



Inter-State Coordination for Clean Air

Airshed-based Governance in the Indo-Gangetic Plains

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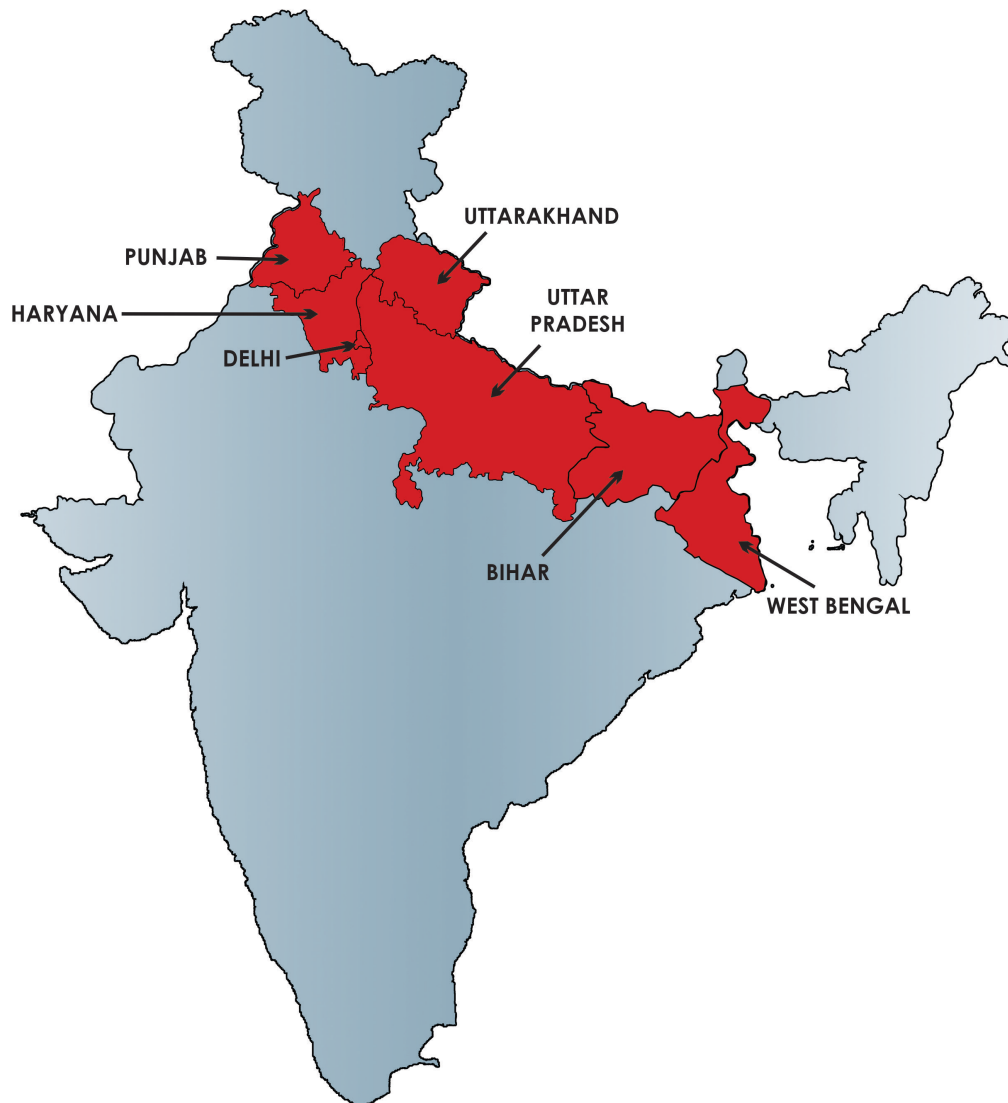
Climate Trends

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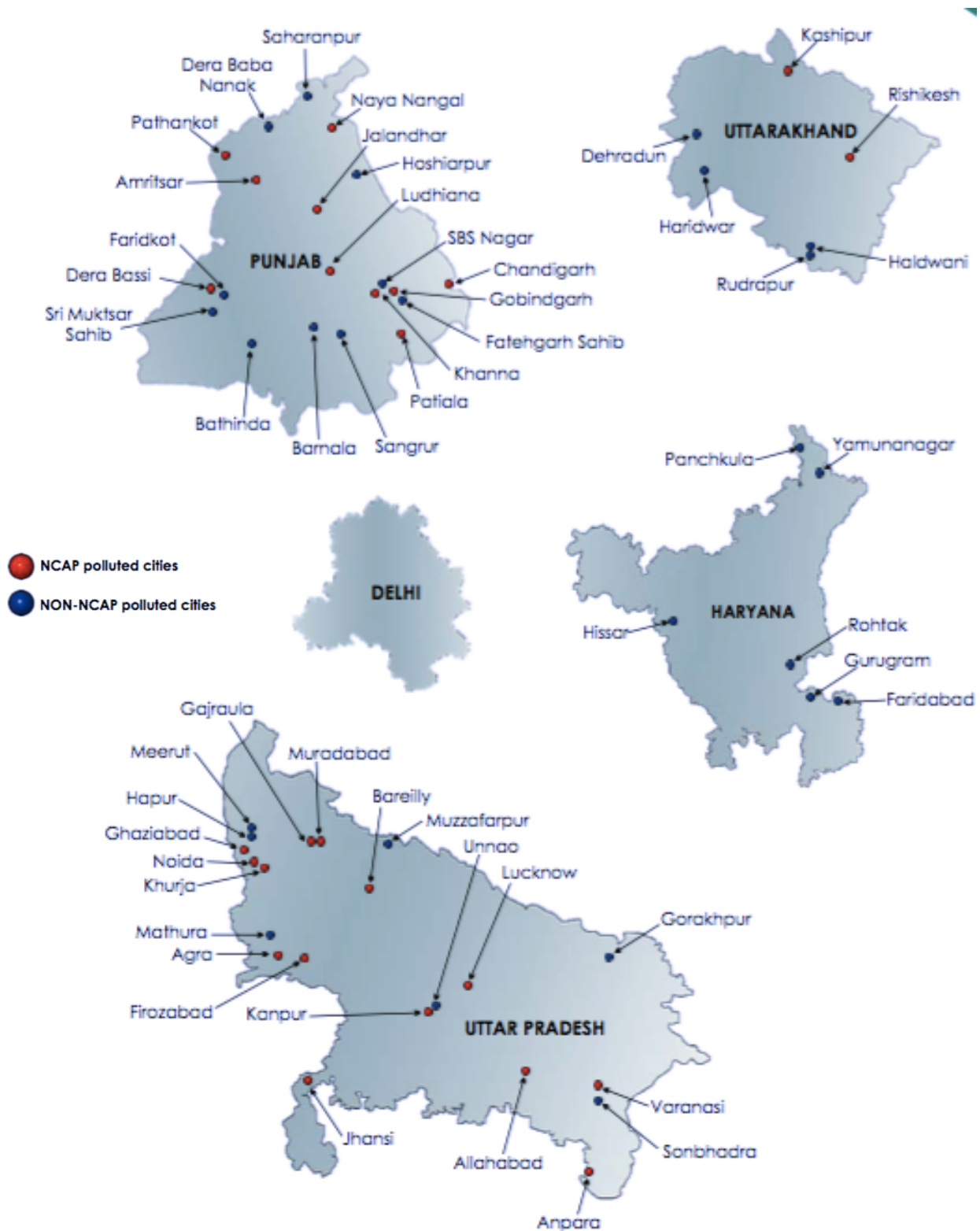
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INDO-GANGETIC PLAINS: A MUTUALLY REINFORCING DENSE HOTSPOT OF PEOPLE AND POLLUTION



NCAP and Non-NCAP polluted cities of IGP



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Context & Scope of the Report

North Indian states in the Indo-Gangetic Plains (IGP) region face the twin challenge of high population density and heavy concentration of air pollutants round-the-year. Both urban and rural areas in the region have to battle air pollution, although National Clean Air Program (NCAP) focusses on cities. While NCAP goal for pollution level in 2024 for many cities is not to contain it within national standards, any substantial reduction in pollution is possible only if the administrative approach includes regional pollution sources.

