Killer air
Learning curve and roadmap for the coming decade

National Media Workshop

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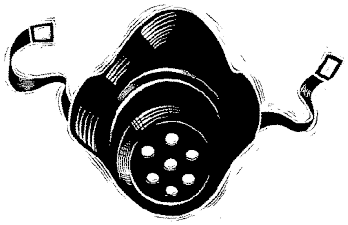
Centre for Science and Environment

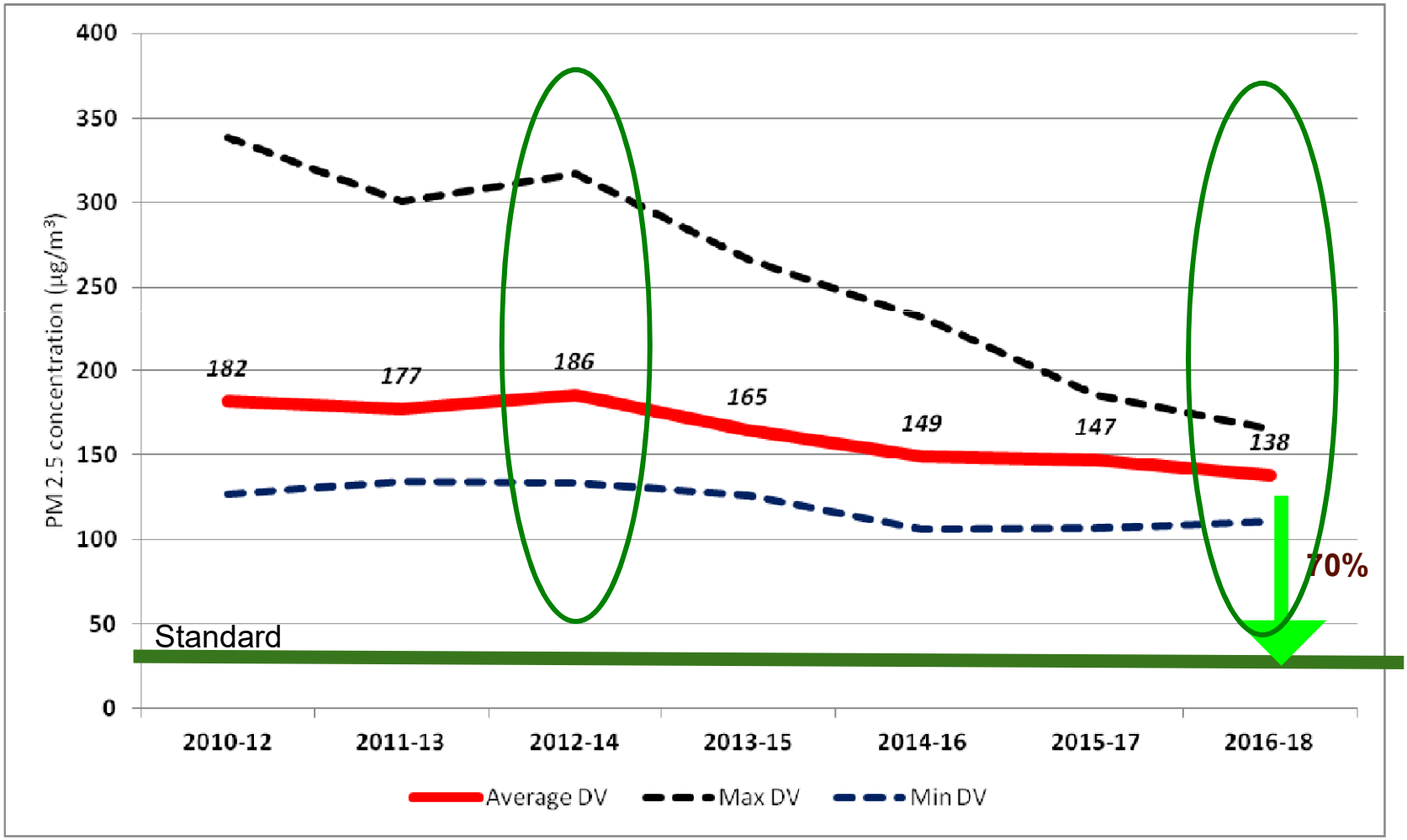
New Delhi, December 20, 2019



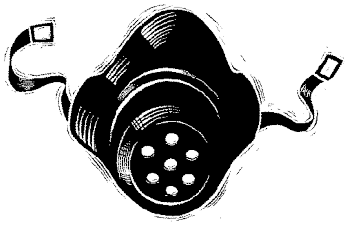
NCAP target for 122 cities:

Reduce particulate pollution by 20-30 per cent by 2024 from 2017 levels…….

Delhi: Decadal PM2.5 trend
25% drop; Need to cut another 65-70%



Source: CSE analysis of CPCB real-time PM2.5 data using US EPA methodology



How will cities report trend and compliance with the NCAP target?

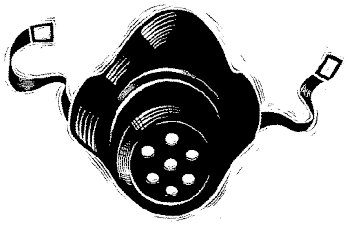
We reviewed the global methods: Applied to Delhi's air quality

•Air quality data from CPCB's online portal "Central Control Room for Air Quality Management - All India" for the period 2010-2018.

•Global regulatory approved methodologies used to develop pollution trend and also address data completeness.

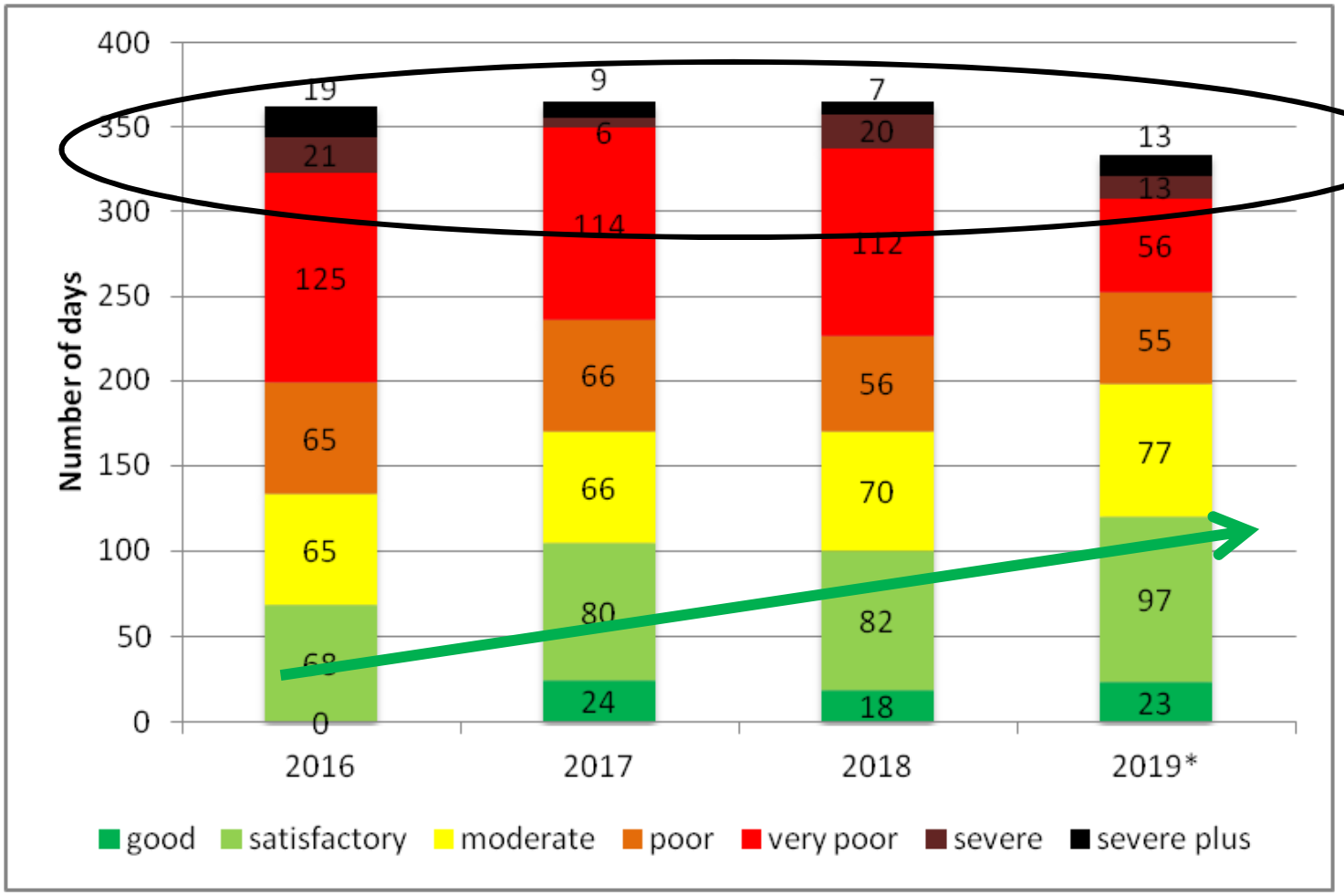
•CPCB needs to inform states about the method of reporting

•How will cities leverage manual and realtime data to construct trend for reporting?



How the years look like?

Number of cleaner days increasing; Severe days still obstinate

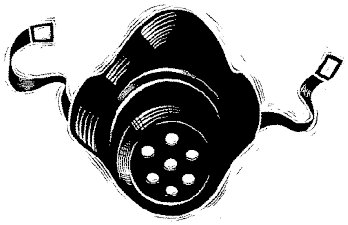


Almost 50% increase in number of days meeting 24-hr PM2.5 standard

Number of severe and sever plus days nearly constant

Very poor days declined

Source: CSE analysis of PM2.5 data from CPCB,



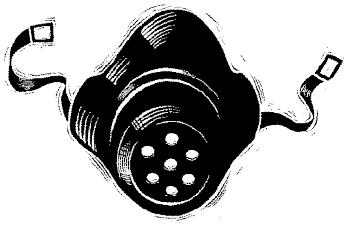
Second generation reforms- Action taken from 2015 onwards

❖ **Industry**

- Approved fuel notification (29.06.2018)
- Petcoke and furnace oil banned in 4 states. At national level, on November 17, 2017, SC requested other states to also ban its usage. Petcoke import also being restricted.
- SC order of May 2, 2017, has directed NOx and SOx standards for 34 groups of industries. MoEF&CC and CPCB issued Notification on January 29, 2018, for 16 groups of industries.
- Expansion of piped natural gas (PNG) network to industrial places in Delhi. Total number of industrial units identified for conversion to gas are 1467. Total number of industrial units converted to natural as are 1150. Also, incentives given to move to gas and removing tax on gas.

❖ **Power Plants:** Progressively shutting down coal power plants

- Indraprastha (405MW): Closed in September 2009
- Rajghat (135 MW): Closed in May 2015
- Badarpur thermal power station (705MW): Closed in October 2018
- Total generation capacity of 1245MW shut down
- Flyash utilization initiative underway including ecopark on flyash yard.
- Natural gas made available for Bawana power plant



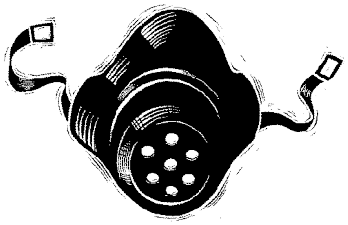
Second generation reforms- Action taken from 2015 onwards

❖ **Vehicular emissions**

- CNG for public transport expanded
- BS VI fuels with 10 ppm sulphur introduced in 2018
- 10 year old diesel vehicles and 15 year-old petrol vehicles are being phased out
- Favourable taxation for clean fuel introduced; also expansion of CNG stations. About 500 CNG stations have been opened
- EPC on big diesel cars and SUVs (more than 2000 cc). Diesel cars sales have dropped substantially in Delhi. At the national level, diesel cars accounted for 19 per cent of the total car sales during 2018-19 – dropping from half all sales in 2012-13.
- Pilot on Hydrogen-CNG buses (CNG with 18 per cent Hydrogen blend)
- Use of remote sensing technology for monitoring emissions from on-road vehicles
- Enforcement of PUC improved across NCR.
- Installation of stage I and Stage II vapour recovery system initiated and expanded. Environmental compensation of Rs 1 crore imposed on oil companies: IOCL, HPCL and BPCL for non-compliance with directions on vapour recovery

❖ **Trucks**

- EPE-WPE, 60,000 trucks have been diverted from Delhi.
- ECC (2015) on - to deter non destined trucks
- Restriction on entry of 10 year old trucks
- Introduction of RFID at 13 entry points in Delhi



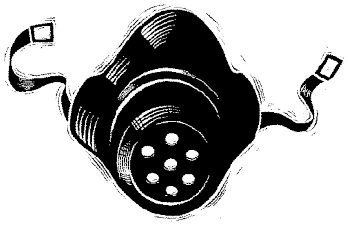
Second generation reforms- Action taken from 2015 onwards

❖ **Public Transport**

- Average daily ridership of DTC buses- increased by two lakhs compared to 2016-17. The average ridership of DTC buses is 42.03 lakh. DTC bus numbers have reduced
- NCR reciprocal agreement -- autos and buses allowed to run across borders in entire NCR draft in 2008 and effective from 2010; Time for its renewal
- Ridership in the metro increased from 1259000 in 2010-11 to 2708376 in 2018-19. The operational route has increased from 165.5 km in 2010-11 to 373 km in 2018-19; Rolling stock has increased from 844 in 2010-11 to 2194 in 2018-19.
- Parking policy as a demand management tool has been notified. Pilot schemes on parking area management plans initiated.

❖ **Waste Burning**

- Solid Waste Management Rules and Regulations 2016 notified
- Delhi byelaws amended based on these rules and notified in January 2017. To be implemented
- The city has over 2,300 waste dumps. Over 80 per cent of the waste is processed through incineration
- Large-scale burning of plastics in Mundka area of Delhi that caused enormous poisonous gases. Now factories have been linked with waste to energy plant for safe removal and disposal of plastic waste in that area
- The status of segregation in the city is not more than 10 per cent and is restricted to a few institutions and colonies only. 12 wards from different MCDs in Delhi have been selected as model wards. To prevent littering 6,000 roadside twin bins have been procured.



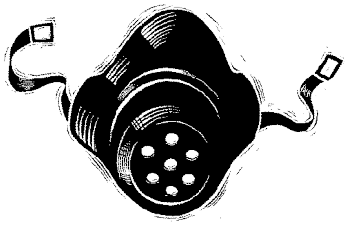
Second generation reforms- Action taken from 2015 onwards

❖ **Construction and Demolition waste and dust**

- Checklist for dust control at construction sites made. According to the latest Economic Survey, DPCC has so far since January 2018, has imposed fine to the tune of Rs 3,55,50,000 in respect to dust control. DPCC has imposed fines on construction projects who have taken environmental clearance (for built up area more than 20,000 sq meter).
- The Construction and Demolition Waste Management Rules, 2016 notified and BIS rules modified in 2014 to allow use of recycled C&D waste in building construction
- There are 60 mechanized road sweeping machines in Delhi
- Environmental compensation of Rs 1 crore has been imposed on Municipal bodies (New Delhi, South, East, North and Cantonment Board) over open dumping/ burning of garbage and C&D waste vide directions dated January 16, 2019
- City has expanded recycling capacity of it's C&D waste recycling plant at Burari from 500 MTD to 2,000 MTD.
- City has also added two more recycling plants to combined capacity of 650 MTD

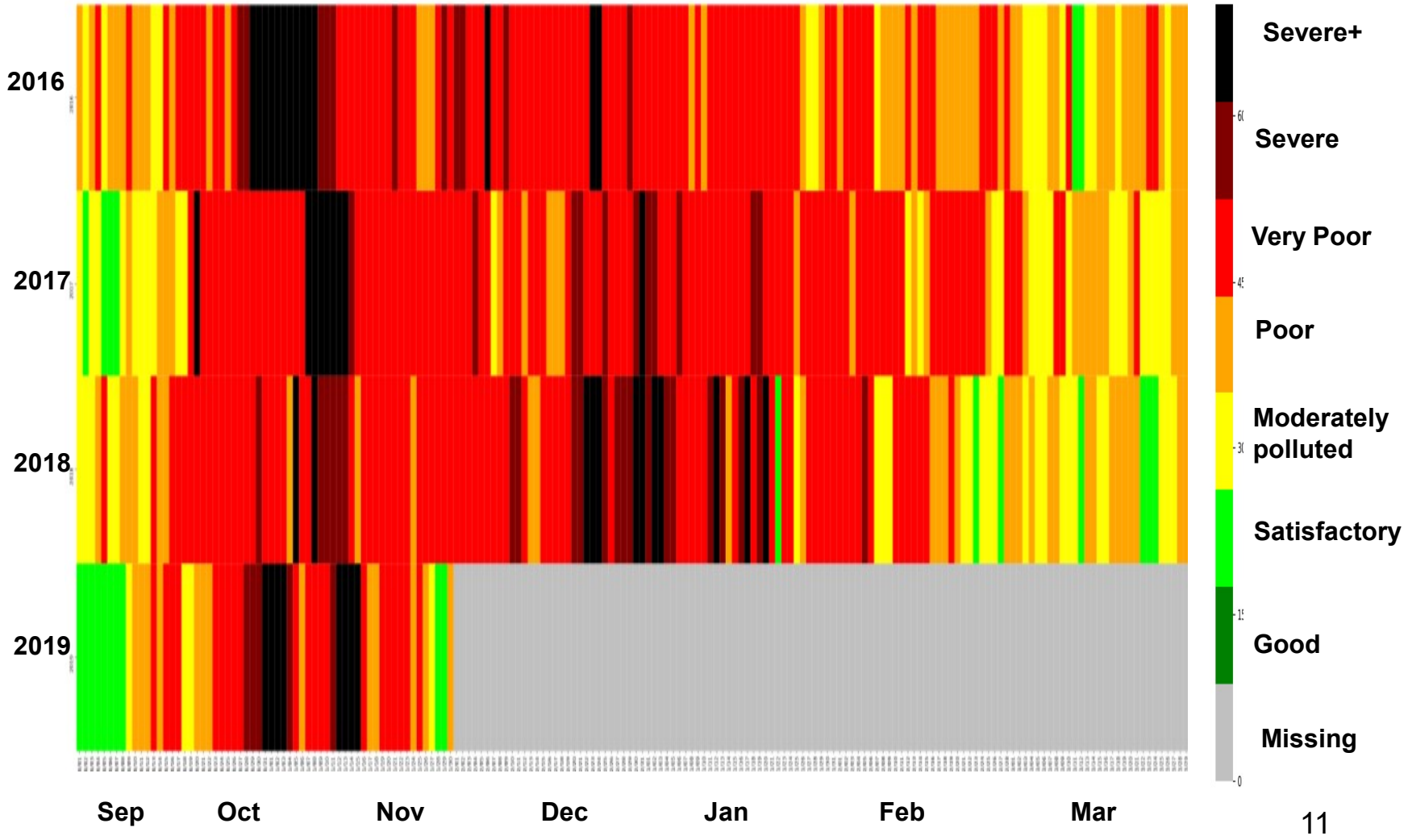
❖ **Monitoring and Graded Response Action Plan (GRAP)**

