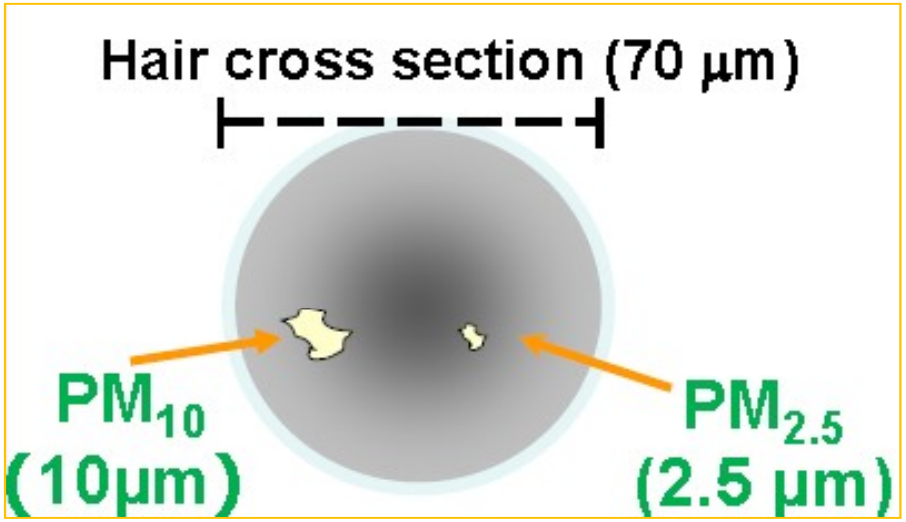
# AIR QUALITY

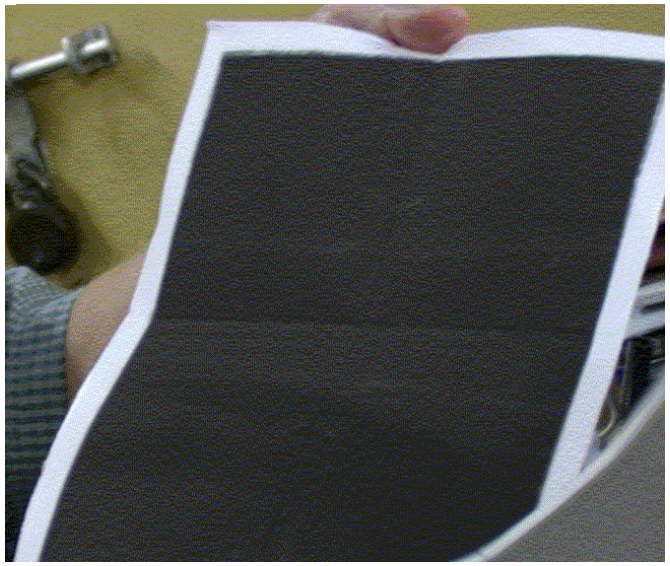
## ANIL AGARWAL DIALOGUE 2020

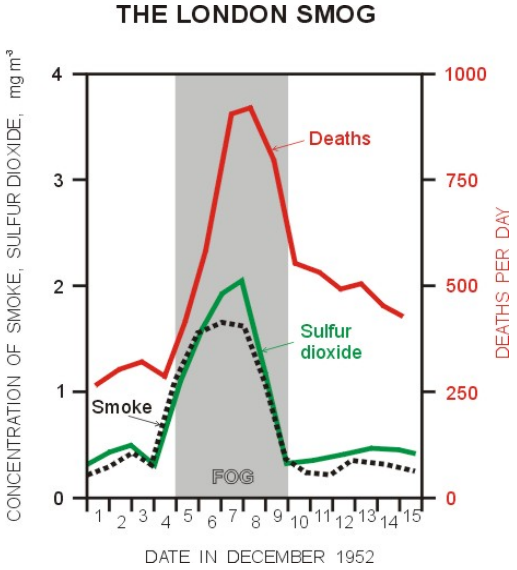
**(February 9-11, 2020)**



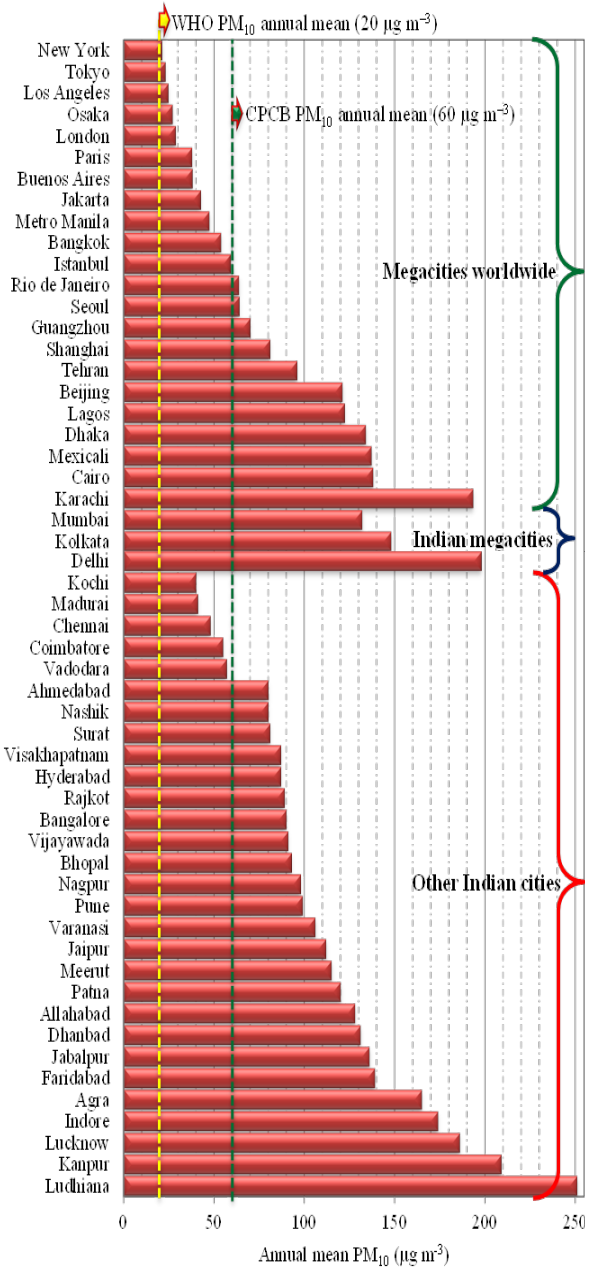

**Mukesh Sharma, PhD, FNAE**
**Department of Civil Engineering**
**Indian Institute of Technology Kanpur**
**Kanpur**

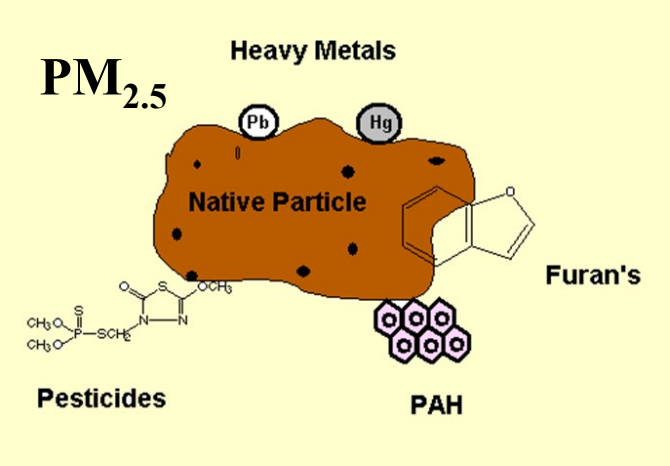
# Do you know what you may be breathing?






(Kumar et al 2013)