This report aims to establish the need and a plausible approach for regional coordination to address this persistent pollution in the IGP states. The report will have achieved its objective when a consistent and effective process of dialogue is established through a regional coordination mechanism amongst the IGP State Pollution Control Boards (SPCBs), state governments and line departments, subject matter experts/technical institutions and other stakeholders. The 5 out of 7 IGP states in focus for this report are – Delhi, Uttar Pradesh, Uttarakhand, Punjab, and Haryana.

Key Messages

1. Round-the-year pollution

- a. Except for the monsoons, IGP states experience pollution levels that exceed national standards across all seasons, including due to exchange of pollution;
- b. Its year-round sources of 'baseload pollution' need to receive much greater attention and share of resources than the seasonal issue of stubble burning.

2. Inadequate pollution coverage

- a. Urban vs Rural: the majority of the population in IGP states (except Delhi) lives in the rural areas which fall in the path of regional pollution transfer as well as generate pollution, and still are left out of the scope of NCAP;
- b. Inadequacy of monitoring: PM_{2.5} as a key primary and secondary pollutant transferred within the region is not adequately monitored.

3. Air-shed based planning & implementation

- a. Air quality experts are of the opinion that cities and districts within a shared air-shed across the IGP need to be mapped to enable a coordinated and integrated action plan to reduce pollution;
- b. Integrated 'winter action plans' are needed for the air-shed with mitigation steps enforced ahead of the winter months to avoid pollution spikes and smog.

4. Policy convergence

- a. The linking of NCAP with development policies within the air-shed - for instance, on transport, energy, construction, infrastructure, housing and waste management will help in integrated planning and efficiency;
- b. A multi-tier coordination mechanism amongst the IGP's State Chief Secretaries, department heads, SPCBs, and research and technical institutions engaged in air quality study, will enable regular dialogue and organized action.

Chapter 1: Scale of Exposure

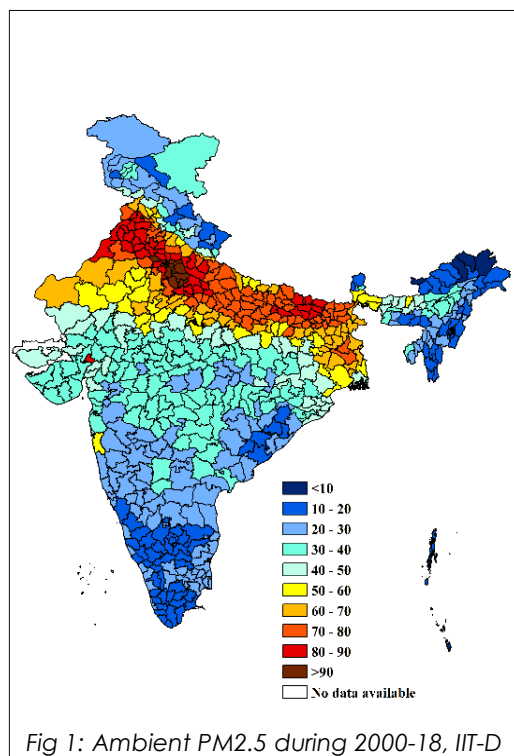
1a. Explained: Baseload, Background and Regional Pollution

Baseload pollution refers to pollution from year-round sources such as road dust, construction and demolition dust, biomass or garbage burning, industrial pollution, and vehicle emissions, all of which take place locally. This pollution is separate from episodic additions such as stubble burning and fire-crackers, and from pollution coming in from other states or cities.

Background concentration is defined as the concentration of air pollution in the atmosphere at any one location which is not directly affected by local emission sources. Background concentration is, however, not a fixed value. It varies as it may be influenced by regional air quality and indirectly by local sources. Pollutants from neighbouring cities may travel long distances to influence the background concentration of another city at a regional scale.

Regional pollution refers to a combination of baseload and background pollution concentration in a region, a portion of which is transferred from one city, district or state to another through winds.

1b. Population in IGP region exposed to air pollution¹



- Population in 5 states of the IGP region estimated¹ at 30.58 crore with 3.78 crore children under 6 years of age;
- A large number of people live in the rural areas of these states (52% in rural and 48% in urban);
- Satellite data reveals high levels of pollution across the region (rural & urban), still comprehensive and consistent ground-level air quality monitoring is lacking;
- There are only 110 CAAQMS stations to measure PM_{2.5} in IGP, at the coverage rate of one monitor per 49 lakh people approximately;
- Figure 1 indicates that the entire region over the past several years has been living on the edge of a widespread public health emergency due to continued exposure to hazardous levels of air pollution.

1c. Particulate Matter levels in IGP cities

CPCB monitoring indicates high levels of PM_{2.5} in the IGP's NCAP and non-NCAP cities (in Figures 2a and 2b).

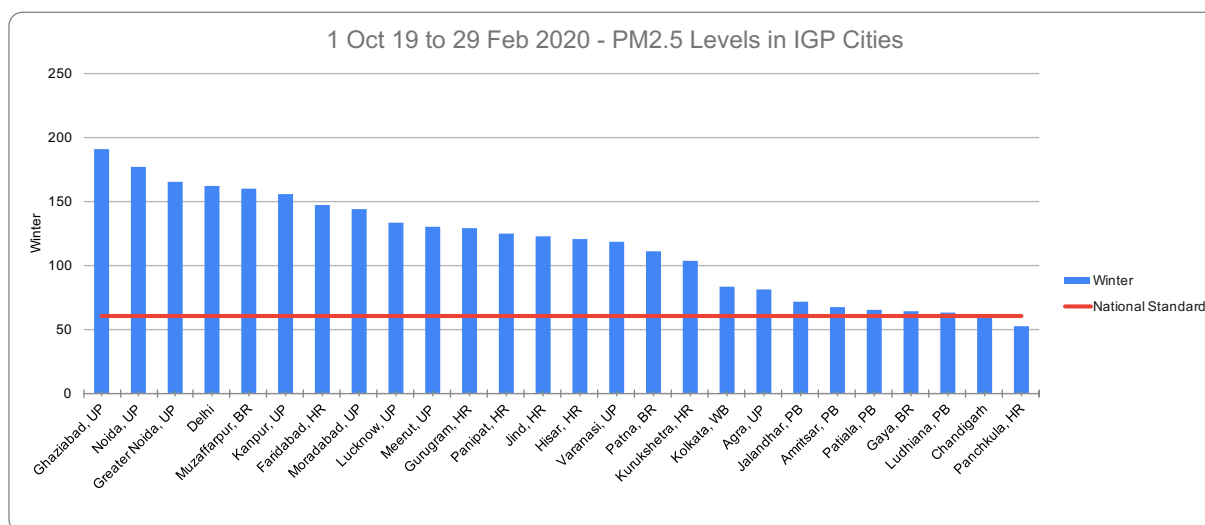


Fig 2a - Winter: NCAP and non-NCAP cities in IGP not meeting PM_{2.5} national standard (CPCB)

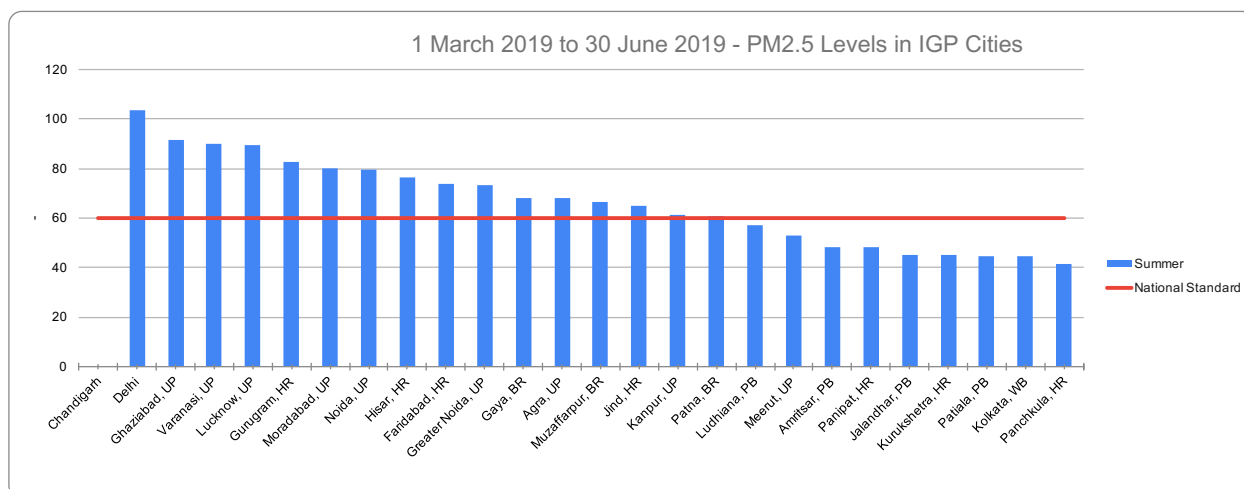


Fig 2b - Summer: NCAP and non-NCAP cities in IGP not meeting PM_{2.5} national standard (CPCB)

