Towards blue sky in Indo Gangetic Plain: Framework for airshed management

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New Delhi: February 6, 2024
Delhi-NCR is not alone. Smog episode wraps a great part of Indo-Gangetic Plain.
Profiling air quality based on regulatory monitoring

- 35% of National Realtime network in IGP.
- 46% of IGP population within 50km radius of the real time monitoring network.
- Over 90% of Chandigarh, Delhi-NCR live within the 50km radius of the realtime network.
- Considerable data shadow areas

Note: Population estimates are based on the 100mx100m spatial distribution of population in 2020 developed by the WorldPop research programme, based in the School of Geography and Environmental Sciences at the University of Southampton. Monitoring locations are approximation based on information available from CPCB website and publications, it is not exact geographical co-ordinate of the stations as that information is not publicly available. Source: CSE analysis.
Synchronised build up of PM2.5 concentration across IGP

PM2.5 trend in 86 IGP cities (daily average Jan 1, 2021 – Jan 31, 2024)

Note: Average PM2.5 concentration is based on mean of daily values recorded at the CAAQM stations given it has adequate data. Source: CSE analysis of CPCB’s real time air quality data
Closer look at Delhi and NCR

Trend in PM2.5 level among the NCR cities

Note: Average PM$_{2.5}$ concentration is based on mean of daily values recorded at the CAAQM stations given it has adequate data. Source: CSE analysis of CPCB’s real time air quality data.
Pollution leaps even in smaller towns when pollution peaks in IGP during winter

Smaller towns experience nearly equally polluted winter as Delhi -- despite much lower annual average.

- Begusarai, BH
- Greater Noida, UP
- Faridabad, HR
- Sonipat, HR
- Noida, UP
- Ghaziabad, UP
- Bhiwadi, RJ
- Meerut, UP
- Purnia, BH
- Bahadurgarh, HR
- Muzaffarnagar, UP
- Gurugram, HR

Note: Average PM$_{2.5}$ concentration is based on mean of daily values recorded at the CAAQM stations given it has adequate data. 2023 annual average is based on mean of four quarterly averages. 2023 winter average is for mean of 1 Oct-31 Dec, 2023.

Source: CSE analysis
Can NCAP cities become green islands in a smogged airshed?

Non-attainment cities in IGP: Need deeper local action but also scaled up regional action

- Punjab – 9 cities
- Chandigarh - 1 city
- Haryana - 1 city
- Delhi - 1 city
- Uttar Pradesh - 17 cities
- Bihar - 3 cities
- Jharkhand - 3 cities
- West Bengal - 7 cities

Source: CSE analysis of CPCB data
Can NCAP cities become green islands in a smogged airshed?

Independent studies mapping regional air quality

- IIT D: Satellite-derived daily (24-hour average) and annual PM2.5 and correlated with surface measurements from the CPCB’s monitoring network
- Poor air quality across the urban–rural landscape

Source: Sagnik Dey et al., 2020, A Satellite-Based High-Resolution (1-km) Ambient PM2.5 Database for India over Two Decades (2000–2019): Applications for Air Quality Management, MDPI, Remote Sens. 2020,

Source 2015, Norwegian Institute for Air Research, International Institute for Applied Systems Analysis, IITM
Airshed approach?

- Scientists consider geographical area with common meteorology, topography and climate that affect the dispersion of its unique air mass, to identify airsheds.

- Several approaches

- But there can be significant overlap in administrative jurisdictions

Example: The World Bank has delineated airsheds
 Cities receive pollution – also contribute to regional pollution

2018, TERI and ARAI study:
• Contribution of NCR to Delhi’s PM2.5 concentration: 23–24%;
• PM10: 26%

• Impact of NCR sources during winter -- 70% and 50% in summer

Delhi also contributes to NCR pollution.
• Summer: Delhi’s contribution to downwind Noida -- about 28%
• Winter: About 40%

To upwind Panipat the contribution is about 1%
Delhi: Dynamic forecasting in the relative contribution of pollution sources to PM2.5 concentration during winter in Delhi: (October 24- November 8, 2022)

Note: 1) For the missing data, mean value substitution has been done 2) This is the mean of the daily average contribution for period October 24–November 8, 2021, 3) Data is from the Decision Support Systems (DSS) of IITM which is part of their ‘Air Quality Early Warning System’ and provides information on the potential emission sources to air quality in Delhi. This uses online chemistry transport model ‘Weather Research and Forecasting with Chemistry’ (WRF-Chem) and its modelling uses available emissions inventory for Delhi and the surrounding 19 districts as well as the PM2.5 data from the ‘Central Pollution Control Board’ (CPCB) monitoring stations and satellite imaging of pollution. This provides quantitative information on contribution of emissions from Delhi’s own sources and the surrounding 19 districts in National Capital Region (NCR), and also the contribution from biomass burning in the neighbouring states.

