Methodological Approach for Airshed Delineation: Meteorology, Source Interaction & Prediction

Mukesh Sharma (mukesh@iitk.ac.in)

Professor Emeritus, IIT Kanpur, India

11 March 2026, BAQ 2026, Bangkok

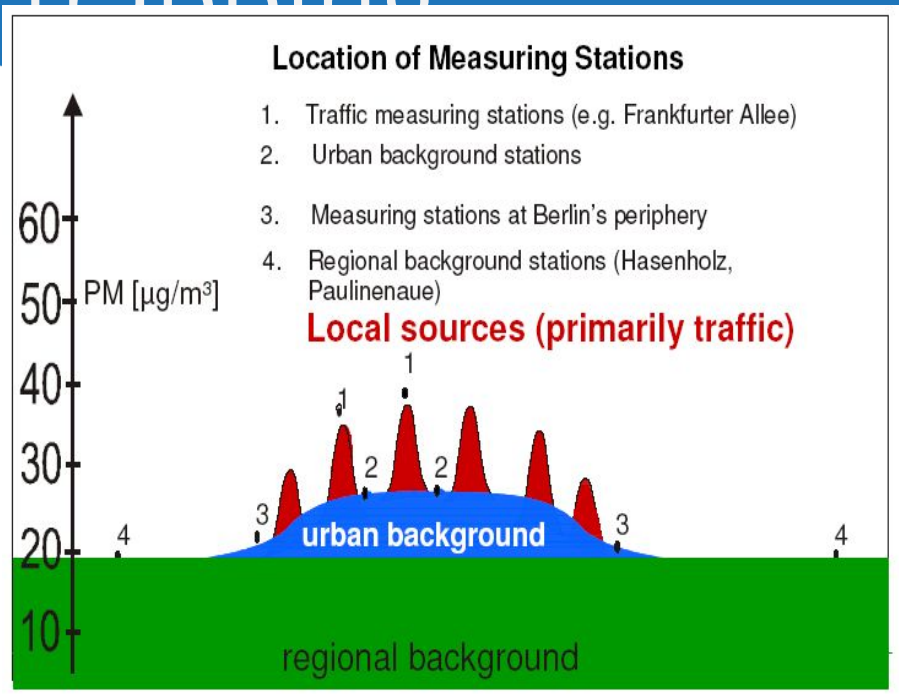
What is an Airshed?

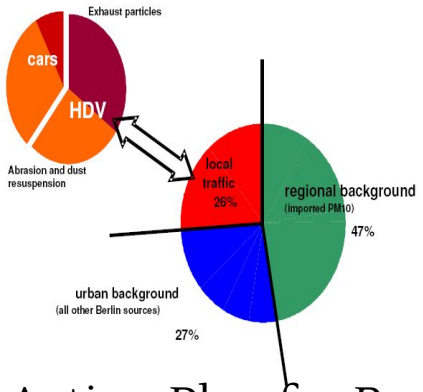
- An "airshed" or "air basin" - volume of air that behaves in a coherent way to dispersion of emissions.
- An airshed is a large common geographical area where air pollutants are trapped
- The region requires collaborative, cross-boundary pollution control, addressing pollution sources beyond political or administrative boundary
- The region requires complex, inter-city, inter-region and inter-countries collaborative approach, benefitting all.
- Key Components:
    - Meteorology: Wind patterns and inversion layers that transport/trap pollutants.
    - Topography: Physical features like valleys or basins that restrict air movement.
    - Emission Sources: Industrial clusters, urban centres, and agricultural activities.
- Benefits**:** Enables cohesive policy-making, optimal resource allocation, and collaborative efforts among neighbouring local bodies.

Why Airshed Delineation is Important?