40 out of 122 cities included in NCAP fall in the IGP region, while there are 52 additional cities in the IGP (figure 4) that are not yet included in the program even though they did not meet the national standards for PM₁₀ in 2017 (baseline year for NCAP). NCAP's approach to city action plans excludes all peri-urban and rural areas in the region, all of which have to deal with industrial, household and agricultural pollution.

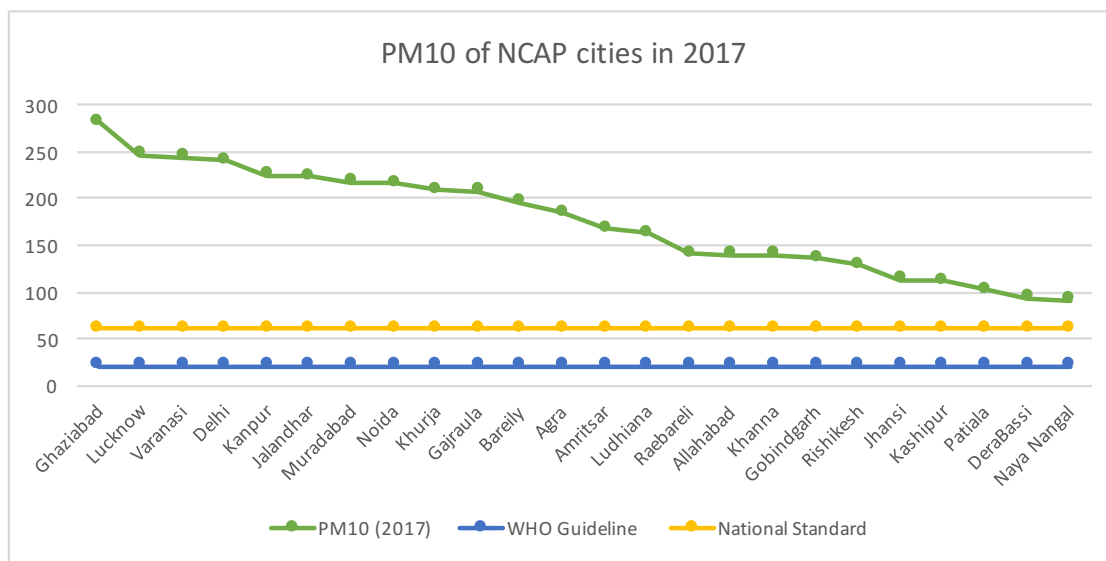


Fig 3: NCAP cities in IGP not meeting PM_{10} national standard of 60 mcg/cu.m in 2017

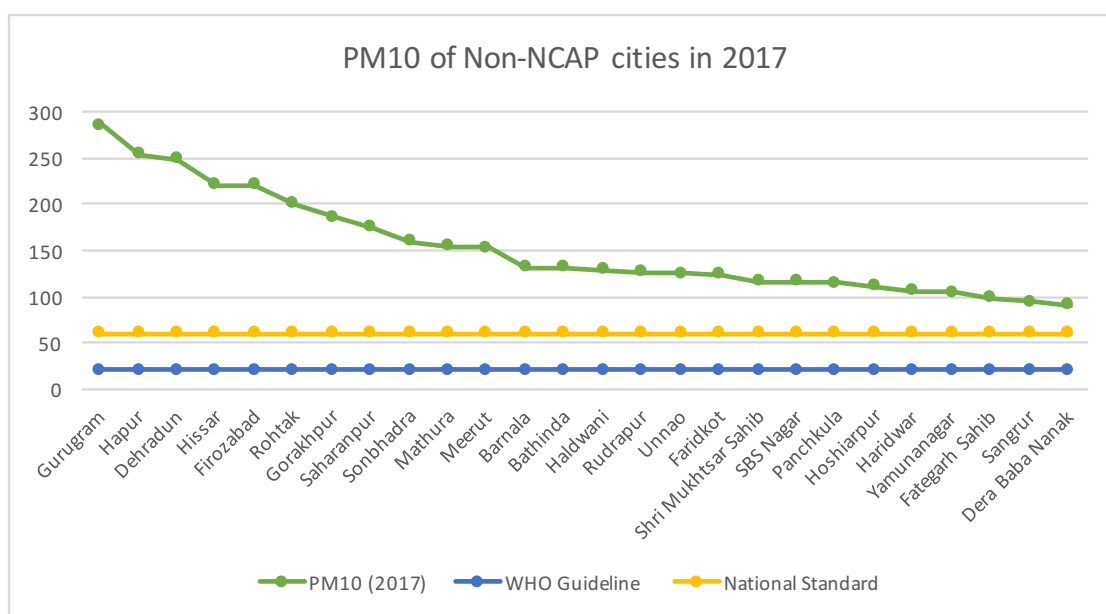


Fig 4: Non-NCAP cities in IGP not meeting PM_{10} national standard of 60 mcg/cu.m in 2017

Chapter 2: Indo-Gangetic Plain and Air-shed Pollution

2a. Snapshot of regional pollution transfer in some cities across IGP

Various studies indicate an exchange of pollution amongst cities in the IGP, some of which are indicated here –

i. Delhi:

- Delhi's in-house PM2.5 pollution generation lies in the range of 26%-36% from summer to winter while the rest comes from outside its territory;
- 41%-52% pollution in Delhi can be addressed through control measures in the NCR and outside in the broader IGP region;
- 13%-33% (upto 1/3rd) of Delhi's pollution originates outside India;
- Delhi contributes 12%-16% of the average PM2.5 concentration in NCR towns during summers and winters;
- 3 air corridors bring into Delhi harmful metal-based pollution from industries, e-waste incineration and burning;
- These emissions are projected to grow under business-as-usual scenario by 2030 despite emissions control strategies such as BS-VI fuel. Hence, additional strategies will be required for control, especially for industries (including power plants, brick kilns, and stone crushers).

ii. Uttar Pradesh:

- Experts attribute pollution levels in Agra and Kanpur to industrial waste in the adjoining areas, as much as 60% for Kanpur;
- Ghaziabad receives 66%–79% of PM2.5 pollution from other NCR regions;
- NOIDA, which is downwind of Delhi, receives 28%-40% of its PM2.5 concentration from Delhi-based sources.

iii. Haryana:

- Gurgaon receives 52%-83% of its PM2.5 pollution from NCR and regions upwind of the city;
- Panipat receives 57%–71% contribution from other NCR regions.

iv. Punjab:

Health checks of the local population indicate high levels of exposure to black carbon in the kitchens of rural Punjab. These particles stay suspended in the atmosphere for long, are easily transferred across regions and add to toxicity, global warming and episodes of smog.

v. West Bengal:

Scientists at the Bose Institute in W. Bengal have found that 60% of the soot in Darjeeling comes from Kolkata while the other 40% is from Bihar and Uttar Pradesh. Particles sized less than 2µm are spread across the region by a thick mass of air under the influence of the strong north-westerly winds between November to April.