- Air quality monitoring stations expanded to 38 in Delhi and over 50 in total in the region
- Early Warning System for Delhi launched in October, 2018
- GRAP implemented during 2017-18 and 2018-19



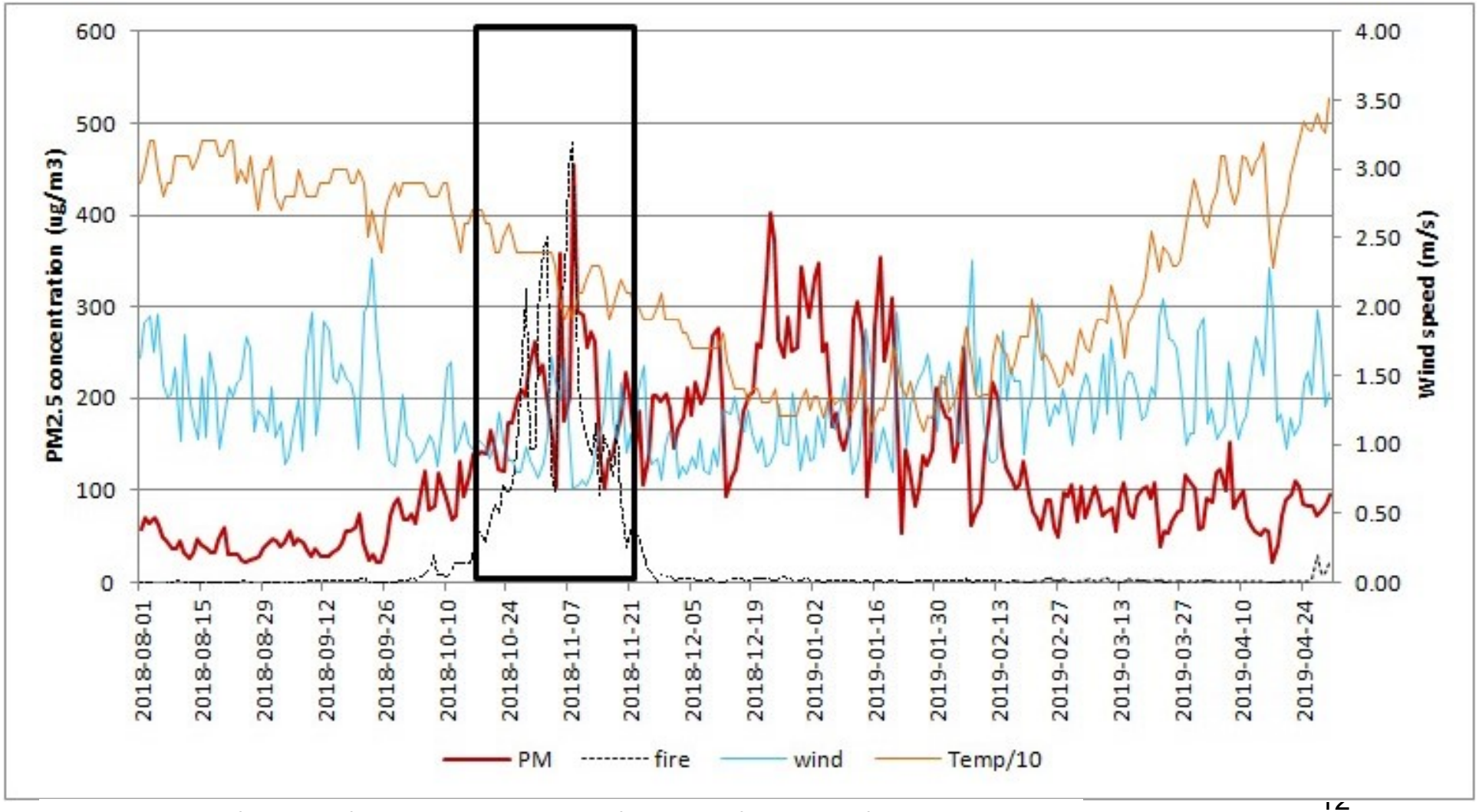
Pattern of winter pollution.....

Delhi winter pollution: changing pattern



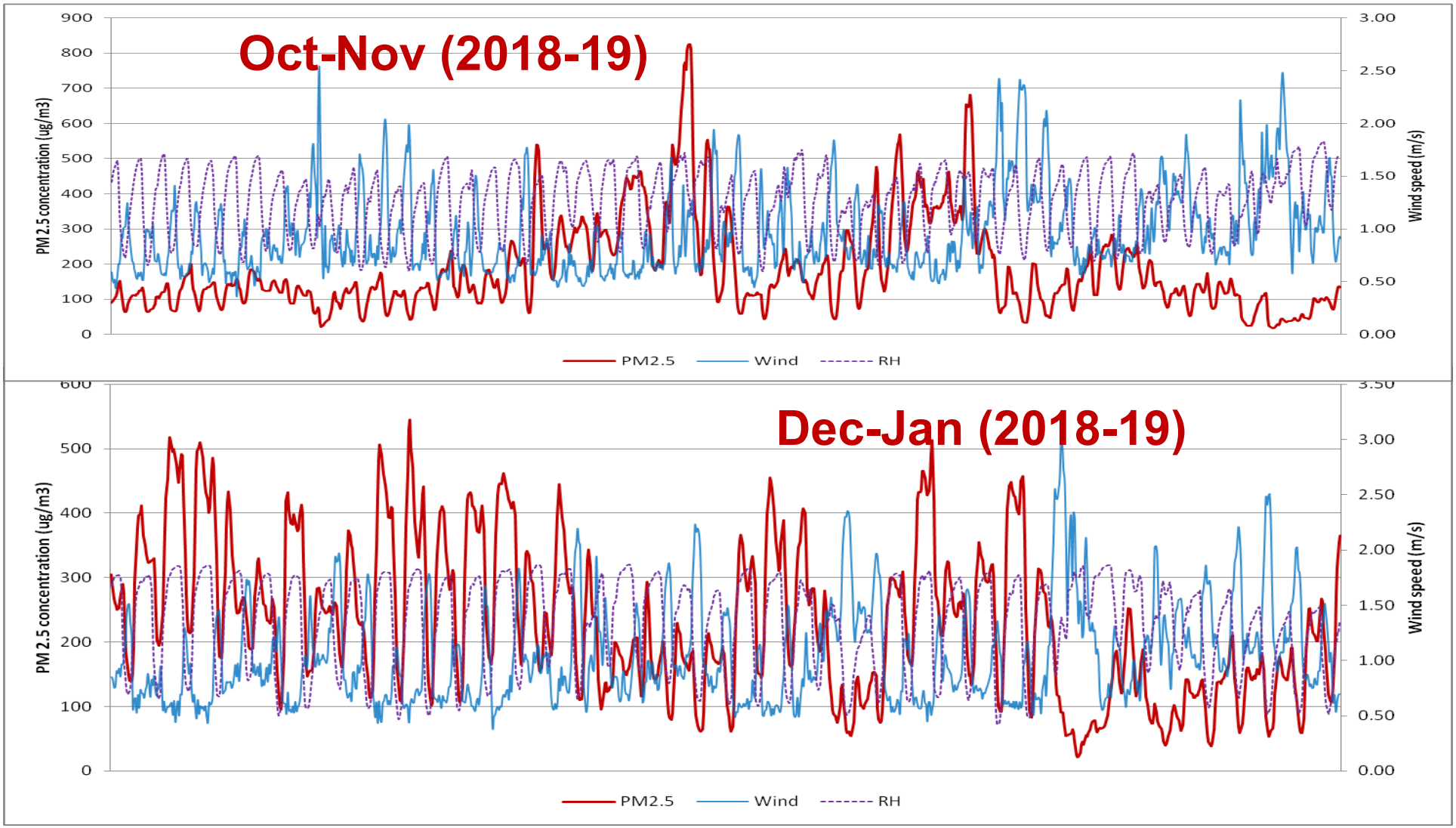
Source: Based on data available on CPCB

Winter pollution says different stories



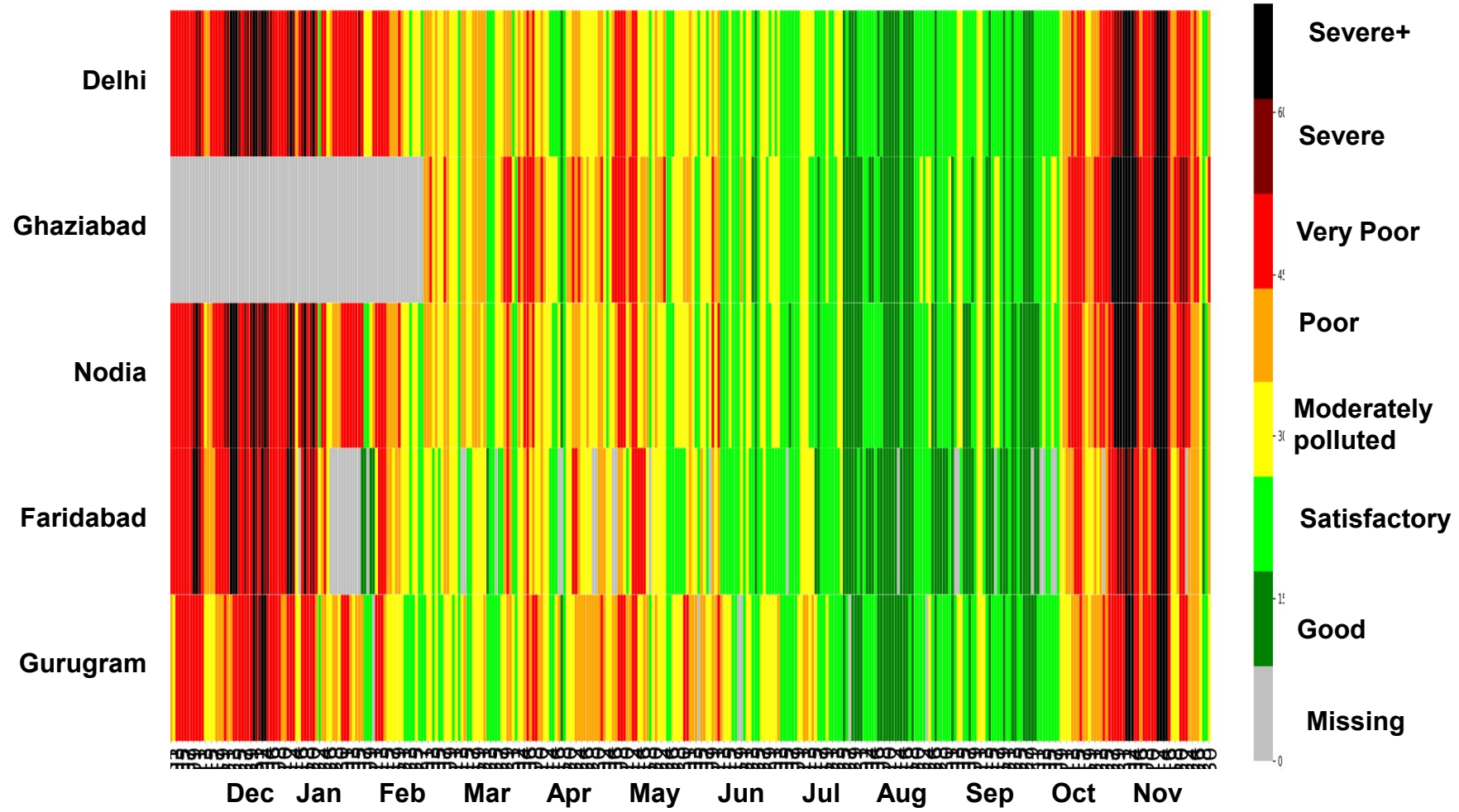
Source: CSE analysis of PM2.5 data from CPCB, meteorological data from IMD and fire count data from NASA

Cycle of smog

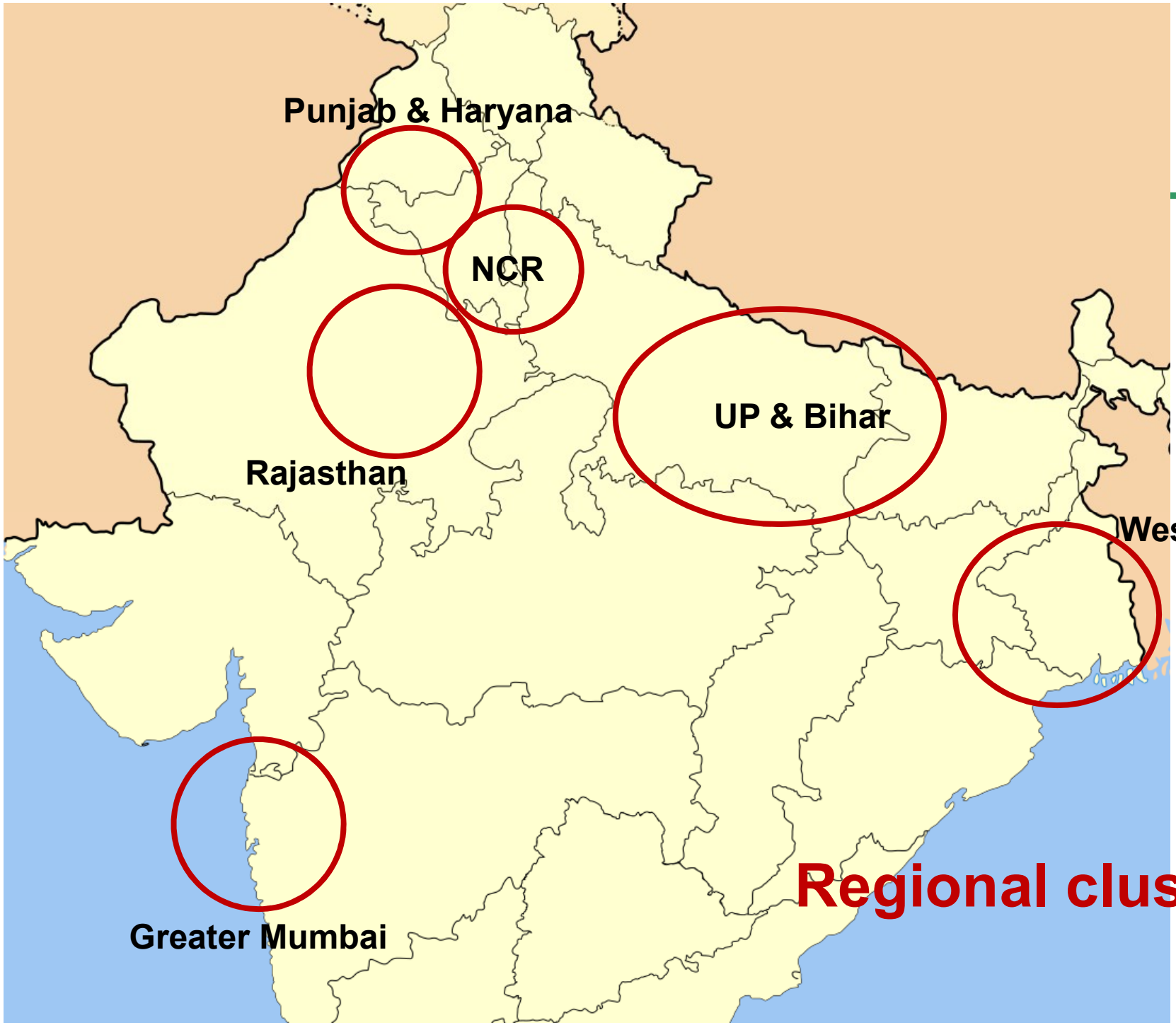


Source: CSE analysis of PM2.5 data from CPCB, and meteorological data from IMD

NCR Pollution: Well synchronised
(Dec 2018-Nov 2019)