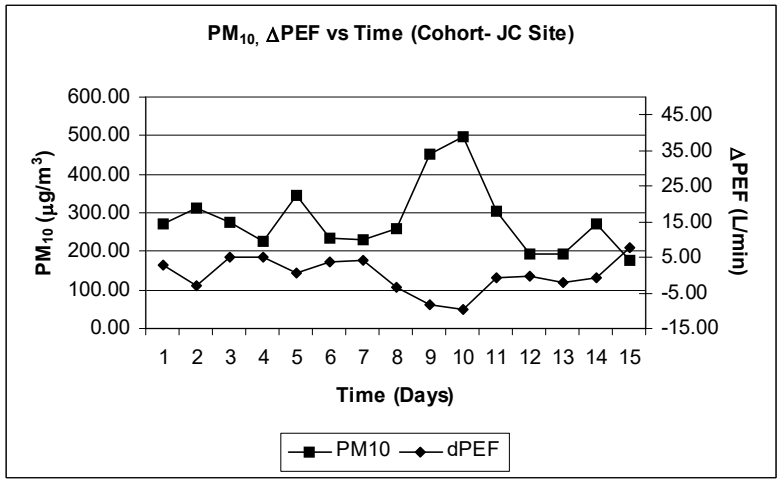

## The big problem

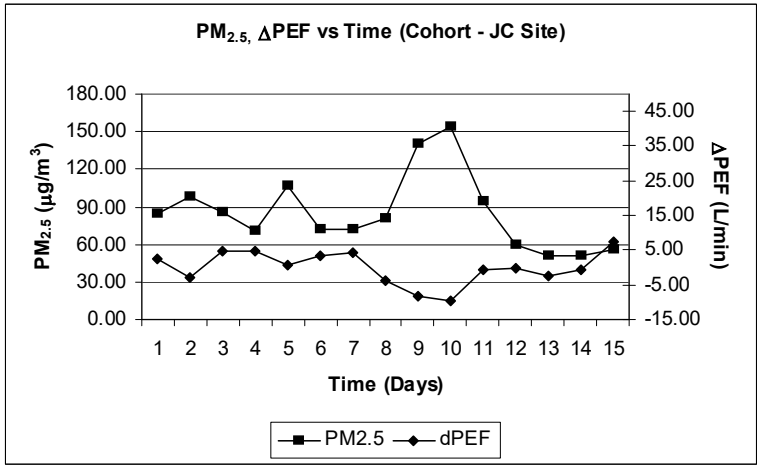
[BBC: London Smog 1952]


PERSONAL SAMPLER

## Variation of ΔPEF with $PM_{10}$ and $PM_{2.5}$ (Sharma et al 2004)

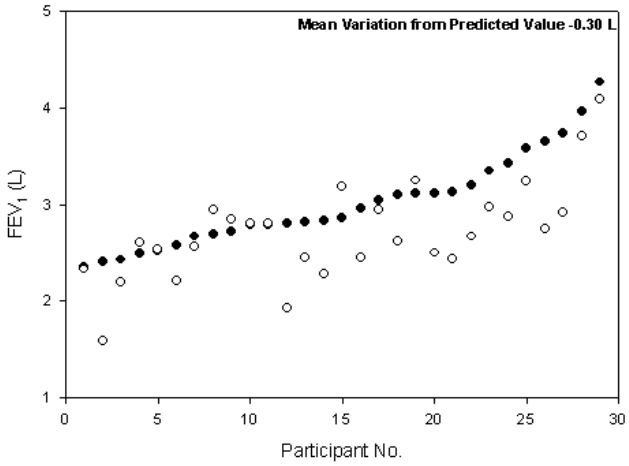
### Age Group ( 20 – 55) Years: 61 male and 30 female