Various experts, research bodies and technical institutions concur on the air-shed approach being a more suitable method of managing air quality over the existing city-centric approach. This is because air pollution does not stay confined to where it is generated. Hence, taking action outside of city municipal limits is necessary to manage air pollution load for a particular city. Source apportionment studies indicate various cities in the IGP receive and transfer pollution from outside their boundaries. This makes

intra-and inter-state regional coordination an urgent necessity in achieving NCAP's targets and national pollution standards.

As a way forward, therefore, this implies that all air-sheds in the IGP region need to be identified, mapped and the information disseminated to the state and city level administration.

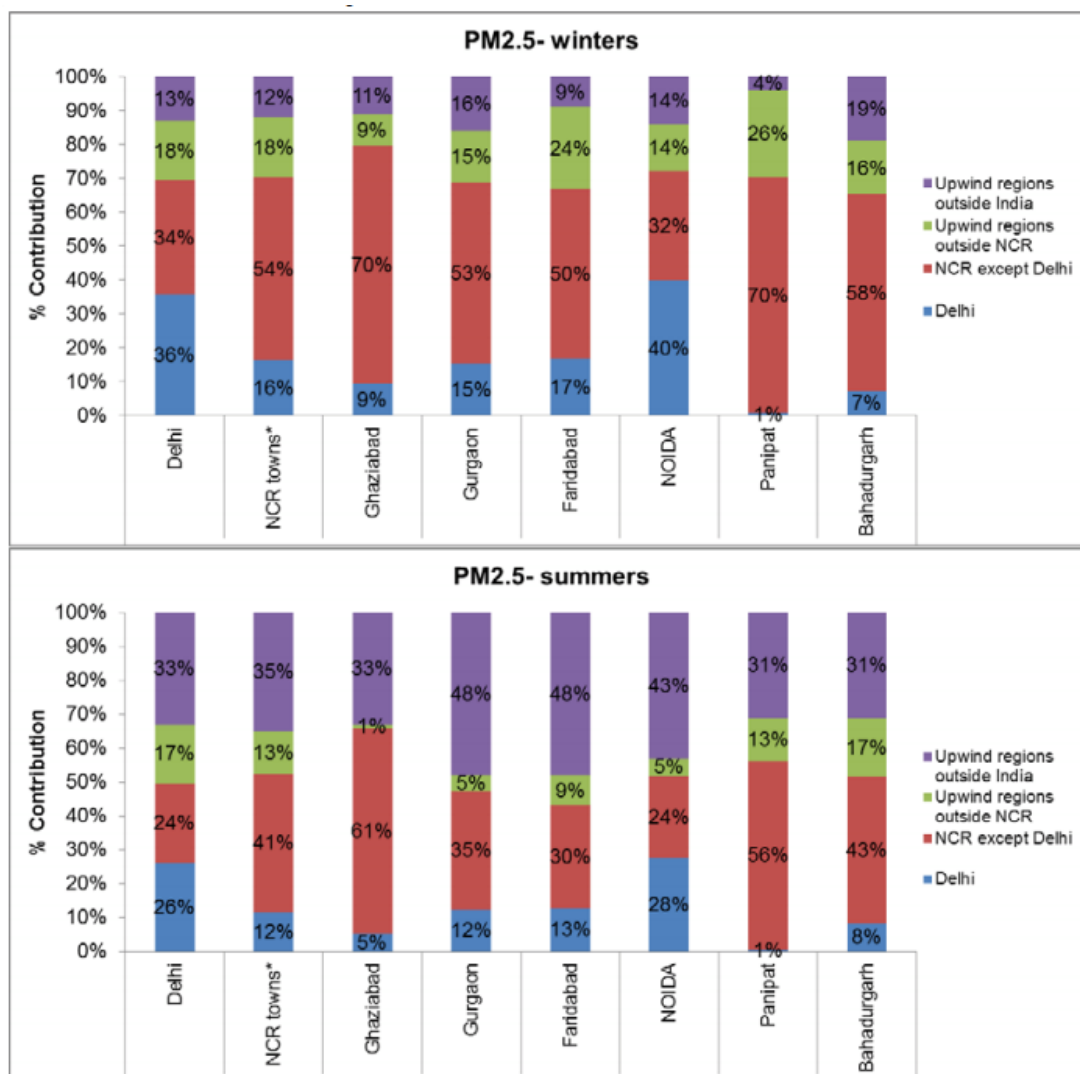


Fig 5: Share of PM2.5 pollution in Delhi NCR cities from regional transfer, ARAI-TERI 2018

2b. Types of pollutants over the IGP states

- Sustained rise in primary pollutants - NASA data shows that emissions of nitrogen dioxide (NO₂) from vehicles, power plants, and industries rose steeply from 2005 to 2014 across South Asia, with the highest rate of increase over the IGP region.

Sulphur dioxide (SO₂) levels too doubled in the same period because of the growing number of coal-fired power plants in the IGP states.

- ii. Secondary pollutants all through the year - The high levels of humidity in the IGP region contribute to the formation of secondary pollutants during winter. It must be noted that up to 50%-60% of PM_{2.5} concentration is secondary in nature.
- iii. Aerosols hotspot - The IGP is an aerosol "super-hotspot" which include natural (dust, natural sulphates) and anthropogenic (soot, industrial sulphates, black carbon, VOCs) sources.
- iv. Seasonal smoke - Burning of paddy crop residues emits large quantities of smoke which coincides with weak surface north-westerly winds. This leads to pollutants stagnating and spreading across the IGP. Stubble burning exacerbates pollution in Delhi, usually twice a year. The winter timing time of the practice also generally coincides with the onset of fog and/or Diwali, and has been responsible for spikes in air pollution.

2c. Sources of regional air pollution in IGP

Besides the locally generated pollution in cities, regional/ trans-boundary transfer of pollution from sources such as 29 critically polluted industrial clusters, 36 thermal power plants, and thousands of brick kilns (legal and illegal) located across the IGP region – most of which fall outside city limits – constitutes a significant share of pollution in its cities.

S.No.	Round-the-year sources	Short-duration sources
1.	Domestic cooking and heating	Crop residue burning
2.	Construction dust	Desert dust
3.	Garbage burning	Fire-crackers
4.	Brick kilns, incinerators, restaurants and industrial activities	
5.	Thermal power plants	
6.	Diesel generators and irrigation pumps	
7.	Transport	

Chapter 3: Regional Action on Air Pollution in IGP

3a. Status of actions on regional sources of pollution

The current state of affairs on required areas of coordination, convergence and unified approach to regional sources of pollution is listed here in table 1 –

Table 1: State Governments Action on Pollution Sources

Pollution Sources	Systemic Change Actions	Progress in IGP States
<u>Thermal Power Plants</u> 10 plants in the NCR missed their 2019 deadline for installation of FGD emissions control systems - Total 36 plants operating in the IGP states need to meet emissions standards by 2022.	- Union Government's 2015 standards to limit the pollutants such as SO_x, NO_x and PM from coal power plants have been relaxed and timeline extended from 2017 to 2022 (2019 for NCR) - Several plants are yet to initiate the installation. Only 1 out of 36 plants have FGD system operational	- Delhi - Badarpur and Rajghat thermal power plants have been shut down - Haryana - Mahatma Gandhi TPS has operational FGD
<u>Brick Kilns</u> - Over 1 lakh brick kilns are estimated in IGP region - Most have not yet converted to zig-zag technology.	- All brick kilns in the Delhi NCR region instructed to convert by June 2018 - Kilns near NCAP cities were instructed to comply by March 2019 and those in other areas by March 2020 - All 5 states have issued orders to kilns for conversion, although the dates suggested vary from the dates issued by the court - Notices of closure to illegal kilns issued in few IGP states.	- Punjab - Kiln owners not having converted till September 2019 allowed to still operate by paying a nominal monthly penalty - Uttarakhand – Compliance date extended to September 2020; the moving area around kilns instructed to be paved for no fugitive dust emissions - Uttar Pradesh - Local agro-industrial wastes residue to be used as internal fuel to replace coal and fly-ash in brick molding
<u>Industries</u> - Emissions data of industries not in public domain - Weak enforcement of existing standards - Stricter standards	No specific provisions in state industrial policies for existing industries on air pollution reduction.	- Punjab - NCAP plan mentions emissions standards for industries - Delhi - aims to relocate/shut down polluting industries and specifies cleaner fuels approved for industrial use - Haryana and Uttarakhand - provide incentives for RE and hydro, respectively - Haryana - disallows polluting industries from

