel Policy committee. In 2003, it was agreed that 13 cities would get BS-III by April 2005, and the rest of the country by April 2010. Then there was a pause for 5 years.

• In 2015, the road map for the rest of the country was decided—fuel progressively made available. BS-IV implemented on April 1, 2017

• In 2016, Government agreed to skip BS V and leapfrog directly to BSVI for all vehicles in April 2020. BS-VI norms were advanced by 5 years.
Passenger cars emission norms: reduction in key pollutants

NOx: 25 to 68% reduction BS4 to BS6

PM: 82% reduction BS4 to BS6
Buses and trucks emission norms: reduction in key pollutants

NOx: 87% reduction -- BS4 to BS6

PM: 67% reduction BS4 to BS6
Challenge of Real World Emissions

Comparison of NOx emission standards for different Euro classes of Vehicles

In 2015 Volkswagen admitted to having installed emissions-cheating devices in its vehicles, which cost the company over $33 billion in vehicle refits and regulatory fines, in the United States.

Source: https://www.eea.europa.eu/media/infographics/comparison-of-nox-emission-standards/view
Electric vehicles account for barely 1.3 percent of total vehicle sales in India currently.

The Delhi EV policy, envisages that 25 per cent of all new vehicle registrations should be EVs) by 2024.
Action taken —on road trucks

Source: Trucks

Action Taken:
• SC imposed ECC on trucks in 2015
• Number of trucks has reduced by 50-60% after the doubling of ECC.
• Reduction in pollution by – after the ECC imposed.
• The entry of pre-2006 registered trucks (10 year old) stopped entering Delhi.
• Western and Eastern peripheral expressways are being used by many trucks now, helping reducing emissions in Delhi
• Installation of RFID based tolling is intended to reduce congestion at toll gates and streamline
On-road emissions management

- Number of PUC stations in the city; availability of 4-gas analyser; audit of the centres
- Level of compliance – how many vehicles turn up for tests
- Failure rate
- Any programme to do visual check of visibly polluting vehicles?
- Fitness and roadworthiness tests of the commercial vehicles
- Restraints on truck movement – bypassing trucks? Freight traffic: Management of warehousing, loading & unloading; Develop Urban Freight Consolidation centres in suburbs; Weigh-in-motion bridges
- Any phase out plan for older vehicles? Any scrappage policy?
- Clean fuel programme for vehicles
- Install vapour recovery system to control evaporative emissions and emissions of VOCs, benzene etc
- Intra and inter-state freight transport on railways to reduce dependence on trucks
Source: Crop residue burning

Issues and action:

• More than half of this burning happens in 3 states – Punjab, Haryana and Uttar Pradesh. 40% of all crop residue burning is attributable to Paddy Straw, 22% to Wheat Residue and 20% to Sugarcane.

• Apart from air pollution, burning crop residue results in the loss of nutrients from the topsoil layer.

• Govt has begun supporting agri-implements such as the Happy seeders, choppers and bailers that can process crop residue to prepare it for utilization – either on the field or in industries

• However, the cost of agri-implements needed to reduce. As these implements are used only for two to three weeks a year, farmers do not consider these worth investing.

• Augment incentives to small farmers and making it accessible to larger number of farmers, promoting co-ownership models and encouraging its usage in power plants, bio-fuels, etc are needed. Intensive and continued action is must for lasting impact in this sector
Action points:

• The Supreme Court had directed the Delhi government to repair the pavements and also to procure vacuum cleaning machines.

• The Delhi government has bought mechanised cleaners, ensuring dust disposal – however it has to be implemented across NCR

• Recycled water sprinkling is also a solution

• Government needs to devise wide spread green coverage
Local Municipal Authority

- Identify gaps in implementation in Solid waste management Rules and regulations, 2016 -- Implement decentralised waste management for residential and commercial areas
- Properly manage landfills sites to prevent fires
- Enforce complete ban on garbage burning
- Ensure proper collection of horticultural waste and composting cum gardening – create facilities
- Waste to Energy Plants – Only if needed -  Strict implementation of emission norms, use state-of-art technology; provide emission data to SPCB
- Implement emission norms for incinerators
- Ensure robust collection system that focuses on collection of segregated waste.
- Develop a siting policy for WTE plants.
- Roadmap for zero landfill policy
- Help poor people during winter -- warm cloths, electric heaters, night shelters
Source: Industrial waste burning

- Need enforcement
- Waste management – recycling
Mobility crisis - Must recognise the threat and opportunity

Cars and two wheelers occupy 90 per cent of road space

Inadequate safe space for sustainable modes such as bicycle or walking, buses and last mile connectivity modes

40-60% use bus and metro
10-20% cycle
20-30% walk
Only 10-20% use car and two-wheeler
Shadow of things to come
Travel mode share 2007-2031

Private vehicle usage will increase.
Public transport will stay stable or decline

Source: Based on: MOUD 2008, Study on traffic and transportation policies and strategies in urban areas in India, Wilbur Smith Associates, Ministry of Urban Development, May
Public transport needs safe walk access

In Delhi accidents near foot over bridges have increased
Delhi: wrong road design force people to cross in unsafe manner. This compromises public transport usage.

Public transport needs safe walk access.

In Delhi accidents near foot over bridges have increased.

Source: Delhi Traffic Police.
Delhi's Karol Bagh: Impact of pedestrianisation of streets (CSE, May 2019)

• Car-free Ajmal Khan Rd of Delhi has lower particulate exposure & 2.7 times more pedestrian count than surrounding roads.

• PM2.5 exposure on Arya Samaj Road was much higher than pedestrian only street during late afternoon/early evening.

• The exposure on Arya Samaj Road was 35 per cent higher than the car free stretch of Ajmal Khan
Air pollution: great equalizer

- **Air pollution is a great equalizer**: rich cannot buy their way out of the air pollution crisis – at the same time poor also suffer more

- **Airshed is one and has no boundaries** – cities, rural areas all get impacted in a region

Therefore, we need to take action.

Governments are responding to control air pollution; action initiated. But much more needs to be done and this needs us to think differently.

*Act with scale, speed and with difference in strategy*
LOOK MA! A PRIMITIVE MAN.