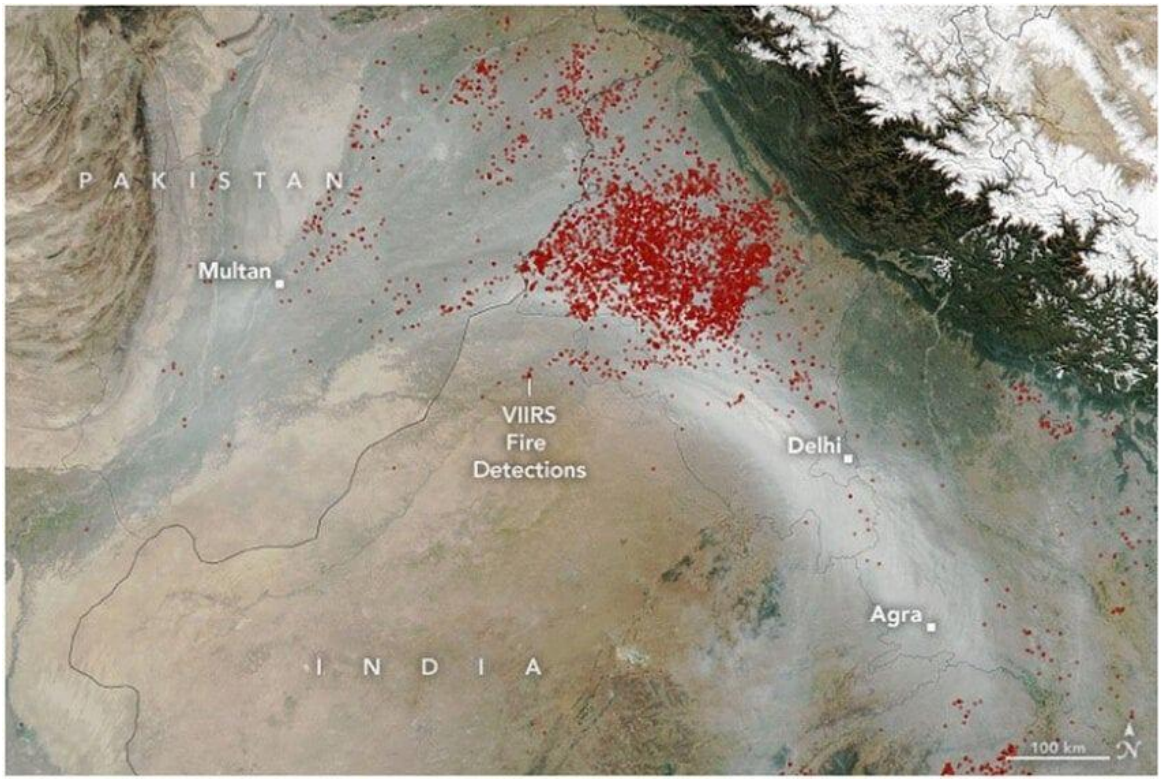
- Regional air quality planning
- Identifying major pollution sources
- Coordinated policy across states
- Effective emission reduction strategies
- Understanding pollutant transport pathways

Long-distance transport and pollution trapping





Clean Air and Action Plan for Berlin 2005-2010



Crop residue burning image captured by NASA satellite (Courtesy: NASA 2021).

Solutions require cooperation and alliances in the region.
Which region?