required		receiving financial incentives
<u>Vehicles</u> - Vehicle density is reaching unmanageable levels - Transport forms a large portion of emissions - Real-world driving emissions not tracked - PUC exemptions given to diesel passenger cars	Most state transport policies do not aim to discourage personal vehicle purchase and use	- Uttarakhand - Electric Vehicle (EV) policy does not provide concrete targets for the share of zero emission vehicles - Uttar Pradesh - EV policy aims to facilitate transition from fossil vehicles though actions are aimed at 2024-30 timeline, thus, missing the impact during NCAP tenure till 2024 - Delhi – EV policy aims to facilitate transition from fossil vehicles and reach 25% target of all new vehicle sales by 2023 - Punjab and Haryana - EV policies are awaited.
<u>Solid fuel combustion (for cooking/heating)</u>	PM Ujjwala scheme for LPG connections to BPL and needy households	- Rural areas have the average annual refill rate at 3 cylinders while the national average is approximately 7 refills per year - Over 10,000 tonnes of firewood in IGP was removed from forests for fuel including for cooking as per 2019 Forest Survey of India - Users with LPG connections still relying on biomass burning
<u>Stubble Burning</u> - The choice of cropping patterns for and modern harvesting methods has led to stubble burning. Lack of financial incentives to alter crops and/or redirect labour to crop harvesting continues the practice - Machines remain unaffordable or are not feasible for small and medium landholding size farmers despite subsidies	- Central Sector Scheme launched to provide partial subsidies on machines for stubble management - NABARD project for farmer awareness on adverse effects of burning, encouraging alternative uses for stubble creating rural entrepreneurship, and suggesting other crop choices	- Haryana - state government in 2019 had pledged Rs 1000/acre and Rs 100 per quintal to small farmers not burning stubble; - Punjab – promotion of bio-fuel from paddy straw; rewards for zero burning districts; - UP - promotion of bio-fuel from crop stubble; - Uttarakhand - Agriculture Department launched a pilot project for the agriculture residue to be converted into fire briquettes and further used as a fuel in industries.

3b. Case Study: Missed opportunity for emission-norms compliant thermal power

The Indo-Gangetic Plains are densely populated with thermal power plants (TPPs) from Punjab to West Bengal. 10 TPPs in the 300km radius of Delhi NCR have already missed their 2019 deadline to meet the emissions control standards, even though they contribute to 6% of the region's particulate matter concentration during the winters.

The FGD systems have not been installed by the TPPs either due to the delayed start of the tendering and procurement process and/or lobbying to shift the costs to the government/consumers. There are 36 TPPs² in the region that need to meet the emissions standards in phased deadlines by 2022.

These TPPs supply power to the states in the IGP who could have used their leverage as customers and regulators to ensure the emissions control systems are installed in time. A contingency plan to assure power supply in the eventuality of CPCB shutting down defaulting TPPs would have further put the onus on the power producers to comply or lose revenue.

3c. Highlights of NCAP plans in IGP states affecting regional pollution mitigation

Table 2 presents salient features of NCAP city plans in IGP states that determine the extent to which regional transfer of all key pollutants is expected to be addressed till 2024 –

Table 2: NCAP Plans to address Regional Pollution

State	Focus on regional pollution	Role of meteorological factors	Dense monitoring for pollution level accuracy	Pollution carrying capacity analysis
Delhi	Stubble burning considered	Recognized	Hyper-local monitoring outside cities through low cost sensors and satellite not in scope	Capacity analysis not in scope although real-time source apportionment is
Uttar Pradesh	Not in scope	Not recognized	Hyper-local monitoring outside cities through low cost sensors and satellite not in scope	Capacity analysis in scope although timeline for completion is 4 years and real-time source apportionment not in scope to measure the breach of capacity
Punjab	Not in scope	Not recognized	Hyper-local monitoring outside cities through low cost sensors and satellite not in scope	Capacity analysis and real-time source apportionment to measure the breach of capacity not in scope
Uttarakhand	Not in scope	Not recognized	- Monitoring capacity to be increased by 4 monitors per city by 2021; - Hyper-local, monitoring outside cities through low cost sensors and satellite not in scope	Capacity analysis and real-time source apportionment to measure the breach of capacity not in scope

Haryana, not included in NCAP, has submitted a plan to CPCB for Faridabad and Gurugram which includes an air-shed approach to pollution management over 300 km around the cities.

3d. Required level of coordination in regional pollution management

With an understanding that in many cities of the IGP region, pollution in the range of 30%-80% comes from outside city limits, an inter-state and air-shed oriented

coordination can significantly lower a part of this load. For this to happen, specific areas of coordination across certain sectors, with realistic targets, need to be identified in order to inform planning, resources, infrastructure, expertise, and to develop a suitable coordination mechanism amongst cities and districts sharing an air-shed.

To instill the NCAP purpose, goals and plans in the functioning of a city administration and state policy governance, opportunities and ways of bringing convergence amongst key sector policies, laws, missions, and schemes of the IGP states need to be considered.

The scope for coordination on roadmap, preparedness, capacity and stakeholder participation is presented in Tables 3-4 while pollution source-focused recommendations are presented in **Annexure 4**.

Table 3: Collective pollution targets for the air-shed and response

Approach	Types of Actions in NCAP Plans	Additional Scope for Regional Coordination
City and air-shed roadmap with sources/sector targets till 2024	- Overall NCAP goal of 20-30% reduction by 2024-25; - Gurugram and Faridabad aiming for 35% reduction by 2022.	- Year-on-year regional roadmap till 2024-25 for reduction in prioritized pollution sources and baseload pollution; - Roadmap to be based on shared targets with neighbouring towns, peri-urban and rural areas in the air-shed of NCAP cities
Collective preparedness for peak pollution periods and emergency situations	- Delhi NCAP recognizes the need to coordinate with neighbours; - Haryana city action plans take an air-shed approach for 300 km beyond city limits.	- NCR Planning Board (NCRPB) to develop a Common Minimum Air-shed Program bringing together NCAP city plans, relevant schemes and court orders on air pollution in order to demonstrate air-shed based city action planning; - All air-shed sharing cities may coordinate to develop an integrated pre-emptive 'Winter Action Plan (WAP)' ahead of winter months aimed at reducing the generation of pollutants than suppression and, thus, avoid the need for GRAP enforcement; - Reforms for GRAP to establish a constant link with pollution levels forecast, enable quick enforcement to avoid severe levels, include metrics to measure its effectiveness, and establish clear accountability to deliver on targets for immediate reduction.
Air-shed level pollution monitoring infrastructure	- More manual and CAAQMS stations proposed; - Source apportionment studies proposed.	- Co-develop guidelines for monitoring coverage as per area, population and pollution source profile of the air-shed; - Aim for ward-level monitoring coverage, including rural areas, through low-cost sensors deployed at scale and satellite

		data to complement CAAQMS and manual monitors in an air-shed.
Health safety targets	Haryana plans to reference to hospital records to determine the link between air pollution and patient admissions.	- Shared methodology on mapping of health effects on the exposed population at local (ward & district) level to develop a database and measure results at the end of NCAP phase 1 in 2024; - Assessment of impact on crop yields; - Regional program to improve facilities for diagnosis and treatment of pollution-related illnesses in all government healthcare units; - Shared regional target to ensure air pollution does not reach severe levels.
Institutional capacity building for SPCBs and city administration	Initial workshop and training for orientation	- Joint technical capacity building program such as real-time source apportionment, forecast, and winter action planning; - Shared resources for monitoring pollution hotspot areas, violations management, and publishing results; - Joint reporting of NCAP plan implementation at state and air-shed level to regularly indicate progress in effective reduction of pollutants; - Common Accountability Mechanism for all stakeholders in an air-shed to enable SPCBs and city administration to initiate action and prevent delays

Table 4: Stakeholder participation

Stakeholder	Types of Actions in NCAP Plans	Additional Scope for Regional Coordination
Public	Engage NGOs in awareness drives, solutions and feedback to implementing agencies	- Expertise and best practices sharing in design and implementation of mass behaviour conditioning systems related to people's awareness, citizen reporting, private vehicles, garbage burning, etc, especially during winter action plan and GRAP; - Joint planning for an inclusive approach of reducing pollution along with keeping affected people informed about actions and polluting sector livelihoods transition
Innovators, start-ups, R&D institutions	Mandate to scientific and technical institutions for R&D	- Joint technical program with regional and national institutions to generate locally suitable solutions; - Pilot implementation across the region for robust testing and economies of scale; - Inviting innovators, start-ups and citizens to propose solutions.