Source: CSE analysis based on data from the Decision Support System for Air Quality Management in Delhi of IITM.
Pollution sources within influence zone
# Secondary pollutants in transboundary pollution

IIT Kanpur: PM2.5 apportionment 2015

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<thead>
<tr>
<th>Sources</th>
<th>Winter</th>
<th>Summer</th>
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</thead>
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<tr>
<td><strong>Secondary particles</strong></td>
<td>30%</td>
<td>15%</td>
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<tr>
<td>Vehicles</td>
<td>25%</td>
<td>9%</td>
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<tr>
<td>Industrial</td>
<td>1%</td>
<td>1%</td>
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<tr>
<td>Coal+Fly ash</td>
<td>5%</td>
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<tr>
<td>Biomass burning</td>
<td>26%</td>
<td>12%</td>
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<tr>
<td>Construction material</td>
<td>2%</td>
<td>3%</td>
</tr>
<tr>
<td>Soil+Road dust</td>
<td>4%</td>
<td>27%</td>
</tr>
<tr>
<td>Boiler</td>
<td>0%</td>
<td>0%</td>
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<tr>
<td>Solid waste burning</td>
<td>8%</td>
<td>7%</td>
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</table>

TERI-ARAI: PM2.5 apportionment 2018

<table>
<thead>
<tr>
<th>Sources</th>
<th>Winter</th>
<th>Summer</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Secondary</strong></td>
<td>26%</td>
<td>17%</td>
</tr>
<tr>
<td>Vehicles</td>
<td>23%</td>
<td>18%</td>
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<tr>
<td>Industry</td>
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<td>11%</td>
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<tr>
<td>Dust+Construction</td>
<td>15%</td>
<td>34%</td>
</tr>
<tr>
<td>Other</td>
<td>4%</td>
<td>5%</td>
</tr>
</tbody>
</table>
Episodic pollution: Crop residue burning

October-November Episodic spike in air pollution levels

Source: CSE analysis of SAFAR data
Emerging evidence -- Apportioning emissions to states

October-November Episodic spike in air pollution levels

Source: Anon 2022. Report of the committee in (O.A.) No. 19/2021 in the matter of Sanjay Kumar versus State of UP & Ors. Central Pollution Control Board
Apportioning emissions to sources in the state

Regional airsheds of India (a) winter (DJF) (b) pre-monsoon (MAM) (c) monsoon (JJAS) and, (d) post monsoon (ON)

Source: Anon 2022. Report of the committee in (O.A.) No. 19/2021 in the matter of Sanjay Kumar versus State of UP & Ors. Central Pollution Control Board
Implications for air quality management ....

- Downwind sites lack jurisdictional power to address transboundary air pollution
- Cannot address unilaterally
- Difficult to meet clean air benchmark without regional action:
  - Lesson from hard locked down days during pandemic: CPCB study: Delhi overall PM10 and PM2.5 levels reduced by about 35 to 40%; NOx by 51% and CO by 32%
  - Impact of aggregated reduction in both local pollution and regional influence
  - Yet reached only satisfactory level in most cases
Genesis of regional air quality management: Delhi-NCR

**Supreme Court - EPCA: Catalysed harmonised strategies in the region**

**Integrated plan**: 2018 clean air action plan notified for the entire NCR
- 2016: Graded response Action Plan for the NCR

**Industry**:
- 2017-18: Phase out of polluting industrial fuels (petcoke, furnace oil)
- National SOx and NOx emissions standards for 16 groups of industries directed by SC
- Ban on import of petcoke
- Direction to industries to switch to PNG in NCR
- Action on brick kilns

**Transport**
- Natural gas vehicles and expansion of natural gas pipeline
- Rapid Rail Transit System facilitated
- Direction on Implementation of parking policy and parking management area plan for demand management in Delhi and NCR (EPCA report SC order of 10.08.2020)
- Jan 11, 2024: SC refers to EPCA recommendation on phase out of old heavy duty diesel vehicles and replace with BS6
- Expansion of air quality monitoring
Expanding mandate on regional air quality management

Post 2019: National Clean Air Programme (NCAP)
- Takes on board regional approach and inter-state coordination.
- Recommends comprehensive regional plan incorporating the inputs from the regional source apportionment studies.
- Highlights measures that can be implemented across multiple jurisdictions.
- **State Action Plans an opportunity** to address upwind and downwind transboundary air pollution -- Inter-State and Inter-department co-ordination.

The Commission on Air Quality Management (CAQM)
- The Act has vested power to take action and enable a comprehensive air quality management in the region.
- The Act recognized the transboundary nature of air pollution and gives cross-sectoral and cross-jurisdictional authority to the Commission.