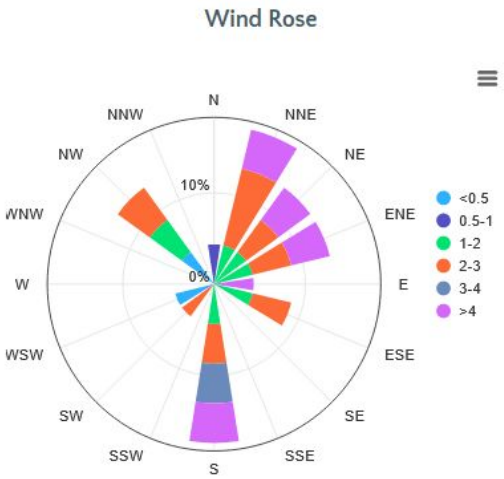
Methods for Airshed Delineation

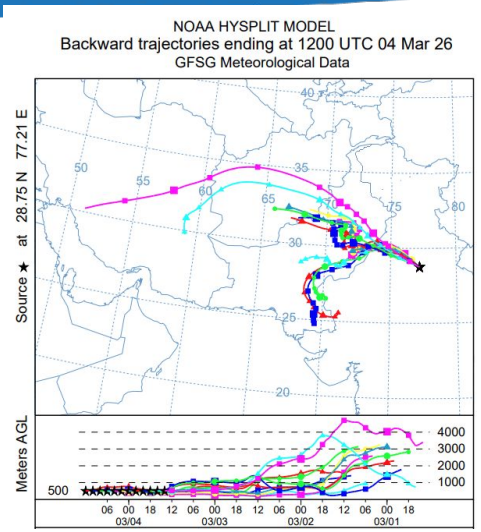
1. Meteorological Analysis

- Wind direction and speed
- Atmospheric stability
- Mixing height

Tools used:

- Wind roses
- Trajectory analysis

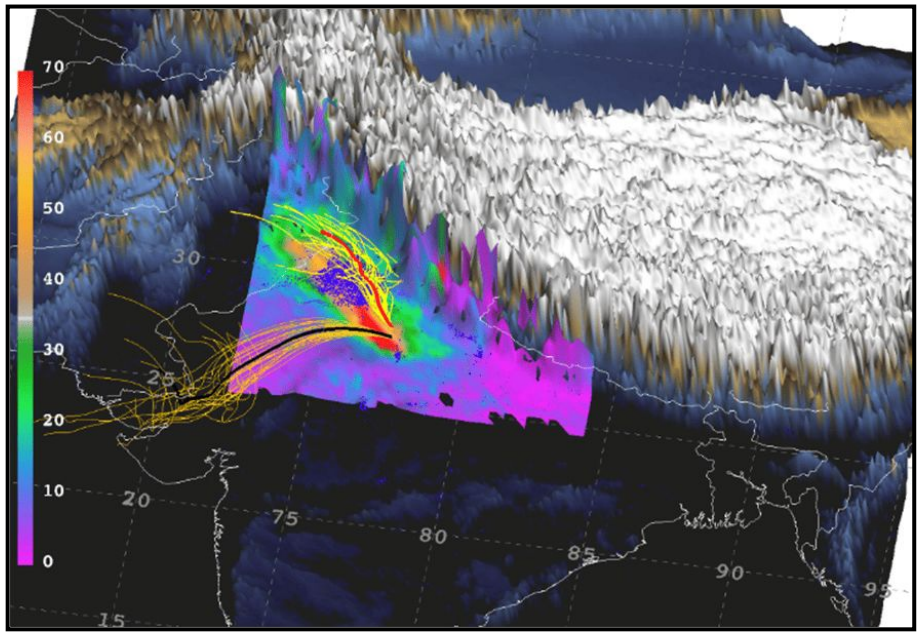




2. Topographical Analysis

Natural barriers affect pollutant movement:

- Mountains
- Valleys
- Coastal boundaries

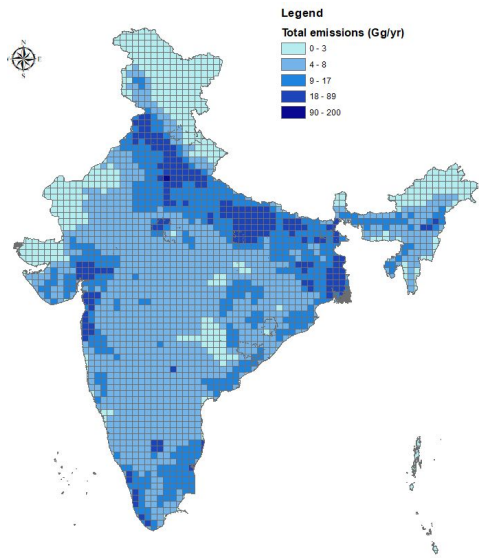


Methods for Airshed Delineation (Contd.)