3e. Framework for an inter-sectoral and regional approach to pollution reduction

A robust regional coordination mechanism will be needed at all levels of the government and other stakeholders. The NCAP already places highest accountability for program implementation at the level of State Chief Secretaries/UT Administrators. Given the intensity and scale of the challenge in north Indian IGP states, a framework of regional coordination could involve -

- Inter-state memorandum of understanding (MoU) for coordination on regional air pollution with timelines for implementation of agreed activities;
- Inter-governmental steering group comprising of State Chief Secretaries and SPCBs facilitated by union government and CPCB;
- Inter-state technical group of SPCBs and NCAP National Knowledge Network (NKN) nodal and regional institutions and experts;
- High-level inter-state emergency response group for 'IGP GRAP' comprising of state Chief Ministers, Chief Secretaries, union government, CPCB and SPCBs;
- A dedicated online platform for sharing of resources, decisions made, progress on activities agreed, and stakeholder input mechanism.

The purpose of such an inter-state coordination framework will be -

- Integrated planning and implementation for holistic results;
- Troubleshooting on challenges faced including through technical expertise sessions for regional solutions to achieve economies of scale;
- Feedback, review, monitoring and evaluation of the plans and activities undertaken.

The regional pollution coordination will need to have an extension forum for dialogue with industry, impacted sectors such as tourism, hospitality, agriculture, and healthcare, the thematic experts, civil society and citizen representatives.

Annexures

Annexure 1.

Influence of topography and meteorology on air pollution in IGP

1a. Topography causing land-locked valley effect on air pollution in IGP

The Indo-Gangetic Plain (IGP) is surrounded by the Himalayas to the north, moderate hills to the south, the Thar Desert and Arabian Sea to the west, and the Bay of Bengal to the east. The IGP is essentially land-locked, with the Himalayas largely blocking air pollution from escaping to the north, creating a valley effect.

The IGP is also the world's largest stretch of uninterrupted alluvium deposits. The fertile alluvium is naturally composed of loose unconsolidated particles which form a part of

wind-blown dust. The very few source apportionment studies that have been carried out for the cities situated in the IGP point out that contribution of natural dust in pollution levels is relatively more than anthropogenic sources. Widespread dust events are a common phenomenon in the region during summers.

1b. Meteorological conditions at play in IGP

Meteorological factors play an important role in determining air pollution levels. The concentration of primary and secondary pollutants in the atmosphere is controlled by the amount of primary pollutants, wind speeds and their direction, as well as precipitation in different seasons. All seasons except for the monsoons contribute to pollution in the region.

Annexure 2.

Current Status of Regional Sources of Pollution

2a. High density of thermal power plants

The 2016 study by IIT-Kanpur clearly mentions that to achieve a significant reduction in the particulate matter concentration in Delhi, emissions from thermal power plants within a radius of 300km from Delhi need to be curbed along with other sources. It is not sufficient to simply shut down thermal power plants inside Delhi.

There are 11 thermal power plants with 33 units of 12790 MW cumulative capacity within a radius of 300 km of Delhi of which, 10 plants with 31 units of 11,470 MW capacity did not meet the December 2019 deadline³ for installing pollution control systems as required by national emissions standards guidelines. These are –

S.No.	Plant & Company	Location	State	Capacity	Units
1.	GHTPS, PSPCL	Lehra Mohabbat	Punjab	920 MW	4
2.	Talwandi Sabo TPS, TSPL	Mansa	Punjab	1980 MW	3
3.	Ropar TPS, GGSSTP, PSPCL	Ropar	Punjab	840 MW	4
4.	Rajpura TPP, NPL, L&T Power	Patiala	Punjab	1400 MW	2
5.	Indira Gandhi STPP, APCPL	Jhajjar	Haryana	1500 MW	3
6.	Panipat TPS, HPGCL	Panipat	Haryana	710 MW	3
7.	Rajiv Gandhi TPS, HPGCL	Hisar	Haryana	1200 MW	2
8.	Yamuna Nagar TPS, HPGCL	Yamuna Nagar	Haryana	600 MW	2
9.	NCTPP Dadri, NTPC	Dadri	U.P.	1820 MW	6
10.	Harduaganj TPS, UPRVUNL	Aligarh	U.P.	500 MW	2
			TOTAL	11470 MW	31

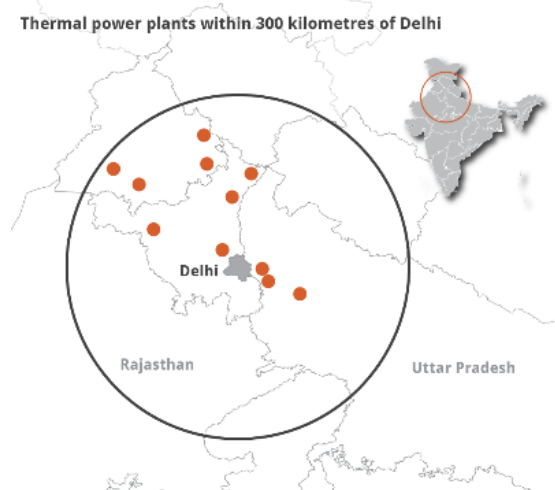


Fig 6: Red dots showing Thermal Power Plants within 300 km of Delhi

Across the Indo-Gangetic Plain there are **36** coal-fired power plants⁴ which need to install pollution control systems by 2022:

S. No.	State	Number of Plants	Capacity
1.	Uttar Pradesh	12	19360 MW
2.	West Bengal	12	12186 MW
3.	Bihar	4	4770 MW
4.	Punjab	4	4840 MW
5.	Haryana	4	4010 MW
6.	Uttarakhand	0	0 MW
7.	Delhi	0	0 MW
	TOTAL	36	45,586 MW

2b. Brick kilns

All brick kilns in the Delhi NCR region were required to be converted to 70% less polluting zig-zag technology by June 2018 while kilns in/near other NCAP non-attainment cities were to comply by March 2019. All kilns in other non-NCAP, non-attainment cities had to comply by March 2020.

The feedback from those converted to zig-zag design is supportive of the technology as the number of good quality bricks manufactured goes up by around 25% while the cost incurred is paid back within two years due to the improved quality and reduced cost of fuel.

In large brick producing countries like China and South Africa, the emission standards for brick kilns are more stringent than India. The standards in the developed countries of Europe and North America apart from being more stringent, cover emission limits for acid gases, mercury, and particulate matter.

2c. Domestic cooking and heating

Unprocessed biomass solid fuels (BSFs) are commonly used for domestic cooking and heating in north India villages. BSF uses could release up to 50 times more air pollutants than cooking gas and it has been reported that BSF smoke contains significant amounts of several noxious pollutants such as carbon monoxide (CO), suspended particulate

matter (SPM), hydrocarbons (HCs) and oxides of nitrogen (NO_x). Further, BSF smoke includes several toxic organic compounds such as polycyclic aromatic hydrocarbons (PAHs), which are known for their carcinogenic properties. Of all emissions, black carbon (BC) are of major concern. They are formed by incomplete combustion of fuel and it scatters, absorbs light strongly, impairs visibility, modifies cloud formation and properties, and it plays an important role in influencing global as well as regional climate. These effects are enforced by the several days-long residence time of soot in the atmosphere, which enables it to be transported over long distances. It has been observed that cooking with BSFs is one of the major sources of ambient BC and PM_{2.5} over the Indo-Gangetic Plains region.