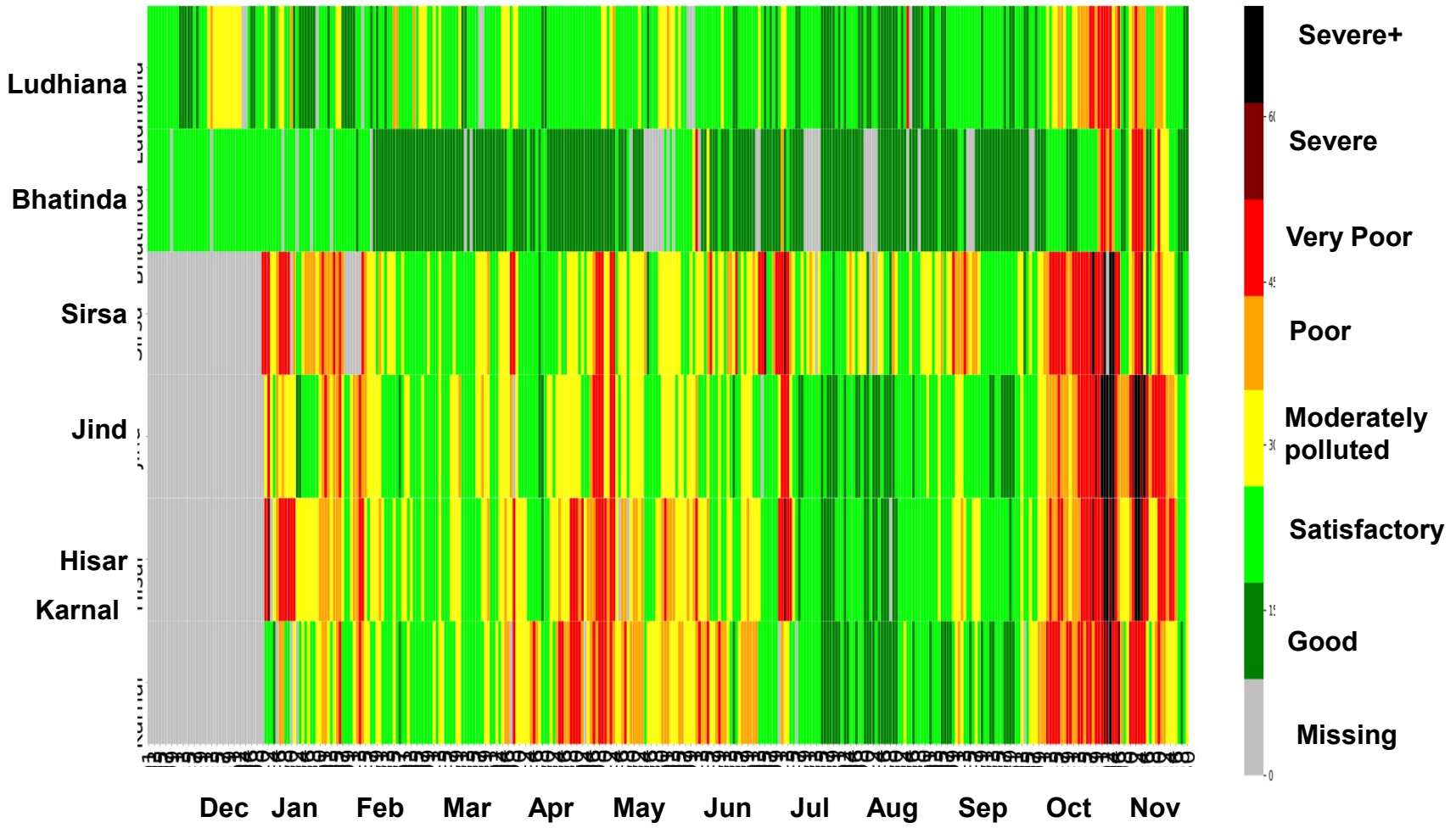


Source: Based on data available on CPCB



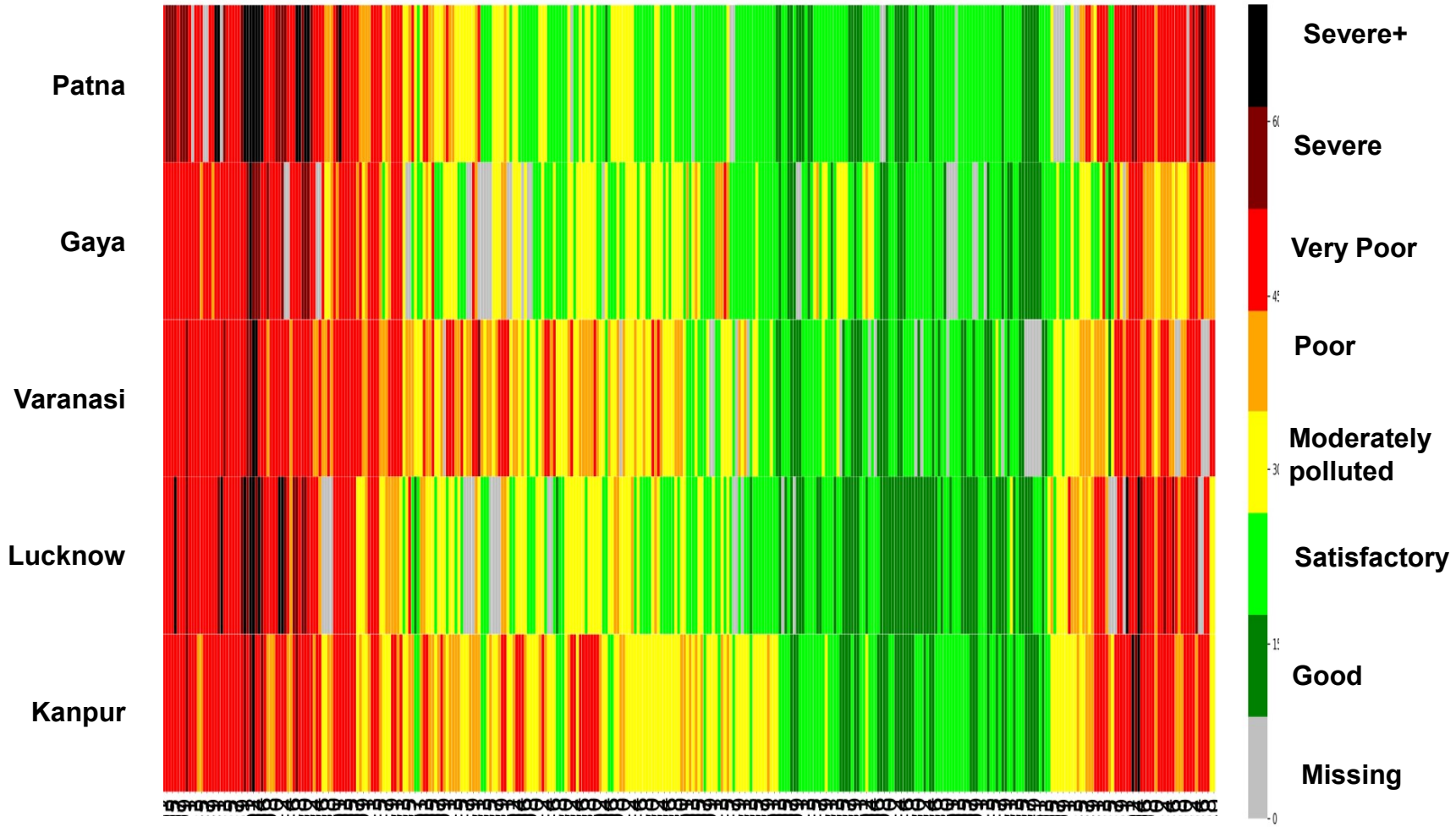
Regional clusters

Selected cities of Haryana and Punjab



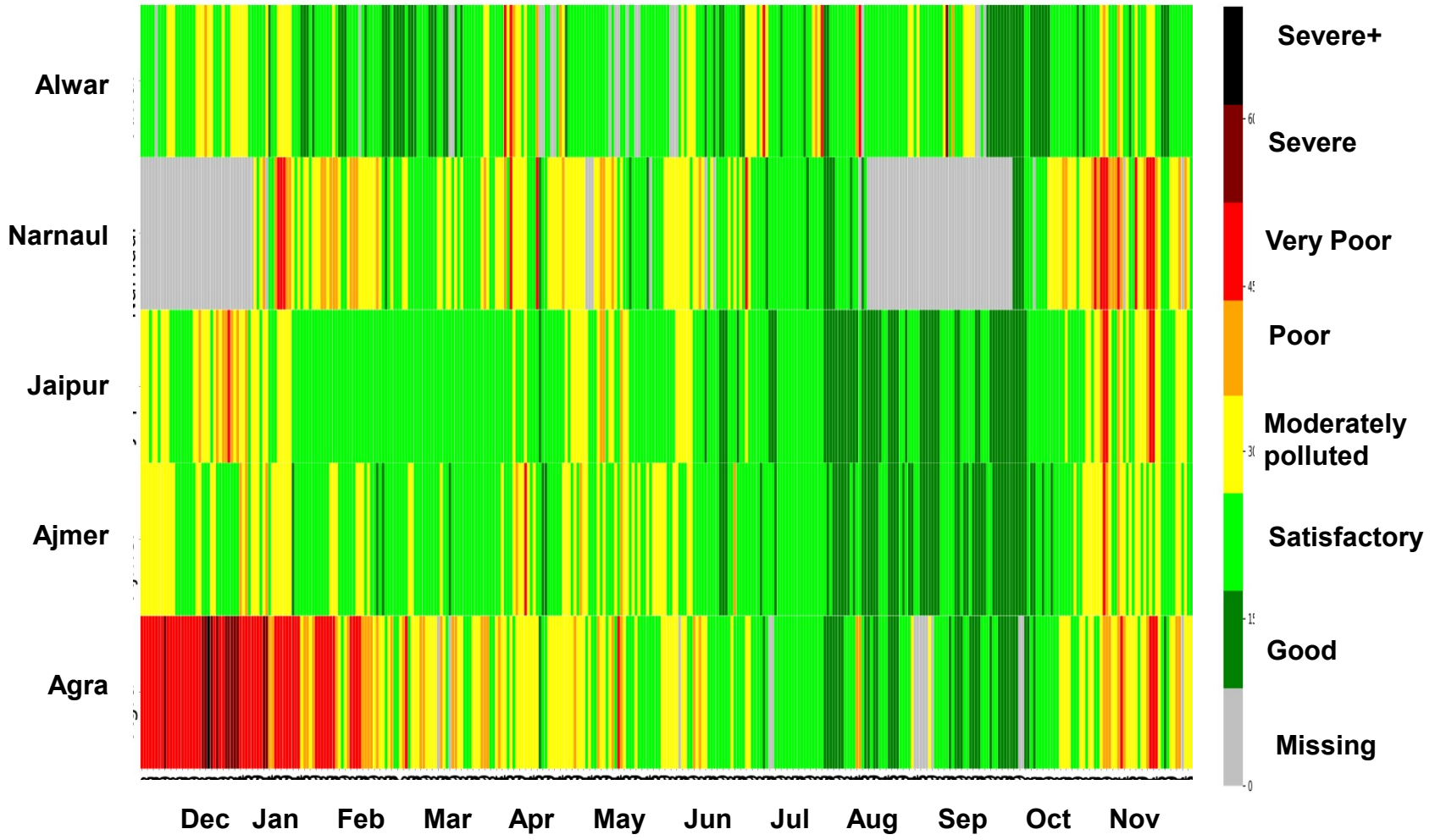
Source: Based on data available on CPCB

Selected cities from UP and Bihar



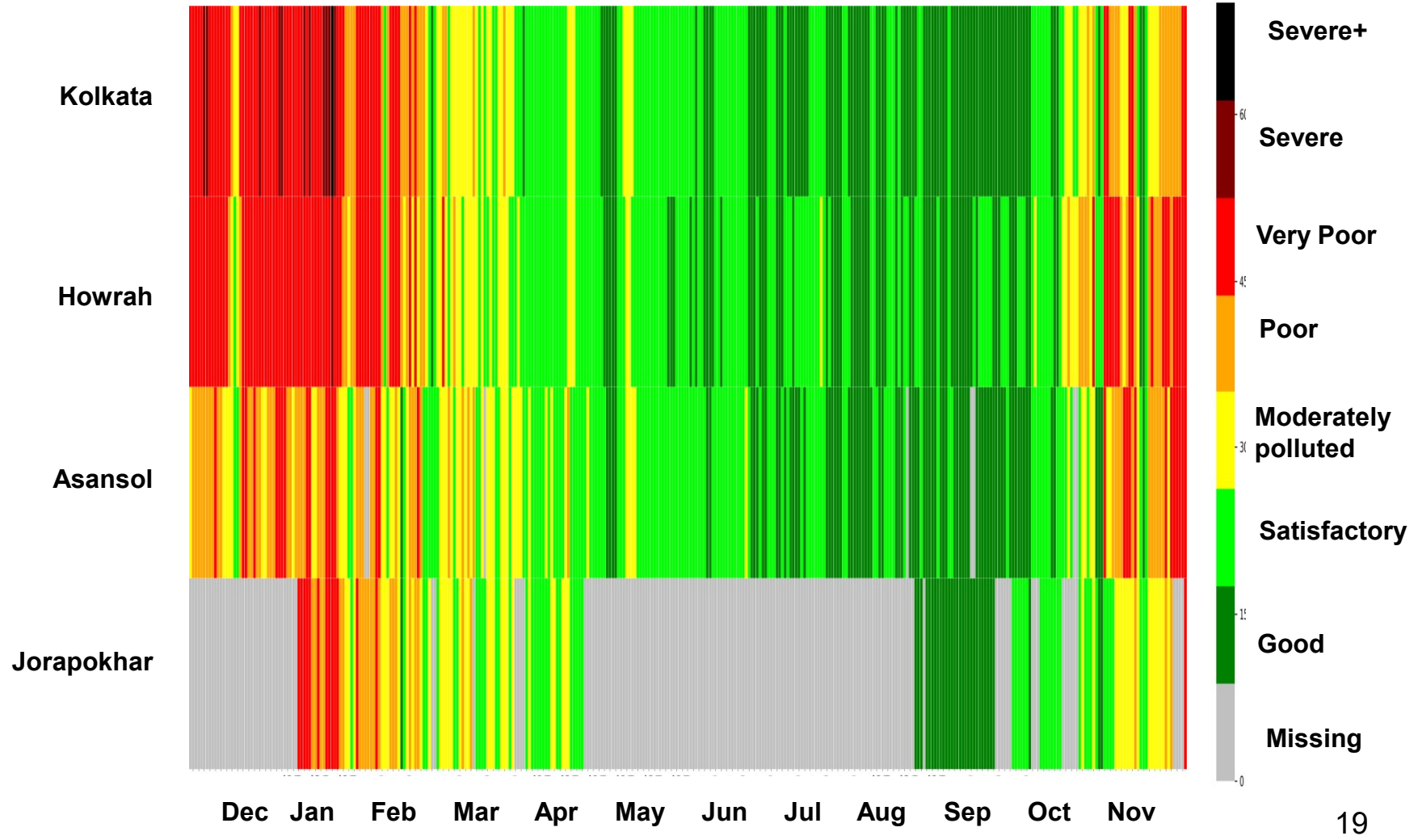
Source: Based on data available on CPCB

Cities of Eastern Rajasthan and Agra



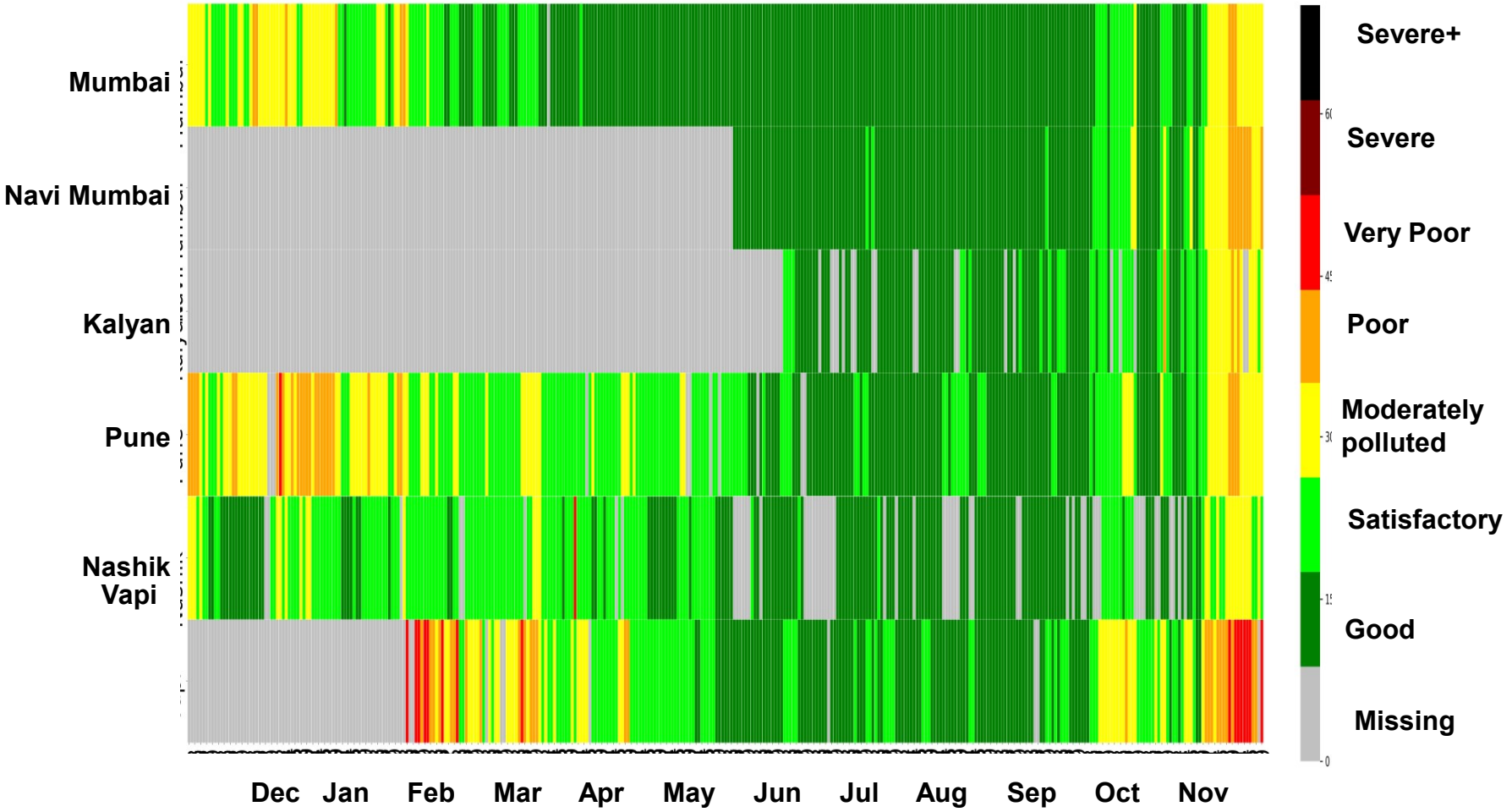
Source: Based on data available on CPCB

Cities of West Bengal and



Source: Based on data available on CPCB

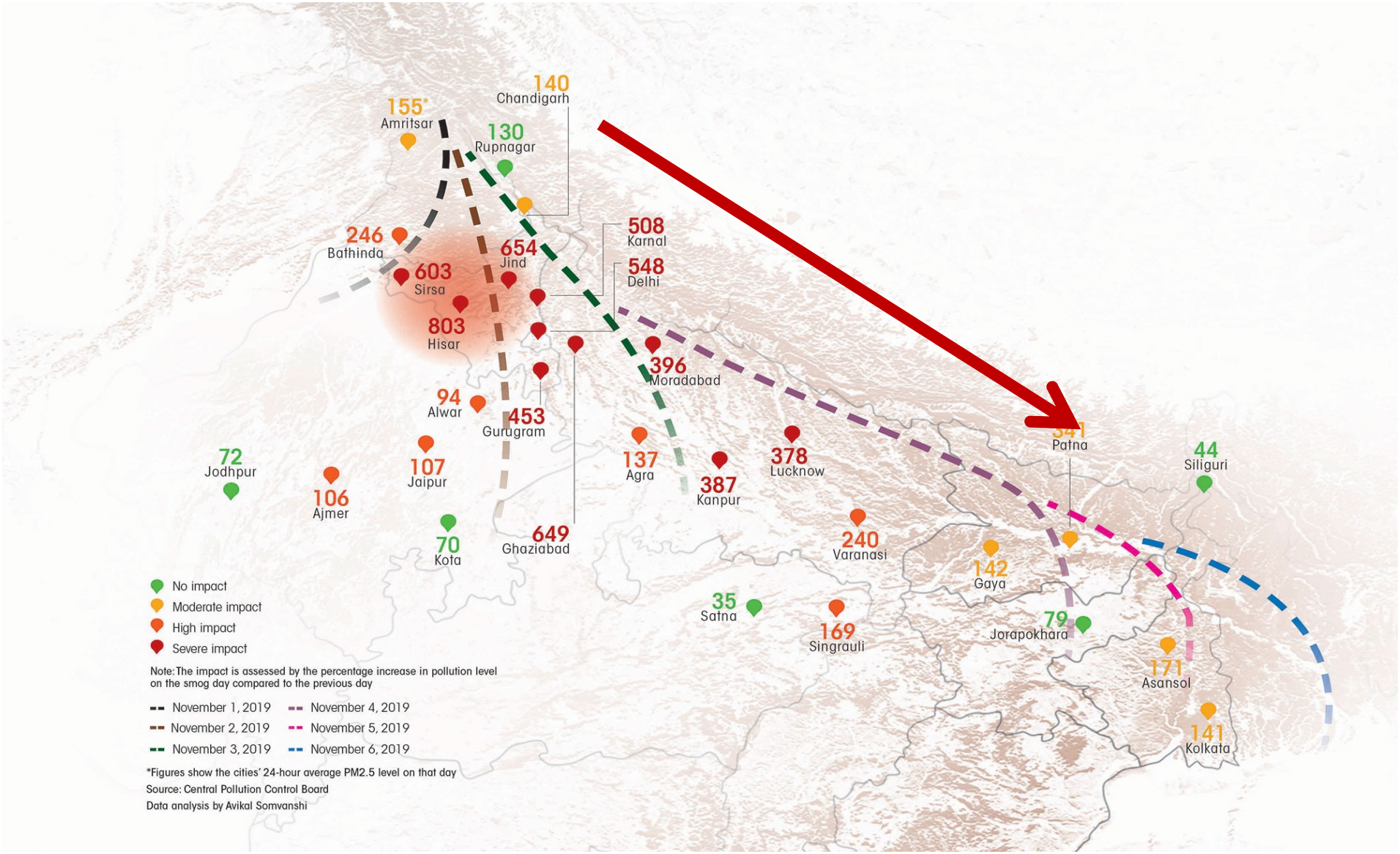
Greater Mumbai region and Vapi

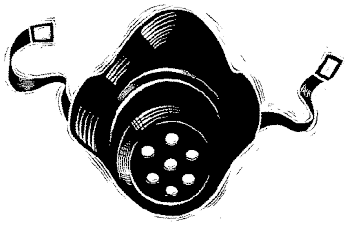


Source: Based on data available on CPCB

Mumabi in November, 2019

Tracking shifting smog peaks in Indo-Gangetic Plain during smog episodes





Pollution – High and Low

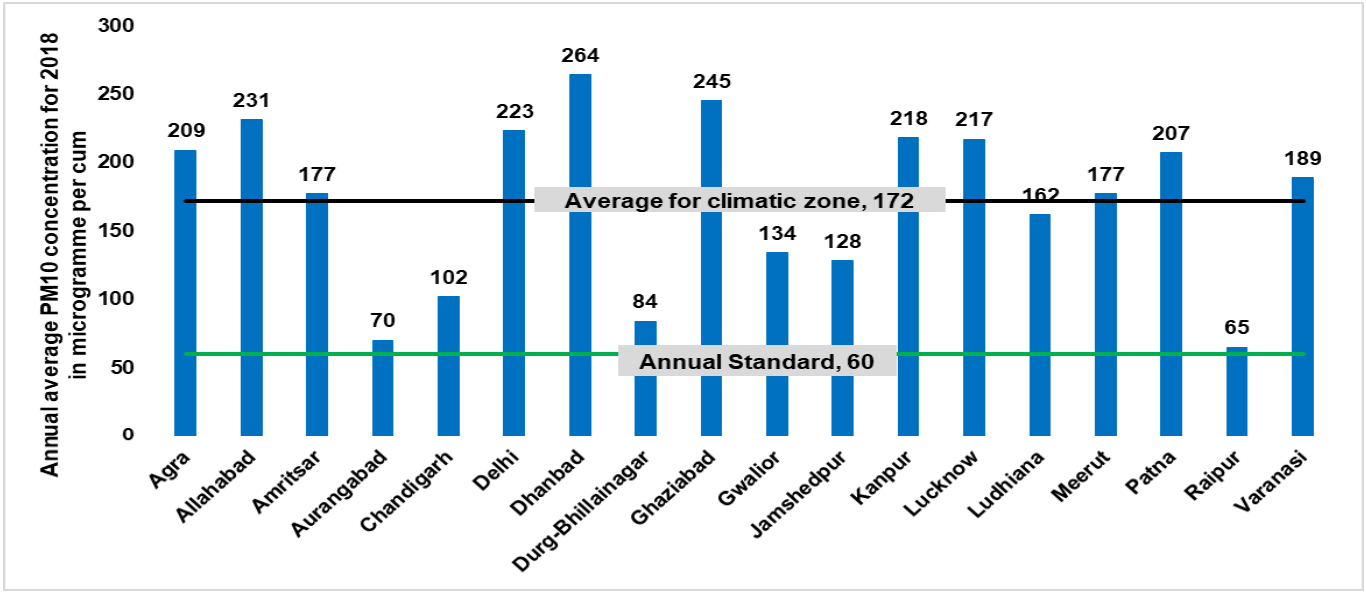
STATE OF AIR POLLUTION

India recorded just nine out of 93 disasters in Asia, but accounted for nearly 48 per cent deaths in 2019. The country also had nearly 46 per cent

LEGEND
00 Annual 2019
00 Daily max 2019

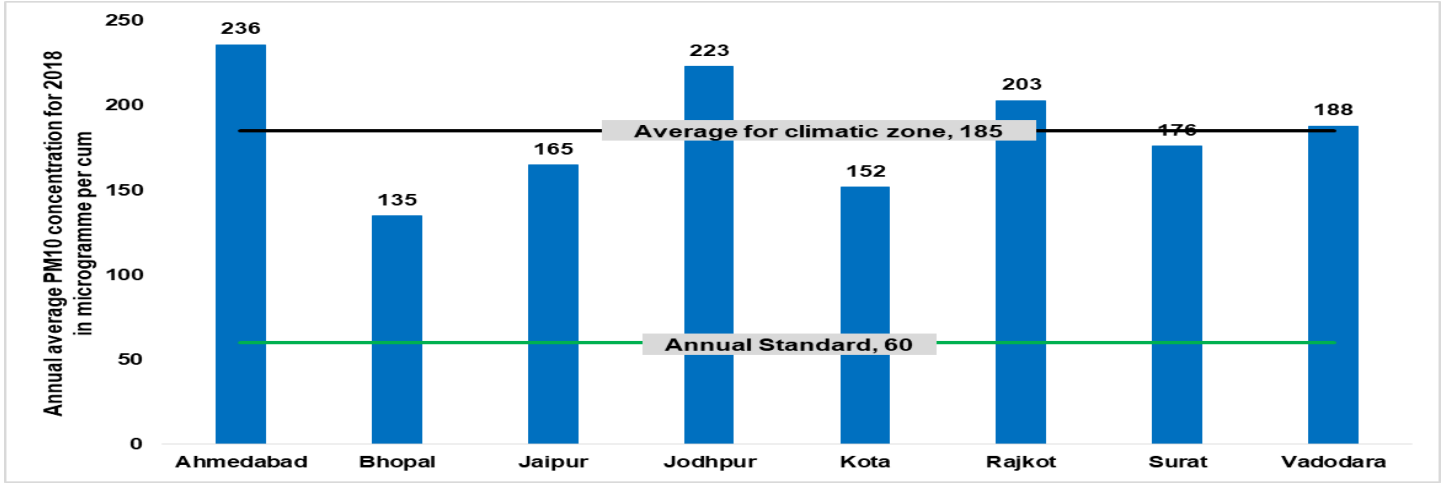
Amritsar 51 | 185
Bhatinda 32 | 246
Chandigarh 57 | 139
Sirsa 85 | 471