3. Emission Inventory Analysis

Mapping sources of emissions:

- Industries
- Vehicles
- Power plants
- Biomass burning



4. Atmospheric Modeling

Models simulate pollutant movement and chemistry.

Common models:

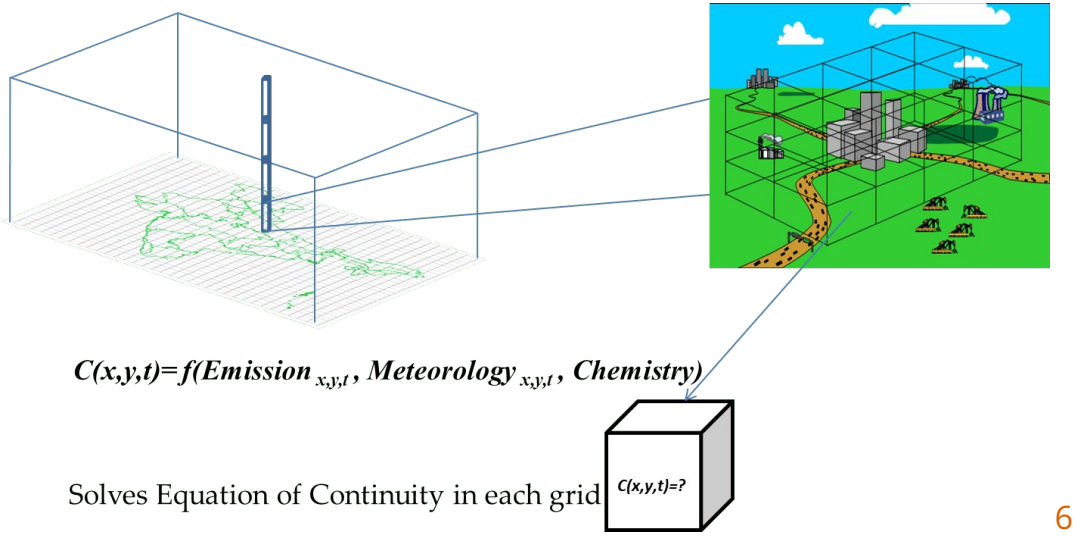
- WRF (Weather Research and Forecasting model)
- CMAQ (Community Multiscale model)

5. Back-Trajectory Analysis

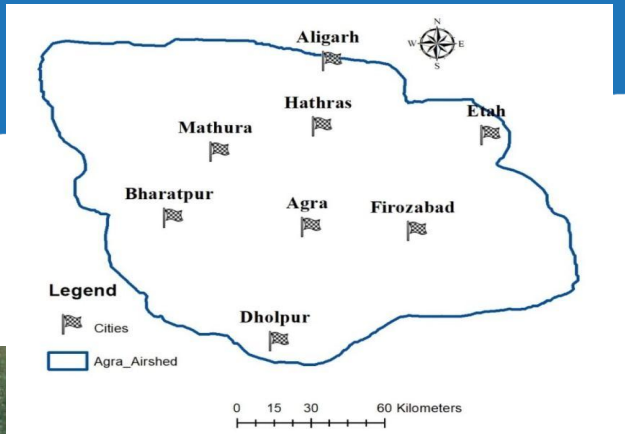
Used to identify where pollutants originate.