2d. Stubble burning

Over 55,000 cases of stubble burning in Punjab, Haryana and Uttar Pradesh were reported⁵ between 1st October – 15th November 2019, as recorded by CREAMS-IARI.

The steady increase in stubble burning⁶ over the last decade is attributed to:

- (i) an increase in landholding size in Punjab from 2.89 hectares (7.1 acres) in 1970-71 to 3.77 ha (9.3 acres) in 2010-11, which is much higher than the national average of 1.5 hectares (3.7 acres). In Haryana, it is 2.25 hectares (5.5 acres). This makes it easier for farmers, and even necessary, to opt for mechanized farming. However, the practice leaves behind residue that must be managed in the short-term, and that is done by burning it off.
- (ii) The short period alludes to a water conservation law of 2009 that gives farmers 15-20 days to sow paddy to cut down on rounds of irrigation needed.
- (iii) Another reason for increase in burning is that the area under paddy cultivation has grown significantly.

The solutions promoted are machine-based ironically, while the farmers have been demanding compensation instead to manage residue through alternative means.

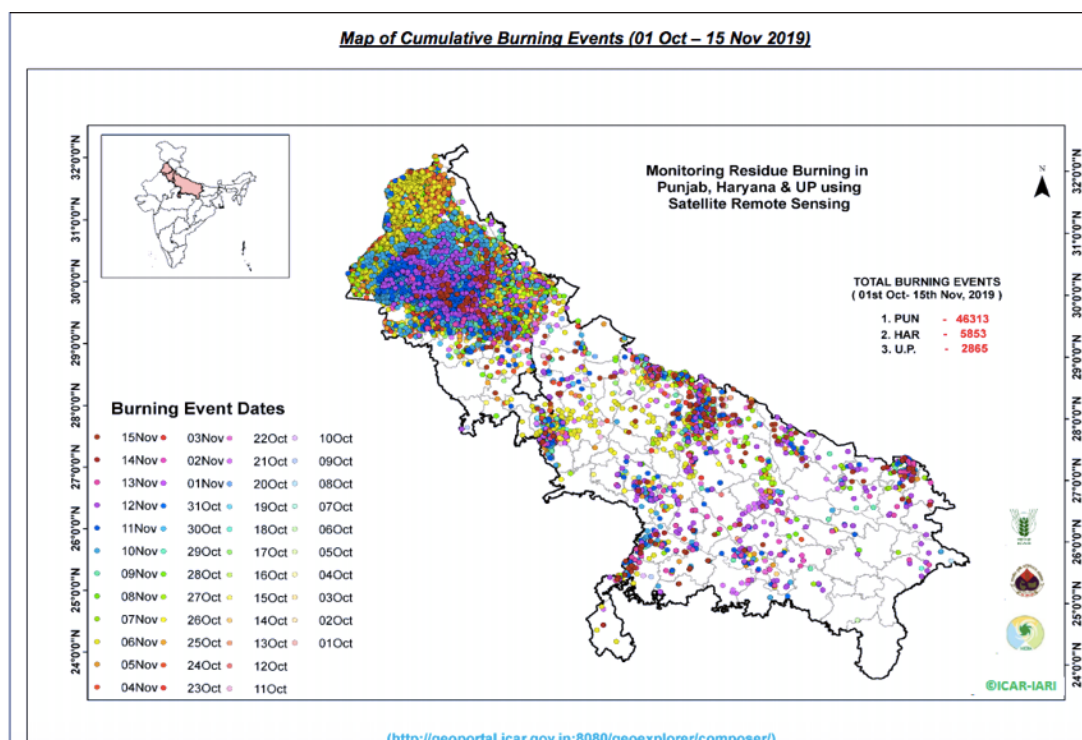


Fig 7: Stubble burning incidents in IGP Oct 1- Nov 15, 2019

Annexure 3.

China's result-oriented approach to regional pollution reduction

The pillars of China's approach to mitigating regional pollution were -

- Regional coordination mechanism for B-T-H (Beijing, Tianjin and Hebei), Yangtze River Delta (YRD) and the Pearl River Delta (PRD) regions
- A regional action plan to integrate all pollutants and key pollution sources
- Time-bound targets to reduce pollution levels
- Extensive monitoring system to track progress and hotspots
- Strict enforcement and inspection system to resolve conflicts on the ground
- Winter action plan, as a pre-emptive, rather than reactive plan, for Beijing and 27 surrounding cities to pause polluting activities in the winters.

A recent study evaluating the Chinese approach in the B-T-H region where PM_{2.5} concentration dipped by 40% over five years between 2013-17 through pollution control measures spanning a large area has recommended similar regional collaboration amongst the IGP states.

Policy interventions that informed regional coordination in China were -

- Coal Consumption Cap (CCC) policy - Aimed at peaking China's coal consumption by 2020, this policy started with a focus on 3 regions, namely, BTH, YRD and PRD. As a result, the country cut coal's share in its energy mix to 59% - down from 68.5% in 2012;

- Winter Action Plan - Targetting Beijing, Tianjin and 26 surrounding cities (so-called "2+26 cities"), the plan resulted in dramatic drop in pollution in the area, with industrial output being curtailed, inspections of polluting factories ramped up and small-scale coal burning being banned. PM_{2.5} levels across the 28 cities fell by 33% in the winter months of 2017, and in Beijing it fell by 54%;
- Planning and Response Coordination - Besides enhancing local air pollution control, Beijing also actively sought to co-ordinate air pollution control measures with the surrounding areas through collaborative planning, unified standards, joint emergency response, and information sharing.

Annexure 4.

Scope for Additional Coordination on Regional Sources of Pollution

Table 5a: Public, commercial and private transport

Action Area	Types of Actions in NCAP Plans	Additional Scope for Regional Coordination
Vehicle emissions	• PUC compliance drives and remote sensor-based PUC system • Initiate retrofit of particulate filters in diesel vehicles • Restrict 15-year-old vehicles from plying • Set up weigh-in bridges at borders, and impose levy on over-loaded vehicles	1. PUC reforms • Synchronized reforms in PUC rules for inclusion of all pollutants and upgrade of fuel to BS-VI norms; • Linking PUC compliance with insurance; • Digital records of vehicles failing PUC test accessible to traffic police across states 2. Road infrastructure • Review and adjust geometry and width consistency of roads inside a city and inter-city traffic routes; • Coordination in scientific traffic management systems design in the air-shed cities / regions including for diverse vehicle types, non-motorized transport and pedestrian-friendly spaces
Traffic congestion and private vehicles usage	• Introduce intelligent traffic systems and parking rules discourage private vehicles use • Introduce more buses (electric and clean fuel) to shift commuters • Widen roads and improve infrastructure including for non-motorized transport	3. Public transport & mobility • Design a Regional Comprehensive Mobility Plan with aim to move maximum people than vehicles across the cities in the air-shed in coordination with civil society, experts and public representatives; • Sharing expertise and best practices on multi-modal public transport system design to accommodate diverse commuters accounting for 80% of the trips in the city; • Make inter-city rail and bus transport

		integrated with multiple modes, safe, accessible through first/last mile connectivity and common smart cards; • Joint advocacy with Railways for ease of freight services usage; • Remove old buses from the fleet and procure additional buses; introduce special buses in seasons such as festivals, weddings, school and college admissions • Streamline pricing of public transport to be cost-effective per km in comparison to private vehicles over short and long distance travel; • Public transport policy amendment to ensure no impact of subsidy on the total operating cost or on budget allocated for future fleet procurement and infrastructure upgrade 4. Congestion and parking rules • Develop and implement congestion and parking policies in all states to discourage use of private vehicles; • Amend state transport policies to increase registration charge for private vehicles and restrict car ownership per dwelling unit address; • Shared roadmap to achieve negative growth rate in private vehicle ownership by 2025 5. Monitoring and evaluation • Sharing of results and learning from monitoring and evaluation of the actions implemented.
Cleaner vehicles	• Introduce electric vehicles in public transport and establish charging infrastructure • Introduce CNG to replace diesel in public transport	1. Promoting cleaner vehicles • Synchronized policies promoting EVs, charging infrastructure availability, and used battery replacement centres inside and outside cities to incentivize transition for EVs to reach 50% of all new vehicle registrations by 2025; • Scheme for DISCOMS and vendors to offer battery recharge points in residential / commercial places & parking areas; • Incentives and dedicated infrastructure for corporate owners of large vehicle fleets, commercial goods vehicles, three-wheelers and taxis to procure / convert to EVs; • Mapping of cities / towns where diesel

		vehicles in public transport are still in use to be replaced with electric; • All new government vehicles and public transport procured to be electric; • Introduction of a regional ecosystem of non-financial incentives for pollution-free private vehicle owners 2. Phasing out fossil fuel vehicles • Synchronized transport policies to discourage petrol / diesel vehicles by eliminating incentives and exemptions as well as imposing annual pollution levy; • Effective scrap vehicles policy for conventional vehicles to be phased out
Aviation	• Not in scope	• Develop customized monitoring devices for measuring pollutants from airplanes