Karnal 76 | 539
Jind 77 | 655
Hisar 89 | 794
Narnaul 63 | 218
Moradabad 107 | 403
Delhi 111 | 566
Rohtak 79 | 472
Ludhiana 49 | 186
Meerut 96 | 570
Agra 86 | 299
Gurugram 94 | 443
Jaipur 49 | 135
Lucknow 102 | 382
Jodhpur 88 | 387
Kanpur 100 | 385
Udaipur 47 | 100
Noida 112 | 590
Patna 109 | 447
Faridabad 100 | 452
Pali 58 | 334
Varanasi 101 | 351
Ratlam 47 | 114
Ghaziabad 100 | 693
Satna 16 | 116
Gaya 89 | 307
Kota 54 | 144
Ujjain 45 | 143
Singrauli 89 | 275
Jorapokhar 62 | 184
Asansol 62 | 171
Gandhinagar 36 | 105
Bhopal 52 | 140
Jabalpur 53 | 138
Kolkata 77 | 314
Ahmedabad 64 | 235
Indore 47 | 116
Vapi 54 | 163
Navi Mumbai 28 | 107
Nashik 33 | 127
Nagpur 45 | 230
Aurangabad 39 | 290
Thane 89 | 550
Mumbai 33 | 102
Pune

PM10 in different climatic regions



Indo-Gangetic plain

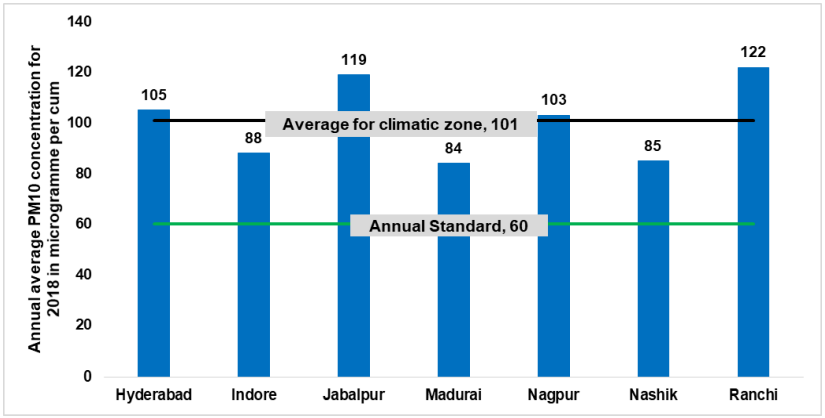
Hot & Dry (North)



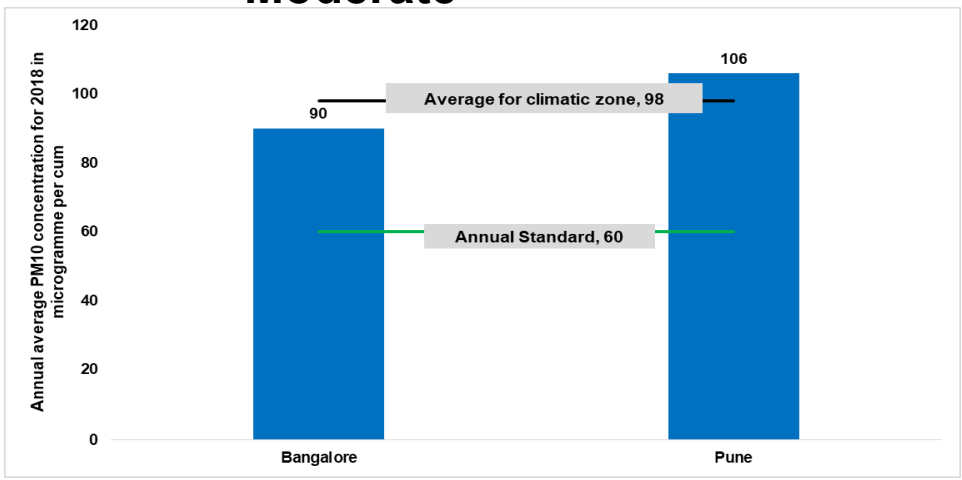
Source: CSE's analysis based on CPCB Envis centre and data submitted to Lok Sabha

PM10 in different climatic regions

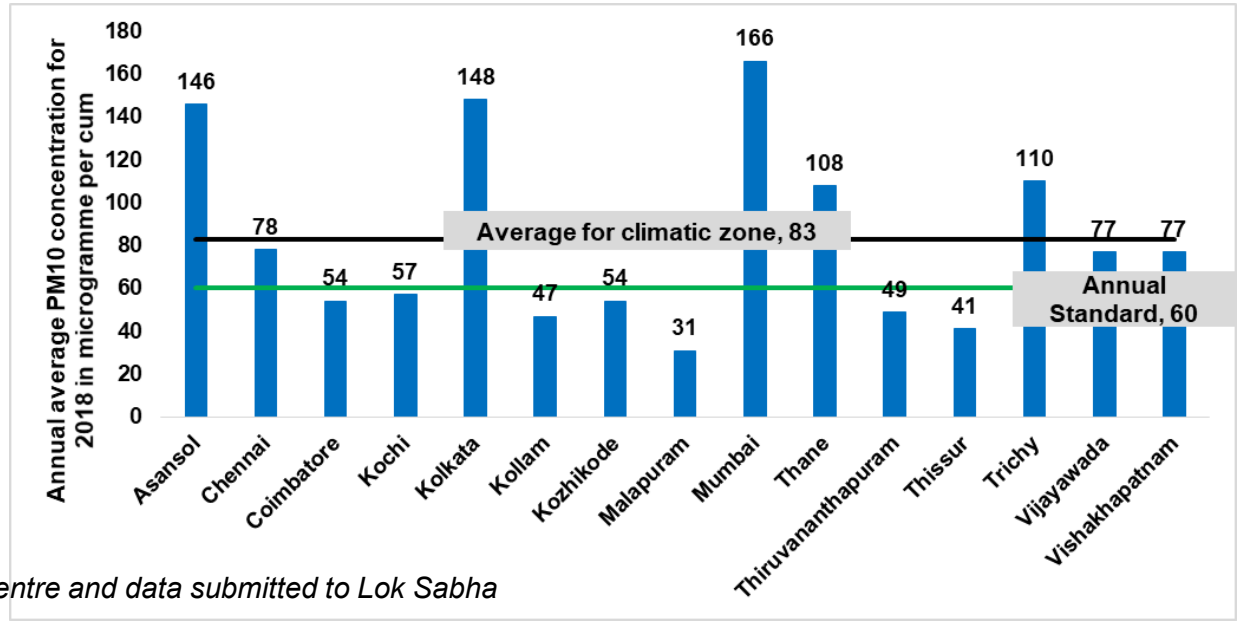
Hot & Dry (South)



Moderate



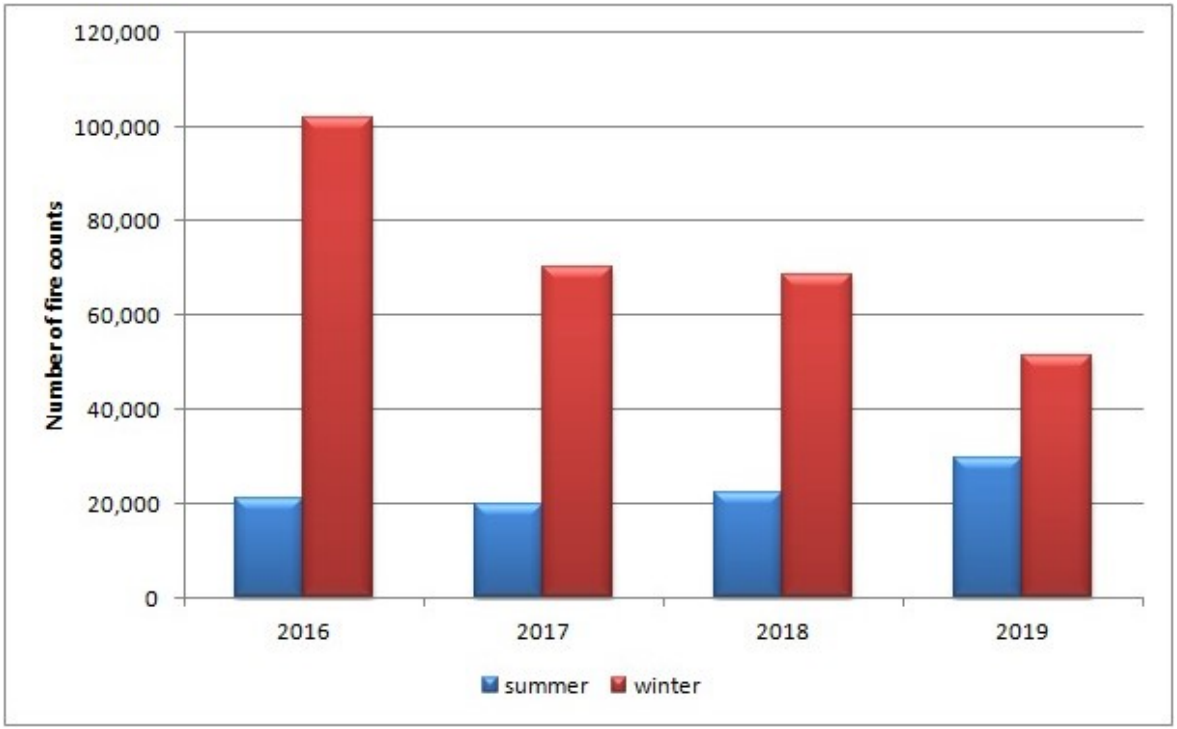
Warm and Humid (Coastal)— PM10 levels have gone up to 2 times the standard in case of Mumbai