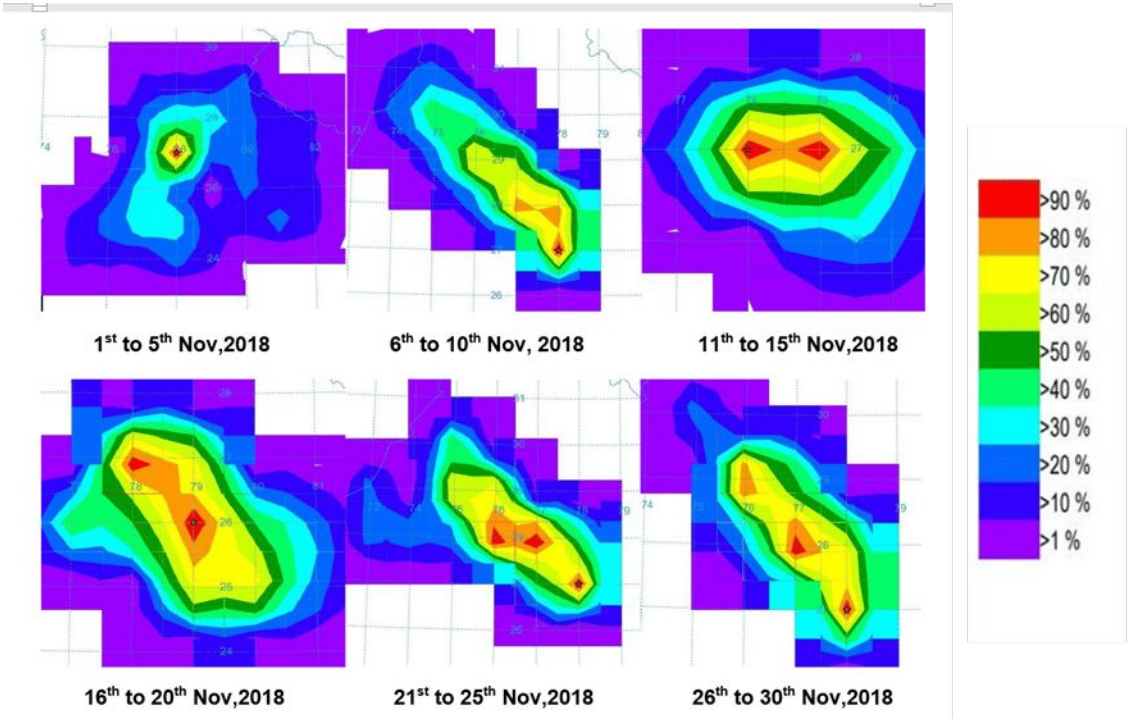
Common tool:

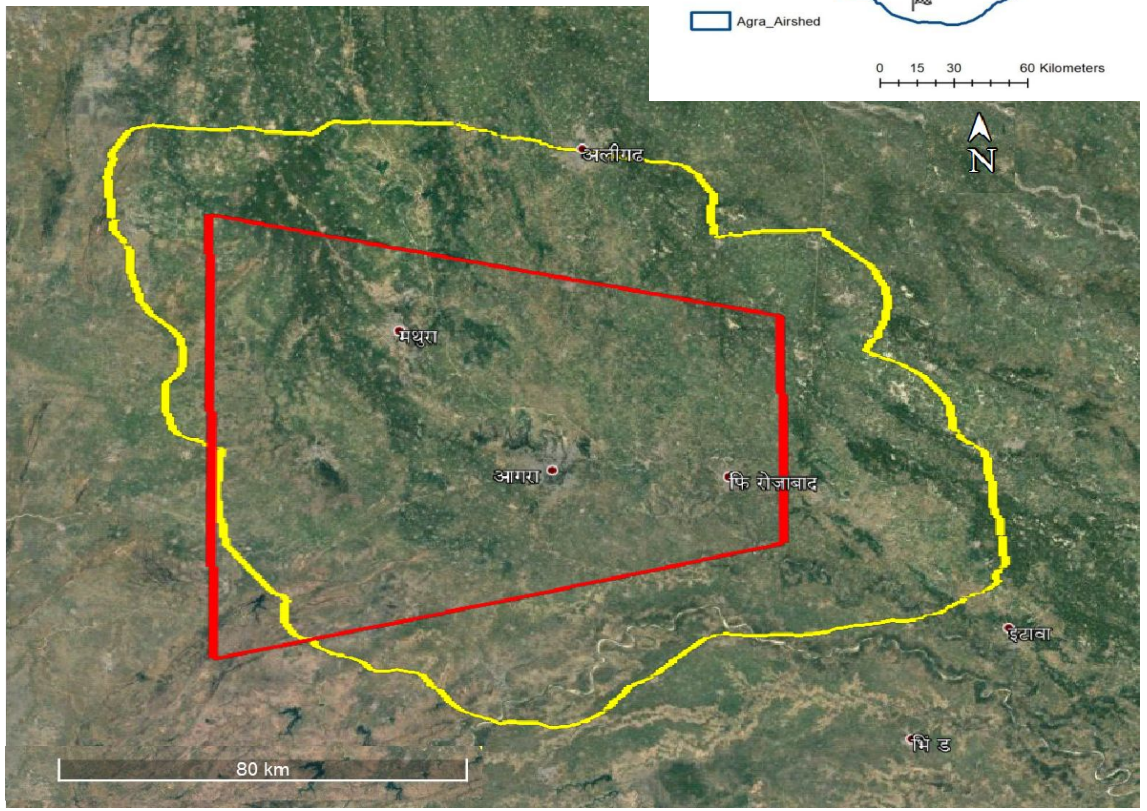
- HYSPLIT model



Agra Airshed Delineation - Example

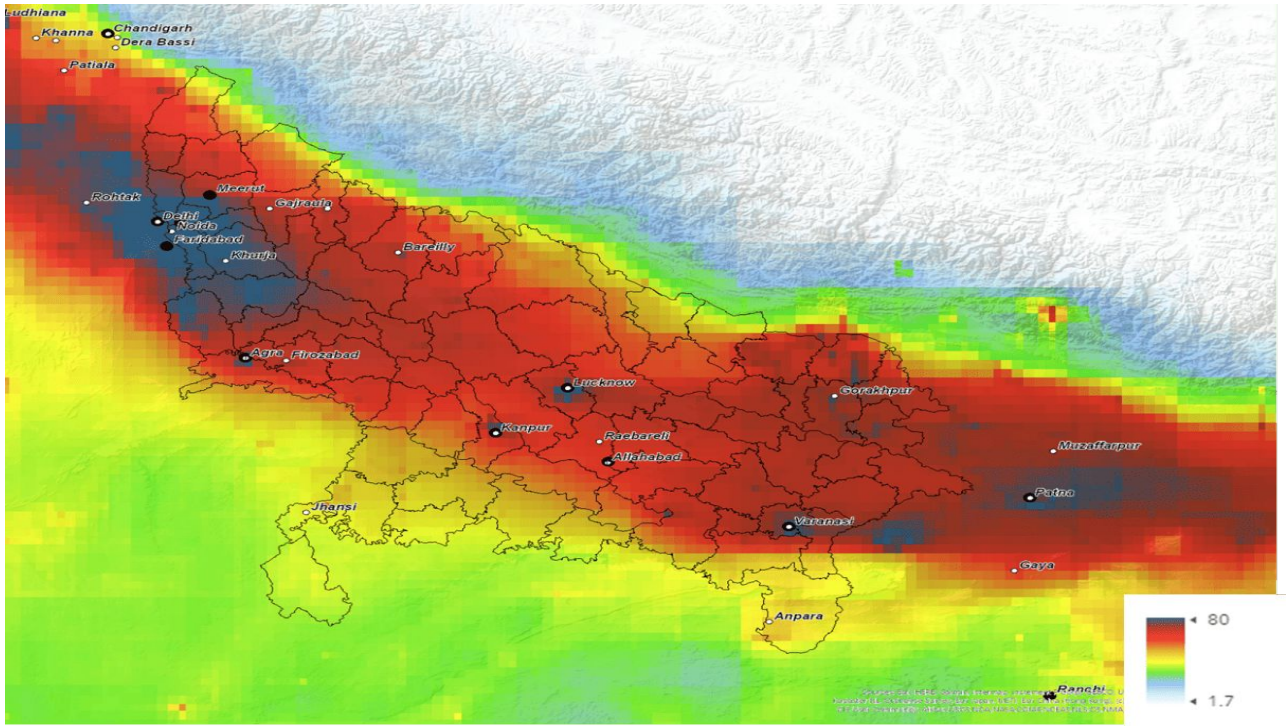






Taj Trapezium Zone (TTZ) : 10,400 sq km
Agra Airshed: 20460 sq km

Airshed of IGP



AOD-based PM2.5 – World Bank 2023, GAINS-IGP model
IGP is indeed an airshed and needs better management