**NGT directive on IGP:** NGT Order dated 9/9/2021, -- a Joint Committee to investigate developmental and industrial activities in the IGP
  - Detailed district-wise emission inventory of fine particles (PM2.5) over the IGP

**Uttar Pradesh already taken steps; Haryana, West Bengal evolving strategies**
Air pollution (Prevention and Control) Act 1981

• **Article 19 of the Air Act 1981**: State government in consultation with the SPCB can declare, alter or merge the “Air Pollution Control Area”

• Can be expanded to cover more jurisdictions and pollution sources under single air quality management framework well within the ambit of the Air Act.

• The CPCB is vested with power to declare Critically Polluted Areas (CPAs) and Severely Polluted Areas (SPAs).

• These provisions, are currently limited to manage the industrial pollution as per the Comprehensive Environmental Pollution Index (CEPI) Act.

• **Need a policy framework and mechanism for airshed management planning** for shared responsibility; integrated planning and management of resources; adaptive management and continuous improvement without degrading the air quality of already clean areas
Tapping the global learning curve ...

Taking lessons from Airshed Air Quality Management Frameworks in the USA, Europe and China
United states

- Non-attainment status for upwind city/states contributing to pollution in downwind sites -- even if they achieve NAAQS locally.

- Good neighbor policy: Cross-State Air Pollution Rule (Good neighbor provision): A contribution screening threshold of 1% of the NAAQS to identify upwind states that may significantly contribute to downwind nonattainment.

- EPA establishes a pollution limit (emission budget).

- Allowances or permissions to emit pollutants are assigned to affected sources based on these state emissions budgets.

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Steps to address the requirements of the Good Neighbour provision for ozone or PM$_{2.5}$ standards:

1. Identifying downwind receptors that are expected to have problems attaining or maintaining clean air standards (i.e. NAAQS)
2. Determining which upwind states contribute to these identified problems in amounts sufficient to “link” them to the downwind air quality problems
3. Identifying upwind emissions that significantly contribute to nonattainment or interfere with maintenance of a standard by quantifying appropriate upwind emission reductions and assigning upwind responsibility among linked states
4. Reduce the identified upwind emissions via permanent and enforceable requirements (e.g. regional allowance trading programmes)

Source: Compiled by CSE using EPA information
Europe Convention on Long-range Transboundary Air Pollution (CLRTAP or Air Convention)

- Signatory parties agree to reduce emissions to the levels set based on their current exposure, available technologies, cost of implementation, and economic constraints.

- Policy framework enables countries to create monitoring networks with uniform technological rules to assure quality and comparability.

- Establishes national emission ceilings for regulating and minimizing the adverse impacts of air pollution, as well as reporting requirements for emissions, airborne concentrations, and deposition in order to track progress toward this goal.

Convention on Long-range Transboundary Air Pollution Framework
Regional cooperation Mechanism in Beijing-Tianjin-Hebei region

- Air quality management plan for entire Jing-Jin-Ji area (Beijing-Tianjin-Hebei region (BTH) with 28 towns, including Beijing)
- Forecasting and early warning mechanism to guide heavy pollution emergency response plan in all provinces
- Alarm thresholds for severe air pollution crises harmonized across Beijing, Tianjin and Hebei
- Unified regional response to heavy air pollution and coordinated measures to reduce emissions in Beijing-Tianjin-Hebei and Surrounding Areas.
- Primary duties were assigned to the region and neighboring areas’ joint mechanism under the principle of “shared responsibility, information sharing, coordinated consultations, and joint prevention and control”
- A special system for regional collaboration in vehicle pollution management devised.
- Implements a regional collaborative environmental investigations and law enforcement.
- Joint law enforcement and special investigations aid in overcoming the challenges that cross-administrative region law enforcement faces.
Towards harmonized approach while addressing local issues....

Compliance framework needs more scalable change...
Performance linked funding demands more integrated scalable action

**Assessment 1: CPCB assessment for FY 2020-21** (FY 1\textsuperscript{st} April 2020 to 31\textsuperscript{st} August 2021, extended due to COVID)

- **82 NCAP cities**: Evaluation of cities based on the 3 parameters (Parameter A, B, C)
  - Parameter A: Strengthening of the pollution monitoring mechanism
  - Parameter B: Source-wise cause analysis for air pollution
  - Parameter C: Progress on action plan and compliance of statutory guidelines/rules

- **42 XV-FC cities**: Evaluation of cities based on the 4 parameters (Parameter A, B, C and D)
  - Parameter A: Strengthening of the pollution monitoring mechanism
  - Parameter B: Source-wise cause analysis for air pollution
  - Parameter C: Progress on action plan and compliance of statutory guidelines/rules
  - Parameter D: Quantification and evaluation of air quality improvement, includes-
    - a) Reduction in particulate matter (PM10)
    - b) Frequency of exceedence in AQI levels