Source: CSE's analysis based on CPCB Envis centre and data submitted to Lok Sabha

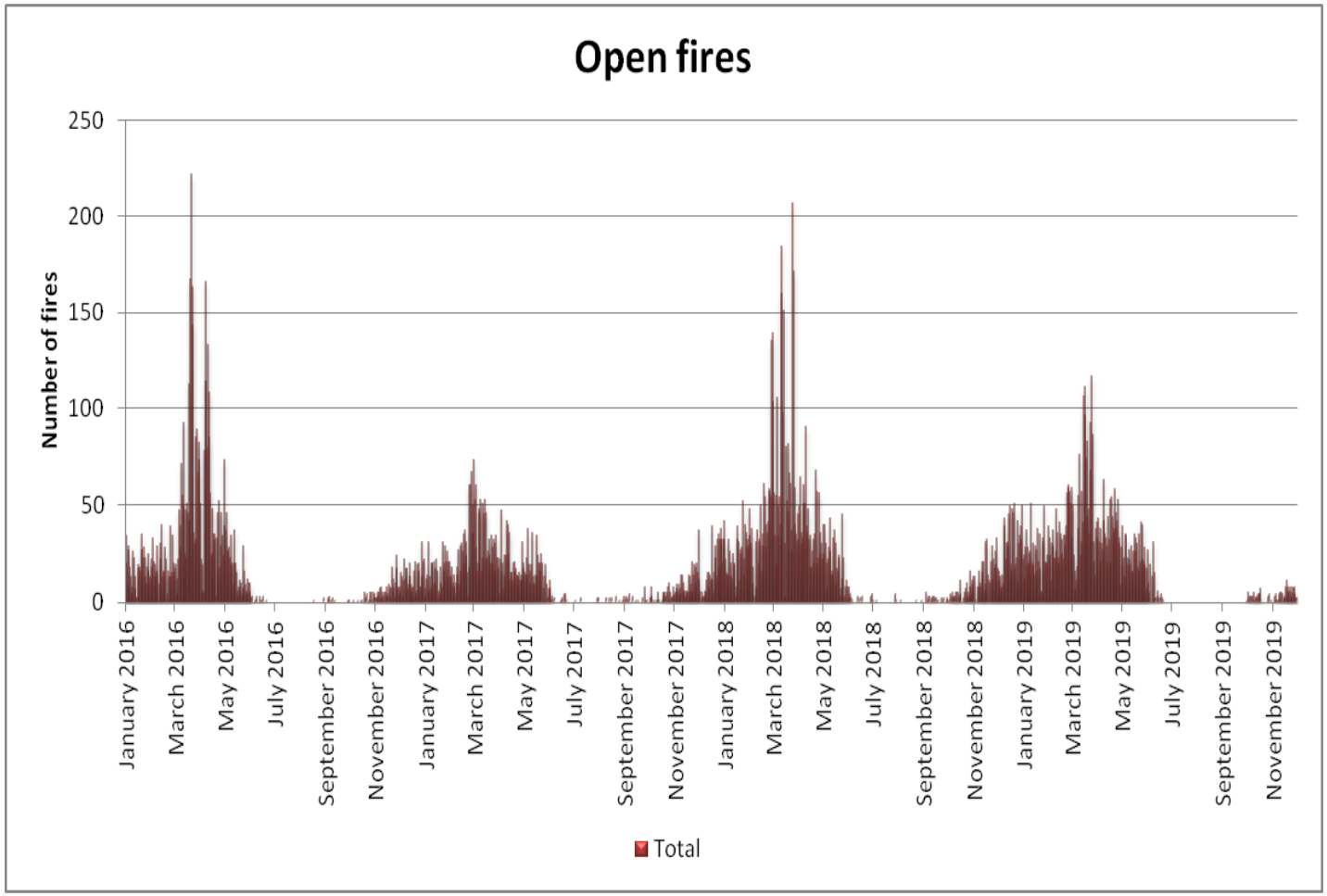
Episodic pollution
Stubble burning in Punjab and Haryana

Fire count from NASA



Source: CSE analysis of fire count data from NASA

Fire patterns in Mumbai Region



Fire instances reported from Nov-May.
Most in March

Distribution of fires (since 2016)
Mumbai: 589
Thane: 8,750
Rajgarh: 13,810

Needs investigation

Source: Based on satellite data available from NASA

Fire in West Bengal

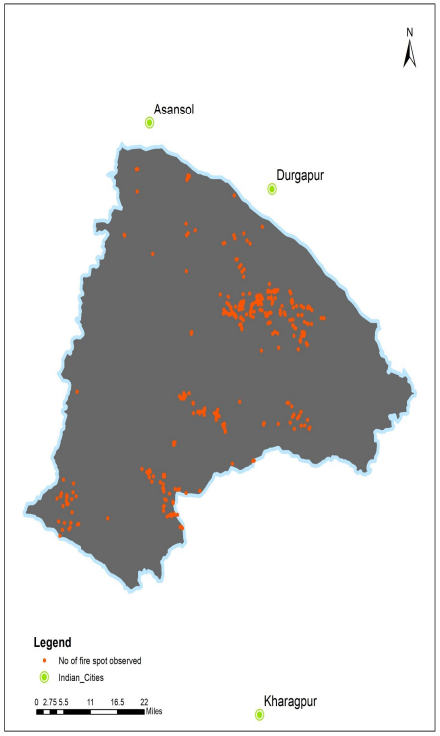
Summer: March- April, 2019

Date	Bankura	Birbhum	Purba Barddhaman	Paschim Barddhaman
Total	353	56	72	937

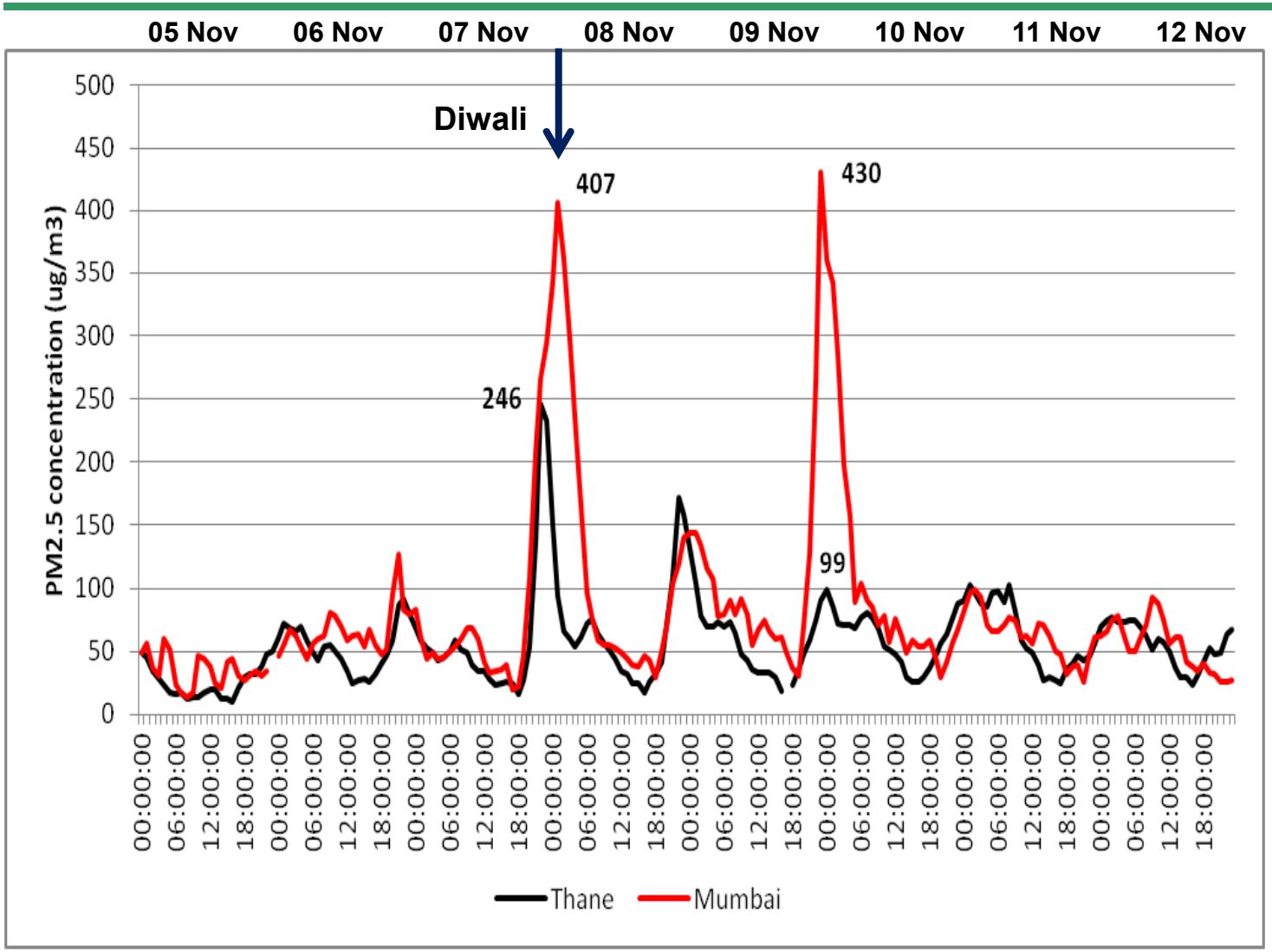
Winter: October – November, 2019

Date	Bankura	Birbhum	Purba Barddhaman	Paschim Barddhaman
Total	49	4	8	881

Source: *FIRMS – Fire Information for Resource Management System, NASA, VIIRS 375m data, web-link: https://firms.modaps.eosdis.nasa.gov/map/#z:6;c:78.8,22.6;d:2019-11-05..2019-11-06*



Mumbai: Diwali 2018

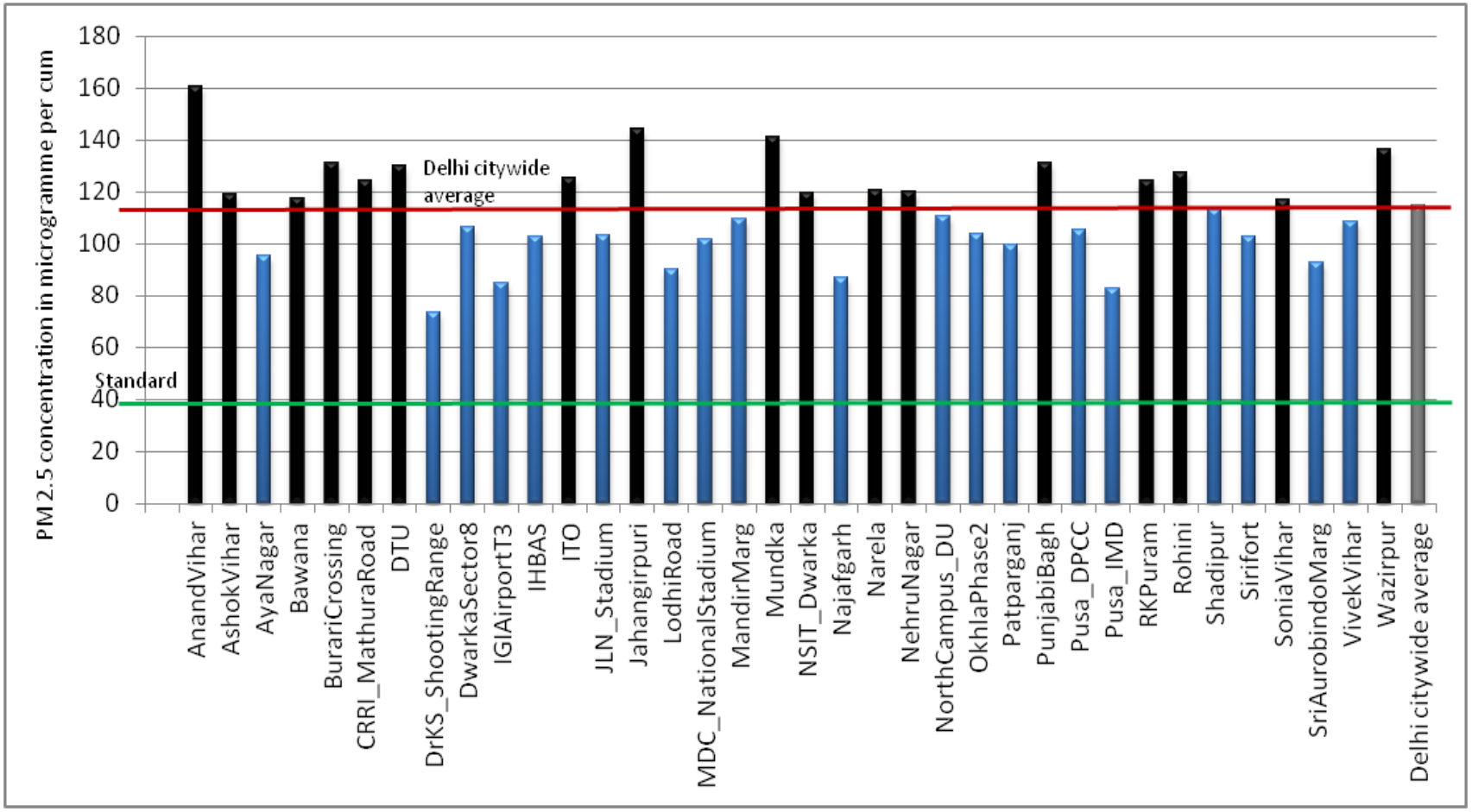


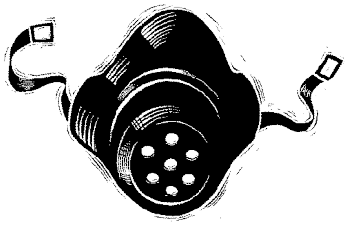
PM2.5 levels rose by **18times** between 6pm to 1am on Diwali night in 2018.

But, there was an even faster and higher build-up on 9 Nov 2018, when levels shot-up from **30ug/m3 at 7pm to 430ug/m3 at 11pm**

Source: Based on satellite data available from NASA

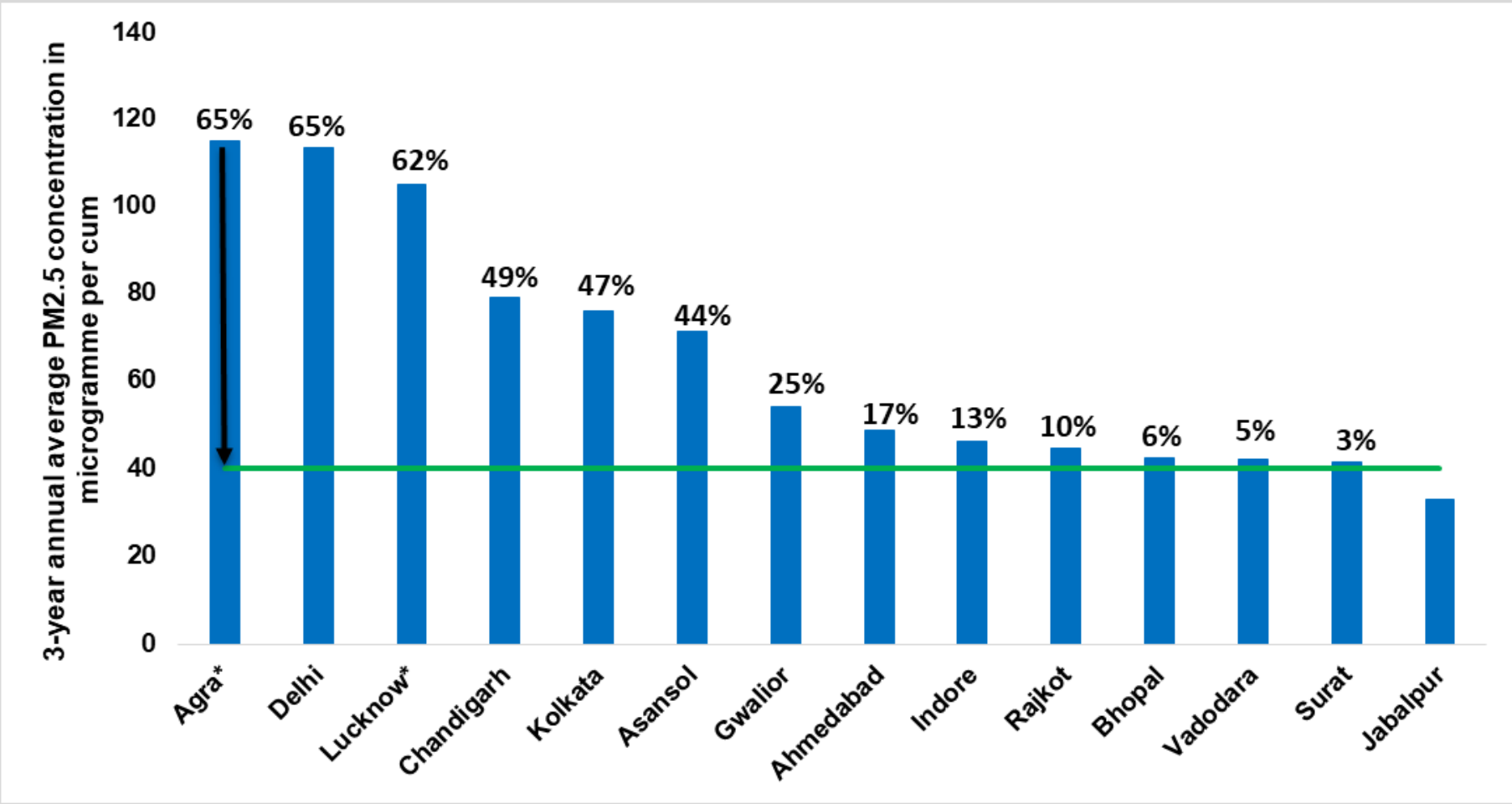
Pollution hotspots in Delhi





Reduction needed to meet the national ambient air quality standard for particulates....