The National Clean Air Programme, launched in 2019 by the MoEFCC aims to reduce PM10 pollution by 40% by 2026. But how?

City-specific action plans for non-attainment cities?. Not Adequate.

Transport of pollutants contributes significantly, especially in North India.

India is now shifting toward regional airshed management.

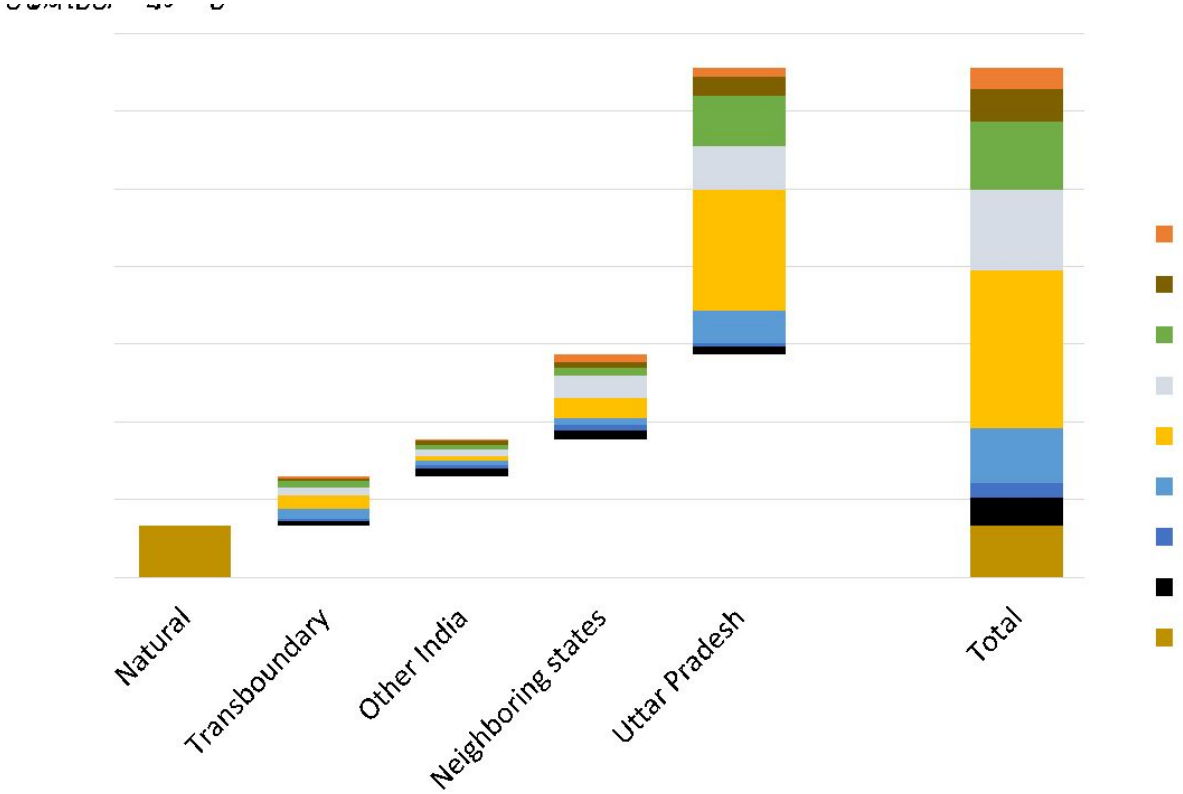
Applications in Air Quality Management

Airshed delineation supports:

- **Regional emission control policies**
- **Pollution source apportionment**
- **Early warning systems**
- **Inter-state pollution management**
- **Clean air action plans**

Source apportionment of (population weighted) PM2.5 exposure in UP< Indian State as a single Airshed 2020

Total contributions (primary and secondary $PM_{2.5}$) by sector:



(The World Bank, 2024)

MoEFCC Office Order and Committee

File No. Q-15014/4/2024-CP
Government of India
Ministry of Environment, Forest & Climate Change
(CP Division)

Indira Paryavaran Bhawan
Jorbagh Road
New Delhi- 110003

Date: 05th September, 2024

ORDER

Sub: Constitution of Coordination Committee for Air Quality Management in Indo Gangetic Plain (IGP) Airshed-reg

National Clean Air Programme (NCAP) was launched by Ministry of Environment, Forest and Climate Change (MoEFCC) in January 2019 with an aim to improve air quality in 131 cities (non-attainment cities and Million Plus Cities in 24 States/UTs by engaging all stakeholders. NCAP focuses on preparation and implementation of national, state & city level action plans in 24 States/ UTs and targeted 131 cites.

2. NCAP envisages to achieve reduction in PM10 levels up to 40% or achievement of national ambient air quality standards (60 microgram/cubic meter) by 2025-26.

3. Programme emphasizes mobilization of resources through convergence of various schemes/ programmes of central, state governments, resources from ULBs and developmental authorities. In addition, financial resources are being provided under NCAP through Million Plus Cities Challenge Fund (MPCCF) under XV Finance Commission air quality grant and Control of Pollution scheme of MoEFCC for addressing critical gaps. NCAP lays down an institutional framework for implementation in the form of National, State and City level implementation, review and monitoring Committees.

4. Indo Gangetic Plain (IGP) area comprising 8 States/UTs, namely Bihar, Chandigarh, Delhi, Haryana, Jharkhand, Punjab, Uttar Pradesh, and West Bengal, on account of typical geography and meteorology, have high baseline levels of air pollution which requires regional airshed management to abate air pollution.

(i)	Additional Secretary (CP), **Ministry of Environment, Forest and Climate**, Govt. of India	Chairperson
(ii)	Additional Chief Secretary / Principal Secretary, Environment Department of one of the **08 IGP States, on rotation on yearly basis**	Co-Chairperson
(iii)	Additional Chief Secretary/Principal Secretary, Department of Environment, Forest and Climate Change of States/UTs: **Bihar, Chandigarh, NCT Delhi, Haryana, Jharkhand, Punjab, Uttar Pradesh, West Bengal**	Member
(iv)	Member Secretary, **Commission on Air Quality Management in NCR & Adjoining Areas**	Member
(v)	Member Secretary, **Central Pollution Control Board**	Member
(vi)	Member Secretary, **State Pollution Control Board/Pollution Control Committee of 08 States/UTs**	
(vii)	**Two experts** in the field of air quality management, as nominated by Chairperson	Members
(viii)	Representative not below the rank of Joint Secretary/ Adviser of **Indian Space Research Organization** as nominated by Chairman, ISRO	Member
(ix)	Representative not below the rank of Joint Secretary/ Adviser of **India Meteorological Department** as nominated by DG, IMD	Member
(x)	Director (NCAP), CP Division, **Ministry of Environment, Forest and Climate Change**	Member Convener

BAQ 2026

BETTER AIR QUALITY CONFERENCE

11-13 MAR • BANGKOK

CLEAN AIR ASIA · ADB · CLIMATE & CLEAN AIR COALITION TO REDUCE SHORT-LIVED CLIMATE POLLUTANTS · ESCAP Economic and Social Commission for Asia and the Pacific · UN environment programme