**Assessment 2: CPCB assessment for FY 2021-22** (FY 1\textsuperscript{st} April 2021 to 31\textsuperscript{st} March 2022)

- **82 NCAP cities**: Evaluation of cities based on Parameter D- Quantification and evaluation of air quality improvement, under which one criterion considered for city assessment:
  - 1. Reduction in annual average PM10 concentration

- **42 XV-FC cities**: Evaluation of cities based on the Parameter D- Quantification and evaluation of air quality improvement, under which 2 criteria considered for city assessment:
  - 1. Reduction in annual average PM10 concentration
  - 2. Increase in good days (AQI <200)

**Assessment 3: “Swachh Vayu Survekshan” 2022-23** (FY 1\textsuperscript{st} April 2022 to 31\textsuperscript{st} March 2023)

- **City Performance Assessment for FY 2022-23 to 2025-26**, based on the Population category and weightage given to 8 sector-wise parameters

- **For 131 NCAP cities**, 8 Air quality sector-wise parameters considered:
  1. Biomass & MSW burning (20% weightage)
  2. Road dust (20% weightage)
  3. Construction & Demolition Waste (5% weightage)
  4. Vehicular Emissions (20% weightage)

- **5. Emissions from Industries** (20% weightage)
- **6. Other Emissions** (10% weightage)
- **7. IEC activities/Public Awareness** (2.5% weightage)
- **8. Improvement in PM10 concentrations** (2.5% weightage)
Lessons from city action

Evidence of positive changes on ground

Local hotspot action to address hyper local pollution (waste burning, construction activities, replacement of solid fuels in open eateries, road dust, DG sets, traffic points, etc)

Clean air action linked with electrification of fleet
Action still very local and not scalable

Evidence of energy transition due to clean air action (Delhi-NCR):

- Delhi - Transport – 46% drop in HSD diesel consumption between 2014-2023
- Share of diesel cars dropped from 35% in 2015 to 7.2% in 2023
- NCR: Substantial migration to natural gas and biomass replacing coal in industry
Lessons from city action

Asymmetry in action
- A big focus on dust control
- Action on industry, transport and power plants incremental -- no clear accelerator
- Pollution sources outside municipal limits do not get adequate attention
- Targets and scope for each sector/area of interventions are often not clear
- Institutional capacity to design strategies for implementation needs strengthening
- Not adequate alignment between sectoral schemes for resource leveraging
- Need stronger interface between state and central government policies – Eg fuel pricing; state’s own policy support to schemes etc

More evolved action in some sectors due to better programme/scheme design:
- Wherever explicitly defined sectoral schemes exist with policy mandate, targets, timeline, monitoring, compliance and reporting mechanism (like SB2.0, FAME etc), progress is better – Align more with clean air indicators
- Need more aligned action for scalable planning and resource mobilization
Vehicle technology and fuel quality
- **Emissions standard** is the common minimum requirement for all
- **Fleet renewal and scrappage policy** for end-of-life vehicles – special focus on heavy duty vehicles (National policy – need state action)
- **Targeted scaling up of electrification of vehicle fleet** (National scheme and state policies)

Mobility transition
- **Integrated public transport; walking and cycling infrastructure**
- Vehicle restraint measures – parking policy, low emissions zones, tax measures

Clean energy and technology transition in industry
- **Clean energy access** – address pricing and infrastructure
- **Affordable clean fuel and emissions control approaches for MSMEs** – scalable state level schemes possible for **boilers, furnaces, brick kilns, locally significant industry clusters** (mineral grinding, metal work etc)
- **TPP emissions standards; retirement of old plants; fly ash management**
Need harmonised and scalable cluster of solutions across the region

Scalable waste management strategy
• Leverage SBM2.0 for 100% segregation and recycling of solid waste, C&D waste, industrial waste, plastics –remediation of landfill waste

Clean energy access in households – LPG, electricity in households and eateries

Crop residue burning

Aggregated approach can make financial support for cluster of sectoral solutions and investments across IGP pollution hotspots more efficient and scalable

Favourable pricing for clean fuel, market based mechanism and requisite reforms
Airshed management needs good science and regulatory framework

- Regional scale air quality monitoring strategy, pollution sources, and assessment of transboundary flows
  - Monitoring at the micro scale, neighbourhood scale, urban scale and regional scale to characterize regional air-quality trends, geographic patterns and regional background and transport of pollution.

- **Delineation of air quality control regions:** The scope of the Air Act, 1981: establish air quality control regions

- Leverage state action plans to establish shared responsibility to account for contribution to air quality in downwind regions within the state

- Need oversight for multi-jurisdiction action in the targeted regions
  - Establish a formal collaborative and integrated process for regional harmonization of action plans
  - Adequate financial support, resource mobilization strategies and capacity building.

Need new generation agenda for a scalable clean air action
Thank you