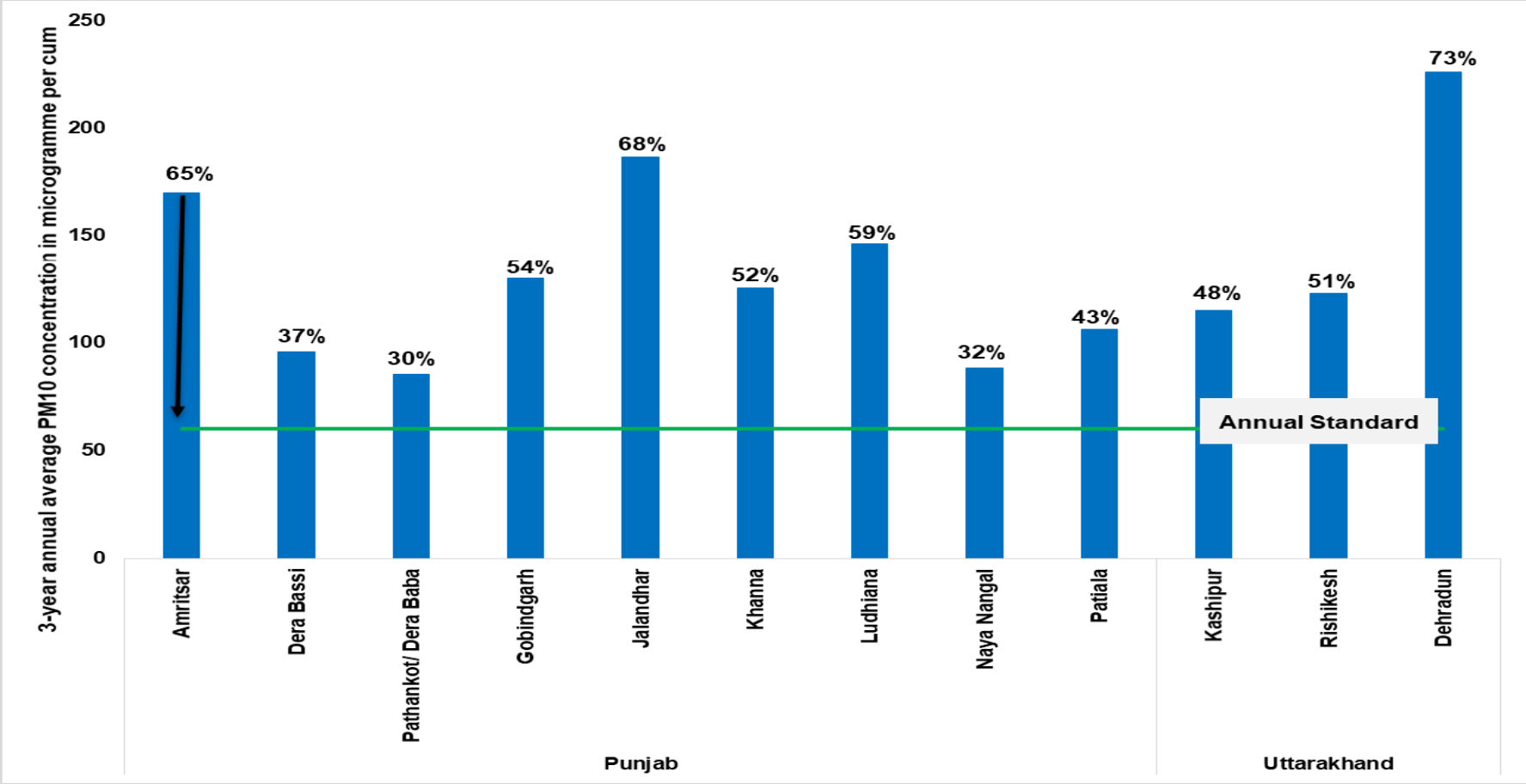
Reduction target for PM2.5



Source: CSE's analysis based on CPCB Envis centre and data submitted to Lok Sabha

PM10 reduction target

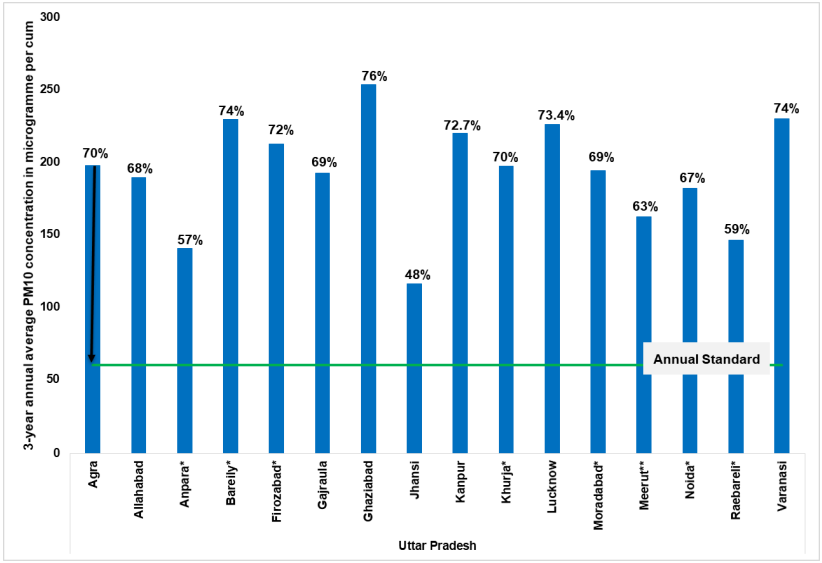
Punjab and Uttarakhand cities



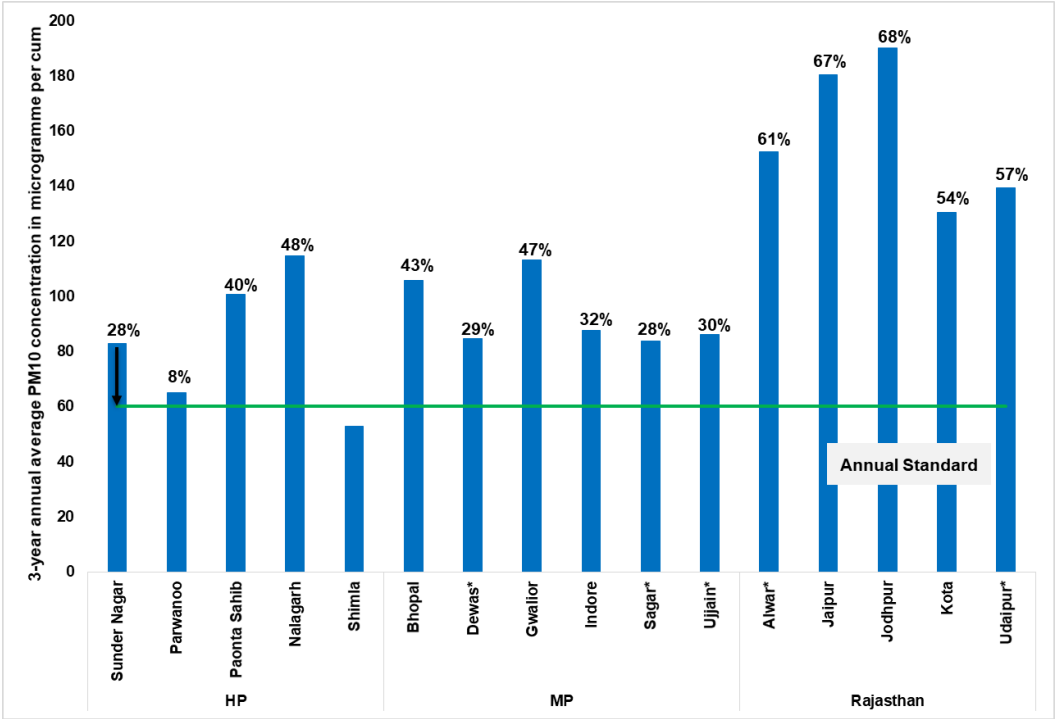
Source: CSE's analysis based on CPCB Envis centre and data submitted in Lok Sabha

PM10 reduction target

Uttar Pradesh cities

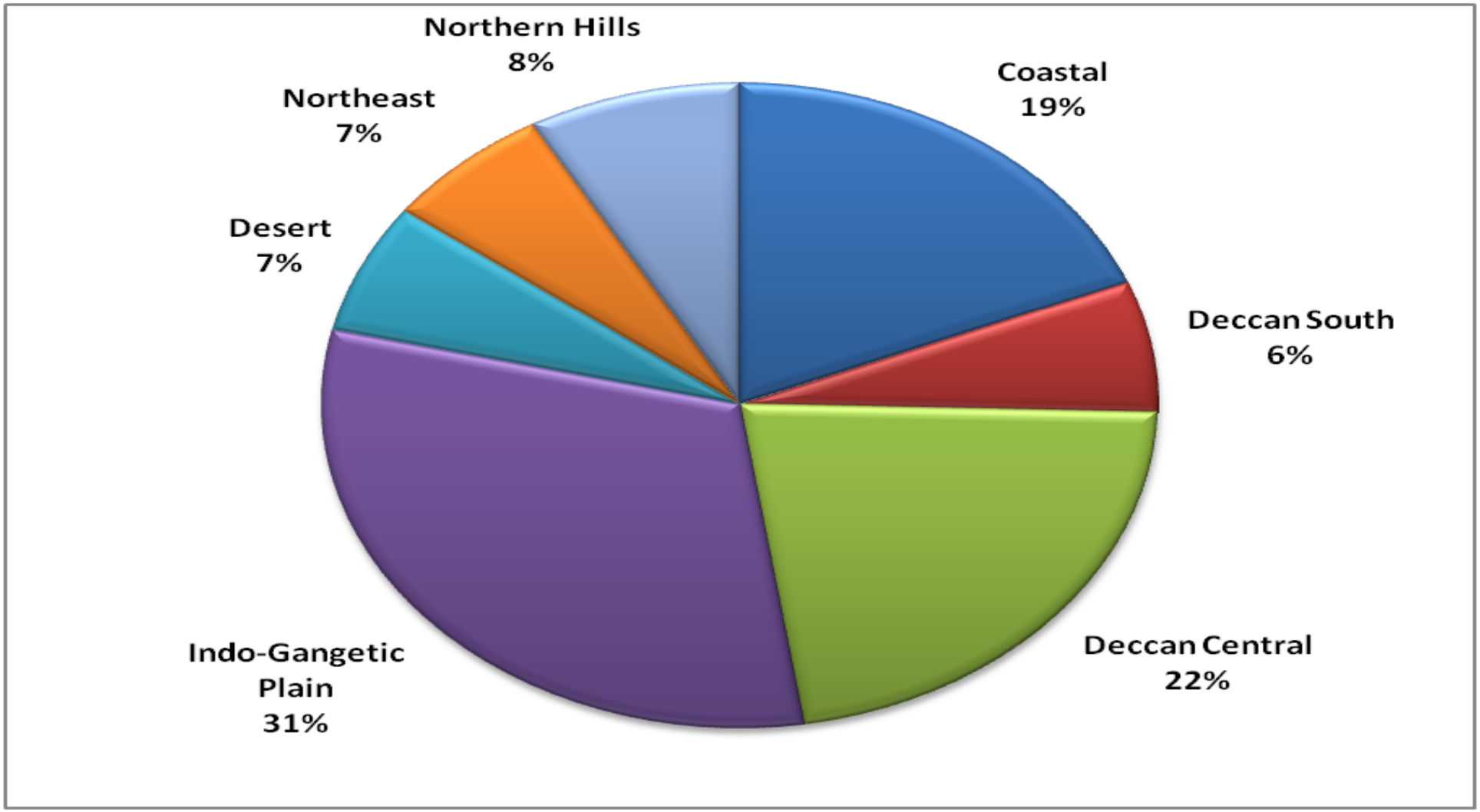


Himachal Pradesh, Madhya Pradesh and Rajasthan cities



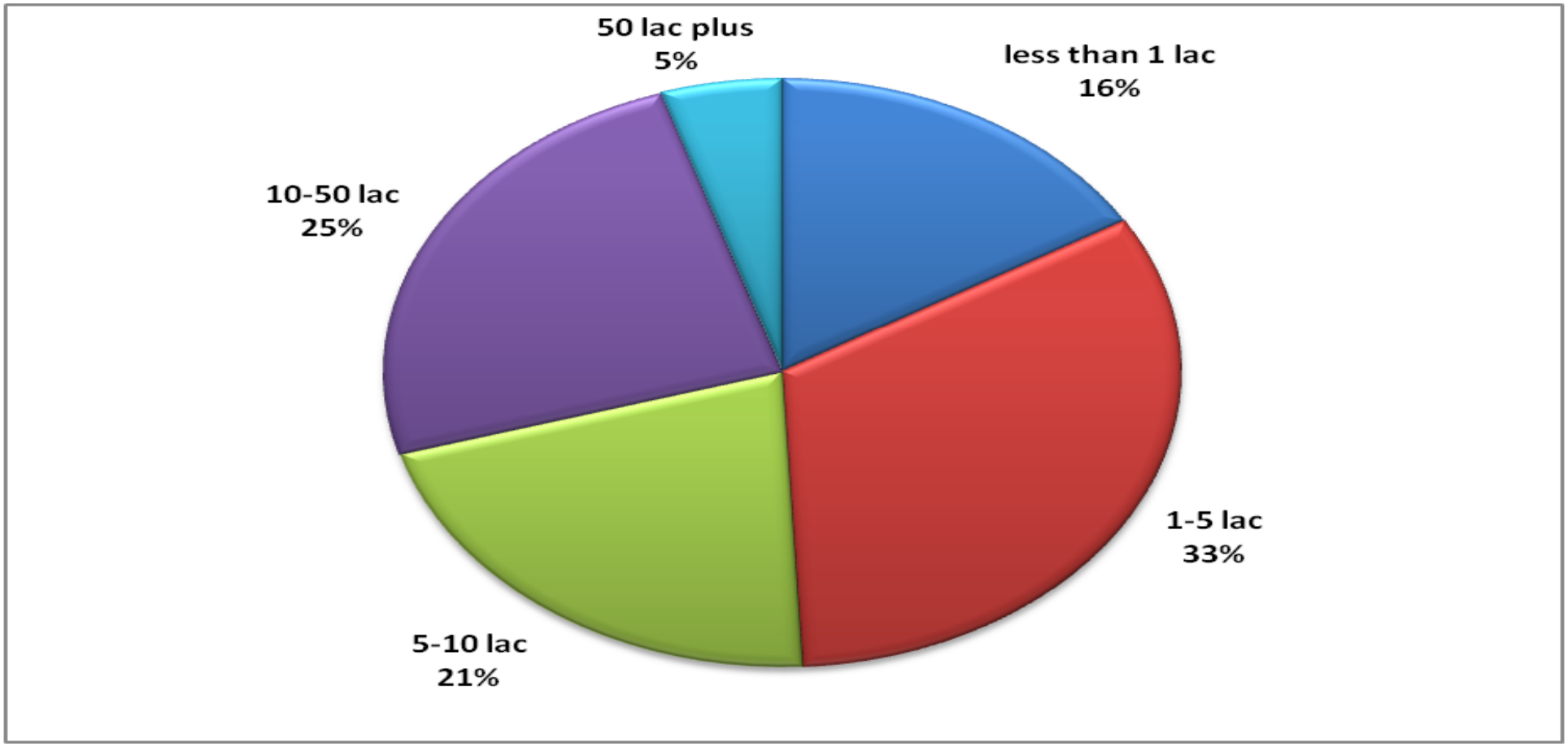
Source: CSE's analysis based on CPCB Envis centre and data submitted in Lok Sabha

60% of non attainment cities in North India



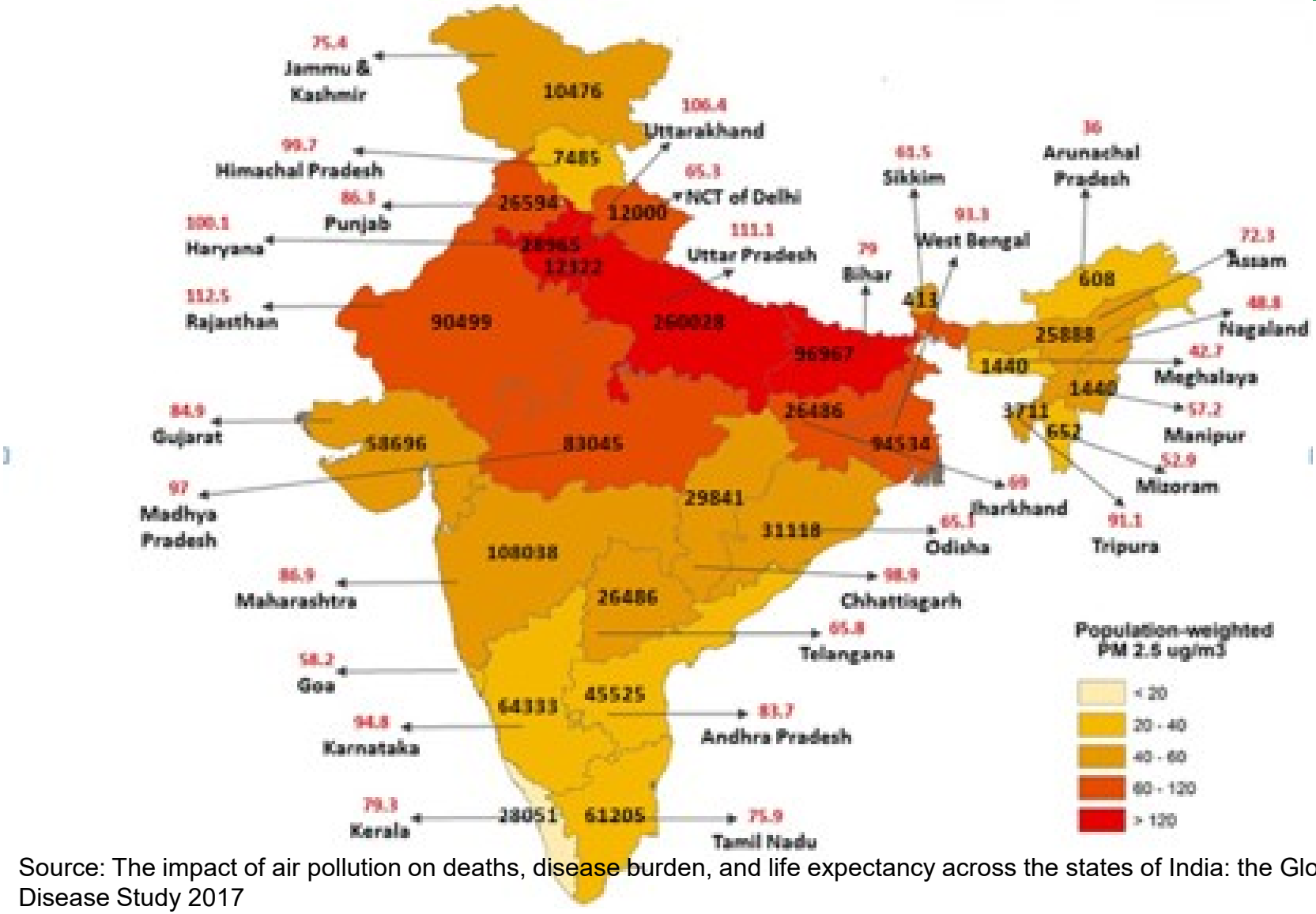
Source: Based on data available with CPCB

70% of Non-attainment cities have population less than 10 lakh

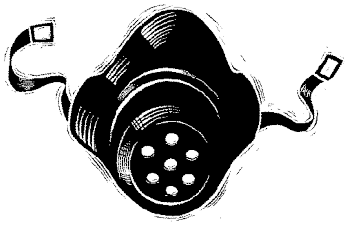


Source: Based on data available on CPCB

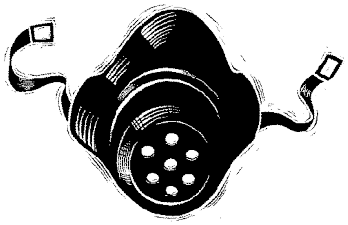
Health is a leveler



Source: The impact of air pollution on deaths, disease burden, and life expectancy across the states of India: the Global Burden of Disease Study 2017



Action planning process under NCAP has started….