Table 5b: Biomass and garbage burning

Action Area	Types of Actions in NCAP Plans	Additional Scope for Regional Coordination
Crop stubble burning	• Awareness drives to stop farmers from burning • Subsidy on machinery for stubble management	• All IGP states to prioritize most feasible solutions that are low-cost for farmers producing quick results for regional air quality; • Provide financial & non-financial incentives for (i) alternative crops / paddy varieties (ii) sowing-harvesting cycles that avoid burning; • Holistic policies and end-to-end subsidy approach for technologies and machinery that make stubble a part of circular economy and generate livelihood; • Pooling of resources for joint fund to support / compensate farmers and/or set up industrial plants for use of stubble; • Awareness drives to address myths related to impact on yields from not burning stubble; • Pre-emptive plan ahead of harvest season if burning is going to be significant
Fuelwood for domestic use, heating	• Replacement of wood as fuel with approved fuels or electricity	• Best practice sharing on increasing rates of PMUY LPG connections and cylinder refills; • Complement PMUY with clean cook-stoves and smokeless fuels, generating local entrepreneurship; • Assured electricity supply to enable shift from biomass to electric appliances
Garbage burning	• Implementation of waste management rules • Enforcement of	1. Waste management • Implementation of ward-level waste management plan in each state with waste segregation at source, collection / recycling centres and scientific disposal to reduce garbage

	ban on burning and	burning; - Involve waste-pickers and informal sector workers in the waste value chain through their registration as per 2016 Municipal Solid Waste Management rules for decentralized waste management; - All bulk generators to have on-site waste management for compostable waste; - All government offices to send zero waste to landfills by 2025; - Incentives and guidelines for large institutions and companies to send zero waste to landfills by 2025 2. Citizen reporting and monitoring - Create remote monitoring mechanism to detect burning of garbage by tying-up with ISRO or other international entities; - Use citizen-generated data identifying areas where biomass / garbage is being burnt or waste left unattended
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Table 5c: Dust

Action Area	Types of Actions in NCAP Plans	Additional Scope for Regional Coordination
Road dust in cities and traffic corridors	- Creation of green buffers along the traffic corridors with plants which are helpful in pollution control - Sprinkling of water and mechanical sweeping - Wall-to-wall pavement and footpath to have tiles with grass cover	- Amend rules to not allow large-scale felling of trees for infrastructure projects and any permission sought as an exception to be published on department website for public feedback; - Deploy road-dust cleaners of latest technology for various road sizes in the cities and nearby regions
Construction and demolition dust	- Covering sites and transported material - Sprinkling of water - Dust suppression units - Usage of pre-mixed mortar	- Implementation of Construction & Demolition Waste Management Rules 2016; - Sharing of best practices and technologies for dust suppression with and without water-use; - Measurement of real-time dust levels through ward-level sensors and publish hotspots on the website/app; - Rule for public display of construction agency and client information on a board at every site; - Citizen reporting through digital platform/app of dust control violations
Sandstorms	No reference to sandstorms though greening of open areas, RWAs and road sides	- Coordination in planning and developing green buffers and sanctuaries on inter-city / inter-state traffic corridors, borders and villages; - Use of sensor-based technologies and

		drones for immediate alert on a potential sandstorm; • Offer incentives for large campuses and farmers to adopt urban agro-forestry; • Enact / amend laws to pause any further deterioration and mining of Aravali hills which act as natural barrier to sandstorms and desertification
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Table 5d: Industry and electricity generation

Action Area	Types of Actions in NCAP Plans	Additional Scope for Regional Coordination
Large and medium industrial units	• Real-time monitoring • Use of appropriate air pollution control devices • Implementation of emission norms and/or shift industries from non-designated areas	• Mapping pollution hotspot industrial clusters in and around cities in the IGP region by deploying sensors at nearby public homes along with public awareness drives on emissions levels; • Inter-state emissions trading and polluter pays scheme mandatory for all industries with reducing emissions caps and legal limits; • Joint program on specialized sensors development for industrial pollution and real-time violation alerts to industry owner, SPCB RO and public monitoring portal; • Policy consistency in IGP states to avoid flight of industries and livelihood loss in the attempt to escape emissions limits and compliance costs;
Small scale industrial units, restaurants, incinerators, unorganized sector	• Shifting of industries	• Deploy low cost sensors in areas of MSME industries and informal sector; • Joint program in the cities and states to provide policy guidance, financial support and technical assistance to MSME industries for installing pollution control systems, switching of fuels and innovation in industrial processes; • Facilitate conversion of tandoors, laundry-ironing workers, incinerators, etc to cleaner fuels/electricity
Regional Renewable Electricity Market	• No reference	• All IGP states may introduce a time-bound legislation for 100% clean and affordable electricity from renewable (RE) sources by 2050 at the latest with no provision for polluting coal power plants in future to give clear direction to service providers and public; • RE generation and purchase targets to be enhanced by all IGP states to meet the demand; • Promote production and trading of RE through a regional market to meet demand, reduce generation costs and replace fossil electricity with RE; • Promote roof-top solar prosumer clusters inside and outside cities; • Harness decentralised RE electricity production in surrounding villages, large parks and urban areas as per suitable technology with increasing targets; • All IGP states to invest in R&D of safe and sustainable

		electricity storage/battery systems
Thermal Power Plants (TPPs) and waste-to-energy plants	- Emissions control systems to be installed by 2022 (2019 in NCR) - Emissions norms for SO_x, NO_x, and PM to be adhered to	- Mapping of TPPs on their real-time emissions and fly-ash generation for compliance status, surrounding areas public awareness and health department's protective measures; - Regional policy to prioritise procurement of cleaner electricity in the state tariff orders from RE and emissions standards compliant non-RE sources to ensure polluting power plants are operated only as much and when needed; - Non-compliant TPPs in the region be temporarily shut down while securing power from alternate sources; - Inter-state roadmap in coordination with CEA to install emissions control systems starting with priority TPPs based on pollution levels and population exposure in descending order; - Roadmap for phase out of thermal power plants where RE is cheaper and public health costs are escalating; - Waste to energy plants cost benefit analysis for emissions control vs power supplied and local waste disposed
DG sets	- Ban on DG sets - Only DG sets that meet standards are allowed	- Dynamic and responsive 24x7 power supply sector through inter-state coordination on demand deficit, thus, avoiding need for DG sets; - Ban on DG sets in phases except essential public services such as hospitals; - Provision for electricity supply back-up for non-essential needs to be permitted only from RE with battery storage; - GIS mapping of operational DG sets along with citizen reporting

Table 5e: Brick kilns

Action Area	Types of Actions in NCAP Plans	Additional Scope for Regional Coordination
Brick kilns using old technology and polluting fuels	- Conversion to cleaner zigzag technology - Monitoring of brick kilns for use of designated fuel - Identification and closure of unauthorized units	- Mapping of non-compliant kilns with citizen monitoring and publishing of status on department websites; - Joint research, pilot and implementation program on fuel/energy source transition and fly-ash use; - Campaign to generate awareness of benefits to kiln owners and employees as well as facilitate transition

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