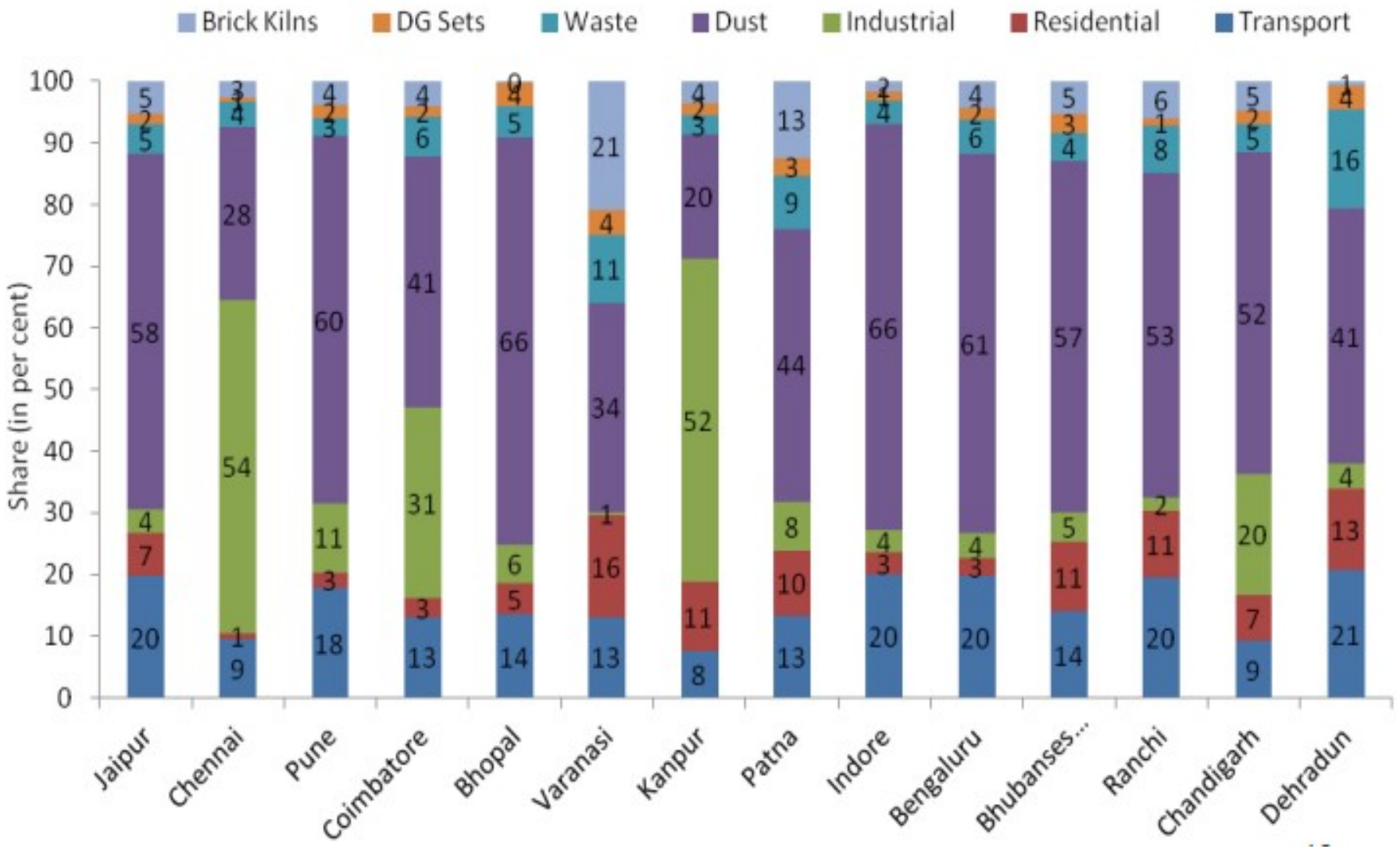
Action planning begins

-- Air quality management and monitoring strategies
-- Industry
-- Power plants
-- Vehicle and transportation strategies
-- Open burning
-- Construction activities
-- Diesel Generator Sets
-- Solid fuel burning (cooking and open eateries)
-- Road dust
-- Greening

What's causing the problem?

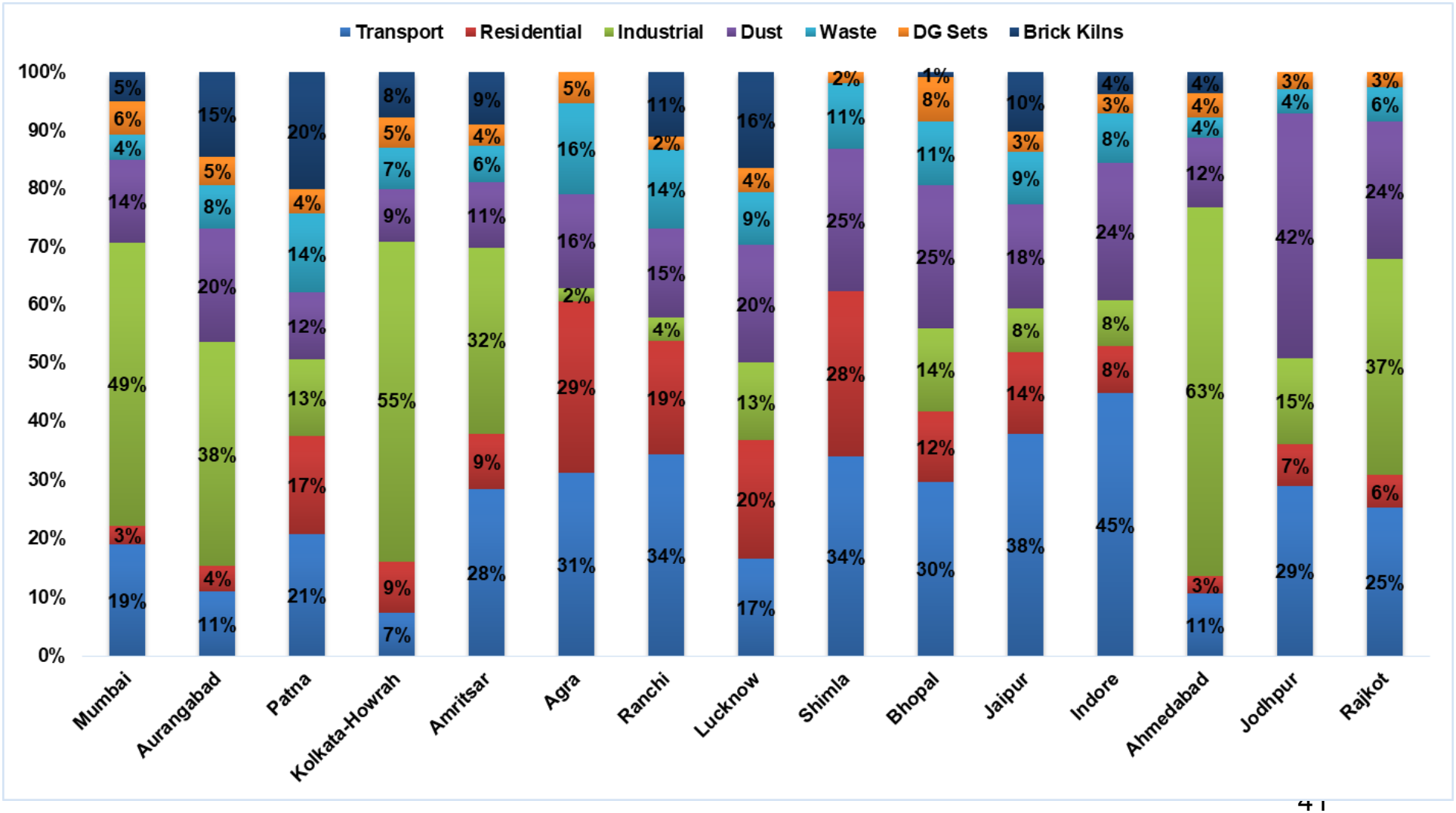
Source assessment

Need deep cuts and multi-sectoral approach

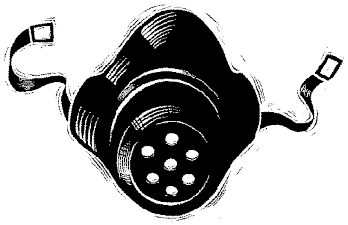


Source: Urban Emissions, 2017, http://www.urbanemissions.info/wp-content/uploads/apna/frontpage/index.html

Emission inventory– PM2.5

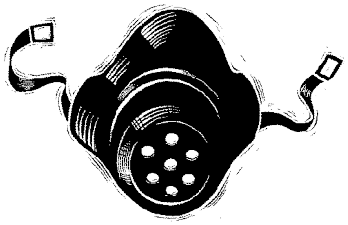


Source: Urbanemissions.info, http://www.urbanemissions.info/india-apna/



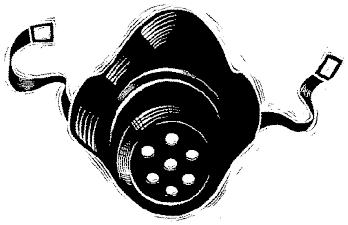
Key approach...

National policies and norms – Common minimum
Aligning ongoing action in different sectors



National action: Common minimum Air quality monitoring and management

- Expansion of air quality monitoring grid (including rural monitoring)
- National Air Quality Index (AQI) for public information system
- SOP for source apportionment and emission inventory studies
- Satellite monitoring



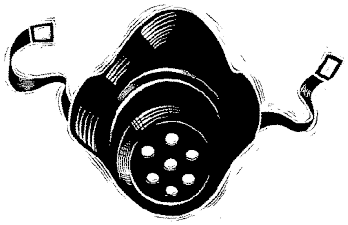
National action: Vehicles

Vehicle technology

- BS-VI norms from April 2020
- PUC revised norms –
- Faster Adoption and Manufacturing of Electric Vehicles in India (FAME-II) scheme to be implemented over a period of three years, with effect from April 1, 2019.

Public transport

- Reform based funding for public transport – Funding for electric buses for selected cities; Metro funding linked to reforms
- Transit oriented development policy
- No strategy for smaller towns



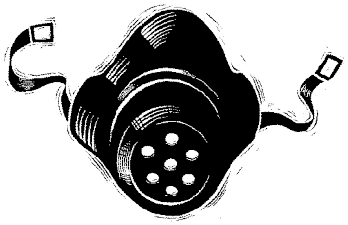
Industries and power plants

Industry

- CPCB notification for SOx and NOx standards for 16 groups of industries; Other emissions standards
- Ban on petcoke and furnace oil in four states; restriction on import of petcoke (allowed as feedstock in select industries)
- CEPI programme being reformed
- CPCB's 2017 notification on improved kiln for brick kilns (zig zag brick setting)
- Smart monitoring of industries -- Online Continuous Effluent/Emission Monitoring System (CEMS) since 2016-17.

Power plant

- New emission norms for power plants: Deadline 2022.
- Fly ash management



Area sources

Waste

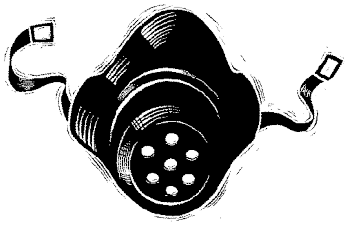
- **Solid waste management**: **Notifications for management of six wastes streams** -- solid waste, plastic waste, e-waste, bio-medical waste, C&D waste and hazardous wastes issued in 2016.
- Notifications for dust mitigation measures during construction and demolition activities.

Clean household fuels

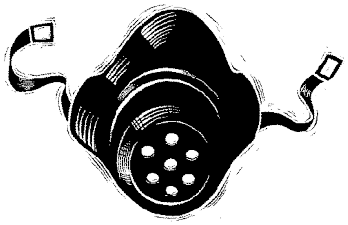
- Pradhan Mantri Ujjwala Yojana launched in 2016, under this scheme LPG connections given to BPL families

Stubble burning

- Central Sector Scheme on ‘Promotion of Agricultural Mechanization for in-situ management of Crop Residue in the States of Punjab, Haryana, Uttar Pradesh and NCT of Delhi’ 2018-19 and 2019-20



States can go beyond minimum national programme



Industrial pollution control

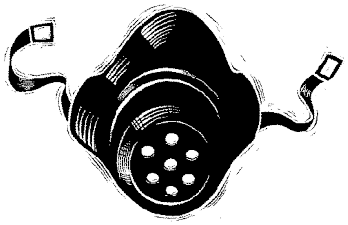
- **Kolkata**: Boiler standard tightened eight times; industries converted coal fired boilers and ceramic kilns to oil or gas fired; State reimbursed 50% cost of conversion. About two third of coal fired boilers and coal fired ceramic kilns converted in small-scale units reduced emission by 98%.

  Free distribution of LPG to open eateries to replace stoves on solid fuels

- **Bhiwadi and Alwar Panipat:** Agro based boilers reducing SOx, NOx emissions.

- **Jhajjar China Light and Power Plant, :** Low NOx burner, full fly ash utilisation, compact plant, FGD installed, also plans to use *parali*

- **State of the art coal handling technology in Maharashtra: (**TATA Power etc)

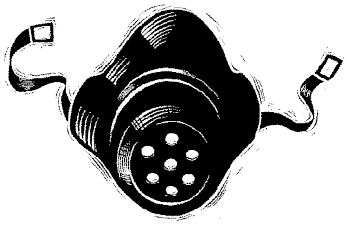


Extra steps

Several cities: Integration of all Pollution Checking Centres with Single web based software for ensuring control & monitoring of polluting vehicles. Digitising data

Cities of Bihar

- Almost 80% brick kilns adopted cleaner kiln technology with much lower emission levels.
- Ban on all State-owned government vehicles older than 15 years (2019);
- Ban on all commercial vehicles older than 15 years in Patna
- Draft Electric Vehicle Policy introduced. State Government procures 6 electric vehicles so far.



Transportation

Bus reforms

- **Bhubaeswar**: Bus reforms, One - single unified web-portal for the city including the transit information.Smart Janpath - 5 km road network of Complete Street Principle.Public Bicycle Sharing System
- **Hubli-Dharwad** BRT, Hubli-Dharwad,) – 2018
- ✓ **Amritsar** BRT, Amritsar, Punjab – 201

  Kolkata: Largest EV bus fleet

  Pune Mahanagar Parivahan Mahamandal Limited, Pune, Maharashtra
- ✓ **Himachal** Road Transport Corporation (HRTC) – EV buses
- **Guwahati** first in NE to operate EV: first NE state to operate EV bus.
- NMRCL - Bus Services, Noida, Uttar Pradesh - Jan' 2019

Intelligent Public Transit System (IPTS):

Sitilink, Surat, Gujarat (Fare integration among BRT and City Buses)

Traffic Management: Hyderabad, Telangana for Hyderabad Traffic Integrated Management System (H-TRIMS)

Remote sensing monitoring in Kolkata

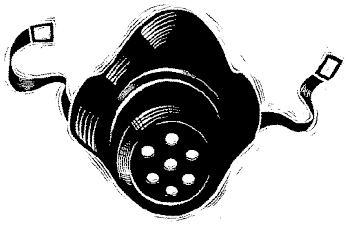
Delhi: ICAT pilot; MORTH-ARAI to develop guidelines
To develop threshold limit to pull out gross polluters
How to use this for compliance

Source: CSE field visit

Parking as a restraint measures

Kolkata: Demand management strategies:
Restricted legal on-street

- Parking on notified roads in commercial and residential areas. Both day-time and night-time parking is regulated.
- Legal parking is notified after street design audit and availability of space.
- Time variable parking adopted in commercial areas.
- Restricted parking in residential areas have created private rental in parking which is a good practice.
- This eliminates free parking and enables implementation of user pay principle.
- Process of preparing parking area management plan initiated



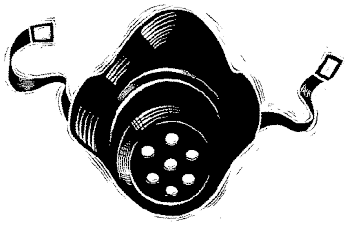
Vehicle restrain measures

- **Punjab Public Parking Policy (2017): All** municipal towns of Punjab. For Municipal Corporation Towns Of Punjab Government Of Punjab (Department Of Local Government)

- **Restricted parking provision, Aizwal, 2019:**

- **Proof of Parking, 2010, Sikkim and Mizoram:**

- **Parking management, Traffic police, Sikkim:**



Push for compact urban form and pedestrianisation and low emissions zones

Car-free Ajmal Khan Rd of Delhi: Exposure to PM2.5 on nearby heavy traffic) road 35% higher than pedestrian street

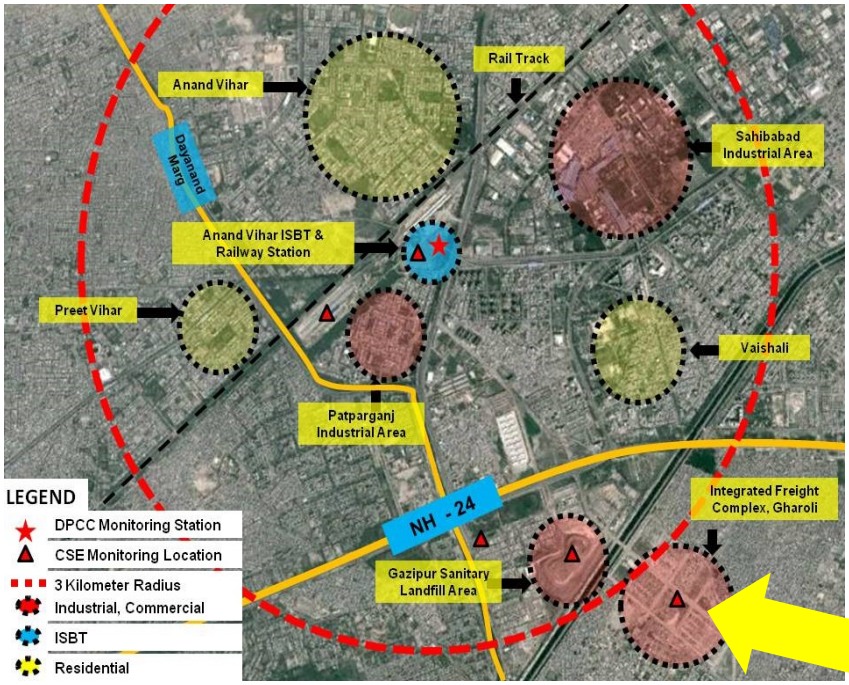
Spurs decision to pedestrianise 22 commercial streets/areas in Delhi


Pavement Blocks and Kerbstones
CSE
Delhi

Delhi:

Supreme Court Extension Project used **1.8 million Recycled C&D waste blocks**

Delhi: Pollution hotspots action



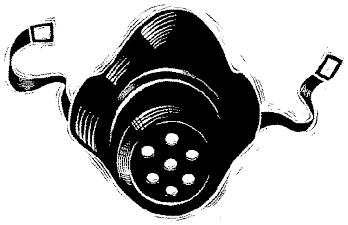
Anand Vihar – pollution hotspot in Delhi:

Hourly levels at the breathing level 3 times higher than the background ambient levels

Delhi: Seeking local solutions

Mundka Plastic recycling plants: massive plastic burning

Immediate action to link with controlled incineration



Towards regional air pollution control

Mumbai Metropolitan Region

4 Non-Attainment Cities

1. Mumbai
2. Badlapur
3. Ulhasnagar
4. Navi-Mumbai

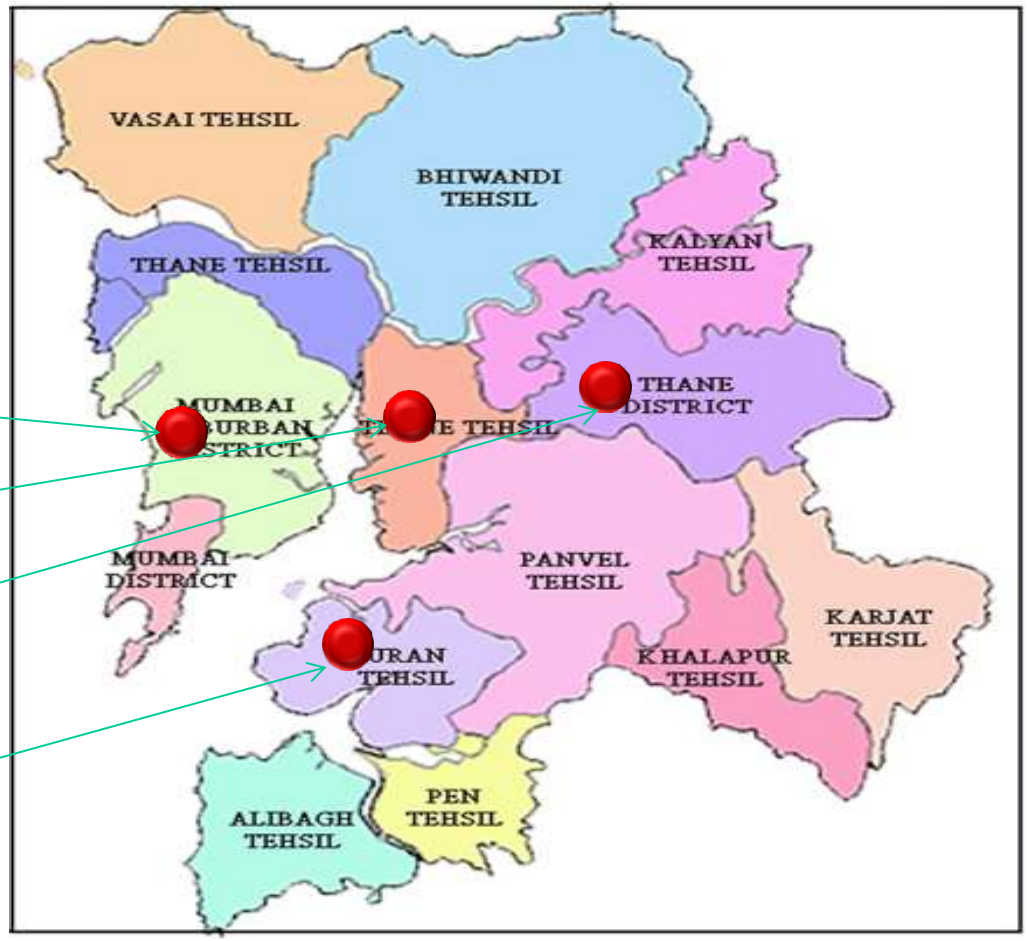
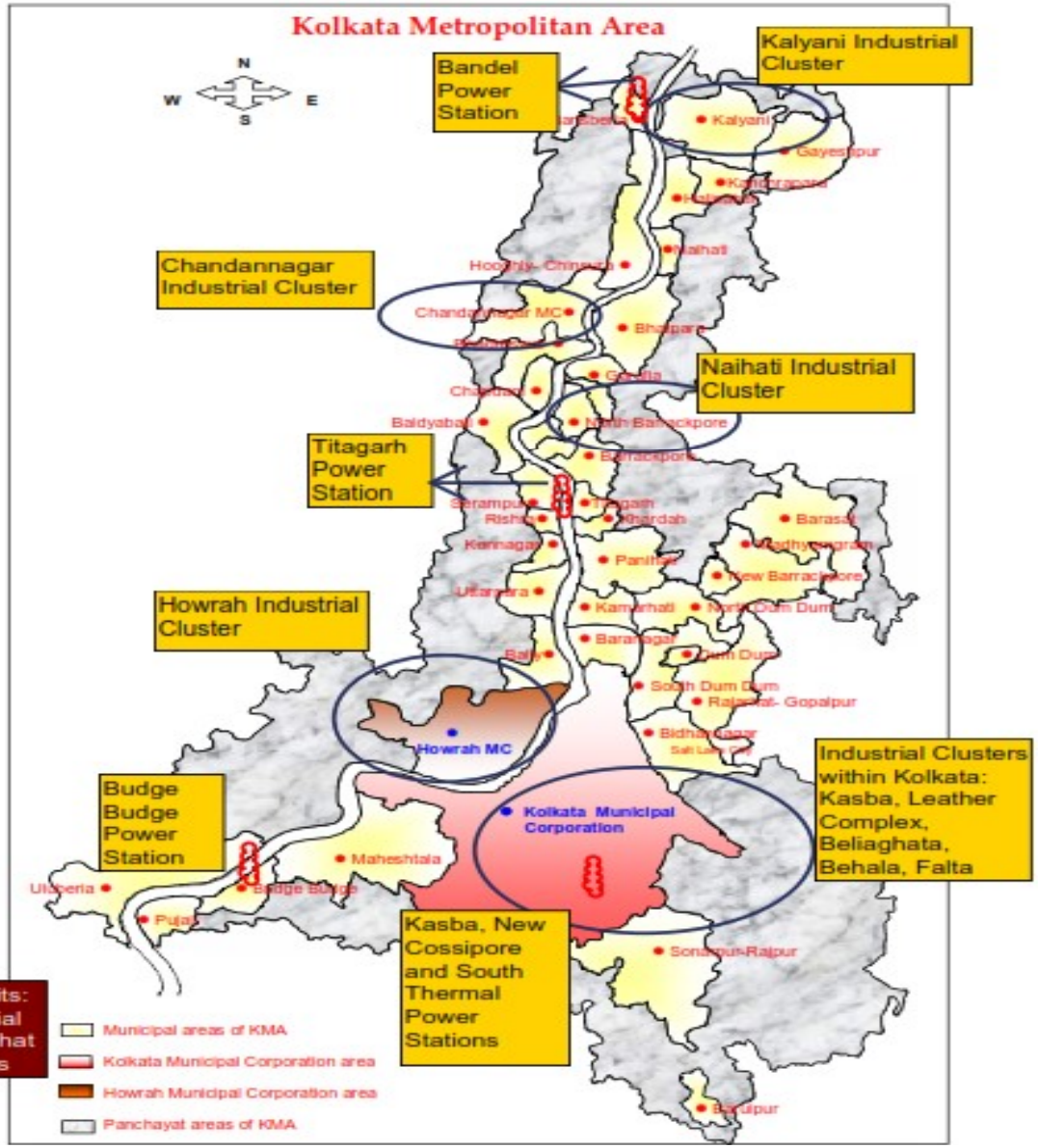
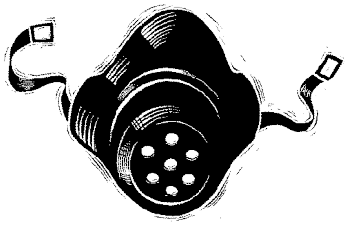


Image Source: https://link.springer.com/article/10.1186/s40410-018-0082-8

West Bengal: Map of Industrial Clusters and Power Stations in the region

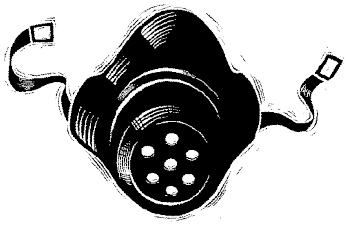




Global action on regional pollution

China

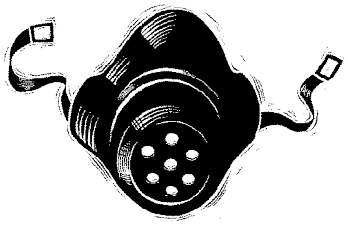
- **Adopted unified planning, monitoring and alerting, and unified standards** in multiple contagious regions. Combined work plan for Beijing City, Tianjin City, Hebei Province, Shanxi Province, Shandong Province and Henan Province.
- **Target:** "2 + 26" cities to decrease average PM 2.5 concentrations and the number of heavy-pollution days by more than 15% from previous year.
- **Revised the emergency response plan to unify the alerts and grading for heavy air pollution**
- **Combined monitoring and inspection system**. Beijing Environmental Protection Inspection team responsible for 15 provinces
- **Mutually agreed action plans to reduce coal consumption, manage area sources and adjust the industrial structure.**
- **Violations of the Action Plan enforced across the region**
- **Reformed vertical management and accountability systems for monitoring, inspection and law enforcement** of the environmental protection agencies.



Global action on regional pollution

United States:

- **Clean Air Act: provisions to reduce long-range transport of pollution**
- **Each state's implementation plan to prevent emission from sources within its borders from contributing significantly to air pollution problems "downwind"** – specifically those that fail to meet standards
- **If a state fails** to develop the necessary plan to address this downwind pollution, **EPA can enforce federal plan**
- **Good neighbor provisions** -- dentify downwind air quality problems; identify upwind states that contribute enough to those downwind air quality problems for further review and analysis; identify emissions reduction necessary to prevent contributing significantly to downwind air quality problems
- **Air quality monitoring is carried out air basin levels.**
- States to take additional steps to satisfy good neighbor provisions or prove why additional measures are not necessary.

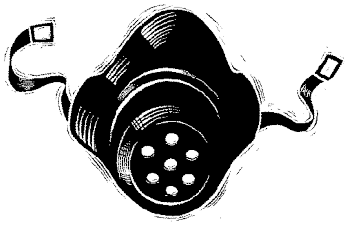


Global action on regional pollution

Europe

European Member States work together to control international air pollution under the Convention on Long Range Transboundary Pollution (the Air Convention).

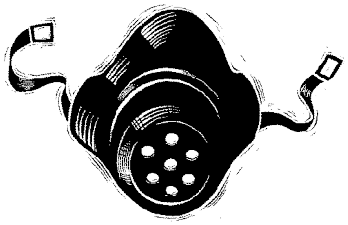
European states within the European Union have begun to explore the regulatory means of building regional action across different jurisdictions.



India?

NCAP:

- A comprehensive regional Plan to be formulated incorporating the inputs from the regional source apportionment studies.
- No enforcement mechanism yet
- Technically no legal hurdle to introducing this approach. The Air (Prevention and Control) Act, 1981, Article 19 confers power to declare air pollution control areas.
- Under this provision critically polluted areas are declared that are largely industrial areas.
- The scope and ambit of this can be broadened to include more jurisdictions for integrated planning and compliance.



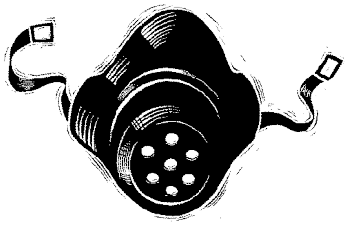
Strengthen legal framework for National Clean Air Programme

NCAP Approach:

- Collaborative, multi-scale and cross-sectoral coordination between central ministries, state governments and local bodies. Dovetailing policies and programmes with NCAP.

NCAP legal framework

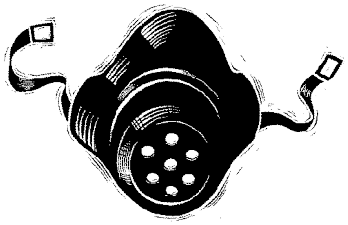
- In consonence with Air Act (Prevention and Control of Pollution) Act, 1981, and in particular the provision of Section 16 (2) (b) to execute nation-wide programme.
- Compliance, monitoring and accountability framework for implementation and to meet targets
- Address the current gaps in laws for compliance and enforcement
- Punitive action, deterrence and incentives
- 15th Finance Commission to *propose measurable performance-based incentives for States*, among others. --- One of the criteria for finalising the states' share in central taxes and grants.



Gap between power and operations

CAG review of several SPCBs show several challenges:

- Failure to take action against polluting industrial units
- No database on pollution sources and pollution load in the state
- No mechanism to monitor validity period of consent and operation
- Consent for establishment and operations to highly polluting industries without mandatory inspections – even to red and orange categories
- “Ease of doing business” policy subvert environmental governance: Automatic consent is supposed to prevent halting of industrial operations – inspection and audit not carried out for deemed consent
- Weak inspection: Massive shortfall in number of inspection (could range from 41 to 49%). This weakens enforcement
- Action on approved fuels very weak
- Not exercising available powers

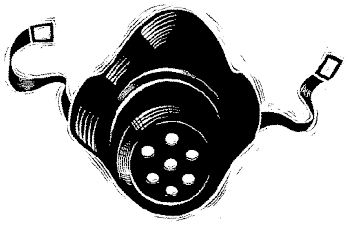


Gap between power and operations

CAG review of several SPCBs show several problems

- Lack of zoning map for locations of industrial units
- Problems with siting policy – often ecologically sensitive areas are not properly identified or as per the MOEF guidelines
- Industrial units found to be operating without valid consent to operate.
- Onground inspection show deviation from conditions for consent to operate (include raw material handling, fugitive emissions, etc)
- What constitutes compliance can be fuzzy – actual emissions or availability of emissions control systems?
- Data on actual compliance status is often not compiled.

Only legal power is not enough. Need capacity and robust operational systems



Institutional Process

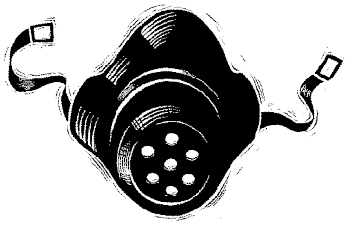
Empowerment, autonomy and accountability and compliance – only legal powers do not help

Departmental responsibilities, Institutional coordination between departments for cross-sector action

Impact assessment and refinement of action plans.

Capacity audit and improvement of implementing agencies

Need impact monitoring



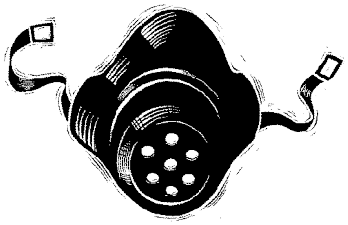
Fiscal strategies

NCAP funding for air quality monitoring and some support for studies, air quality monitoring, and plans

Align CAP principles and guidelines with the budget of all line departments – leverage existing line funding

Mobilise resources based on polluter pay principles to create dedicated funds – Eg from Delhi – Environment Compensation Charge on trucks and big diesel cars and SUVs; Air Ambience cess on each litre of diesel etc. Sector specific funds

Reform based funding



Need massive transition

Clean fuels and technology transition in industry and power sector:

- Small and medium units; fugitive emissions from industrial processes and material handling etc; effective stack monitoring for enforcement
  - Pricing and availability of clean fuels
  - Monitoring and compliance in bigger industries and smart monitoring
  - Clean fuels for households

Mobility transition

- Need scale in public transport services and non-motorised transport in big and small towns – Need design rich solutions
- Effective vehicle restraint measures
- Zero emissions mandate for electric vehicles and control of real world emissions

Paradigm shift in waste management

- Enormous infrastructure deficit to control waste – address this
- Need scale in decentralised segregation, recycle and reuse
- Episodic fire incidents

Need scale, effectiveness and accountability

Need awareness to build support for difficult solutions

Thank You