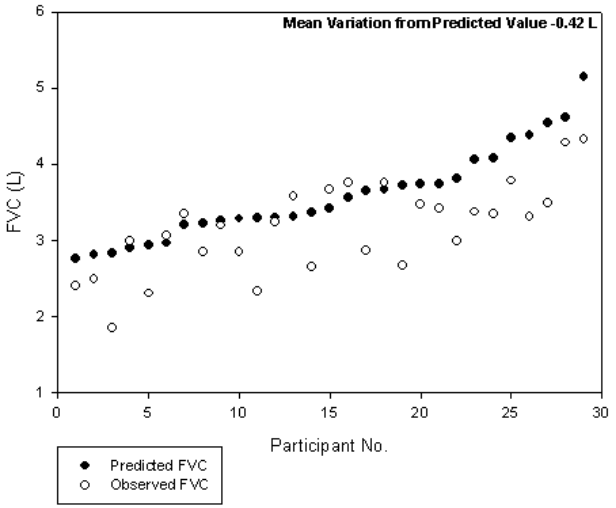



**Increase of 100 µg/m³ of $PM_{10}$/$PM_{2.5}$ reduce PEFR by 3.2 l/min (Pope & Dockery, 1992: 1.8 l/min)**

## Spirometry-observed $FEV_1$, FVC from Reference (Vikas Nagar)



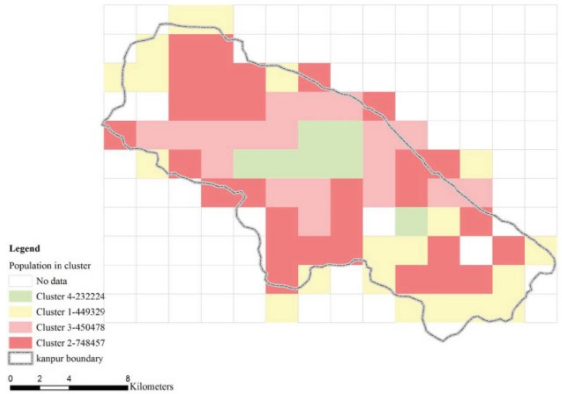



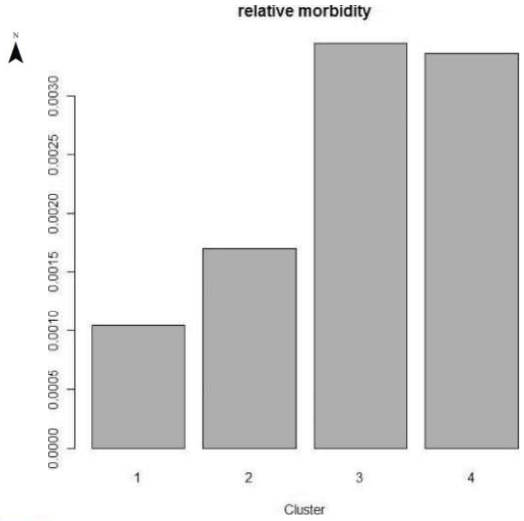

**Increase of 100 µg/m³ of $PM_{2.5}$ reduce $FEV_1$ by 0.12 L and FVC by 0.15 L (i.e. ~18%)**

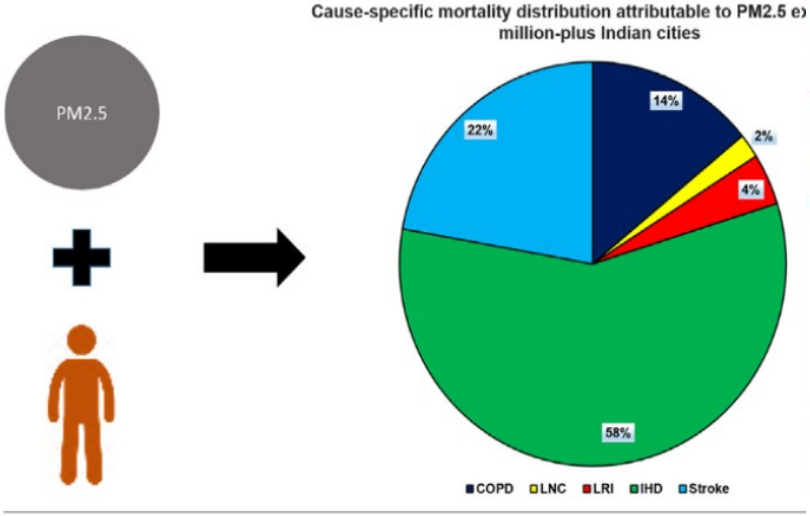
# Respiratory Disease in Relation to Outdoor Air Pollution in Kanpur (Liu, Sharma, et al., 2013;)

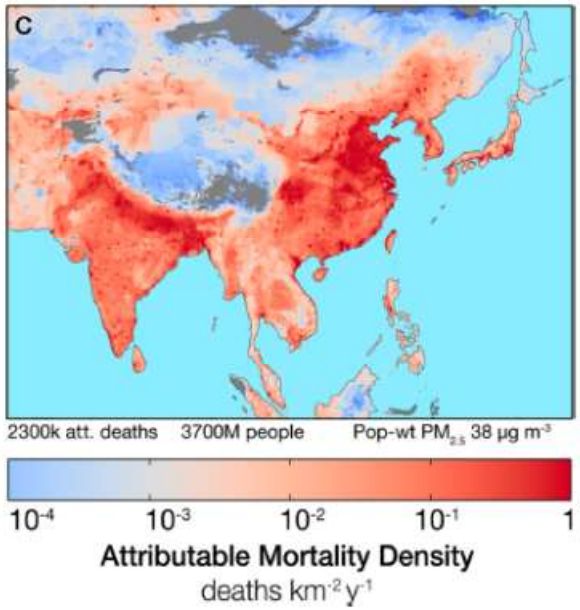
number of patients visiting pulmonary hospital with symptoms of respiratory disease

| Serial number | Symptoms | Total number of patients |
|---|---|---|
| 1 | Abdominal pain and epigastric pain | 391 |
| 2 | Breathlessness and dyspnea | 4,318 |
| 3 | Chest pain | 3,446 |
| 4 | Common cold | 440 |
| 5 | Bough | 6,433 |
| 6 | Fever | 4,356 |
| 7 | Hemoptysis and similar symptom | 929 |
| 8 | Loss of appetite | 1,249 |
| 9 | Weakness | 475 |
| 10 | Other aches and pains | 626 |
| 11 | Swellings | 375 |
| 12 | Other unspecified symptoms | 544 |




Global Mortality 4.2 million
Indian Mortality: 0.67 million

(Apte 2016)

# PM2.5 Exposure and Mortality; Million Plus Cities (Saini & Sharma 2020)

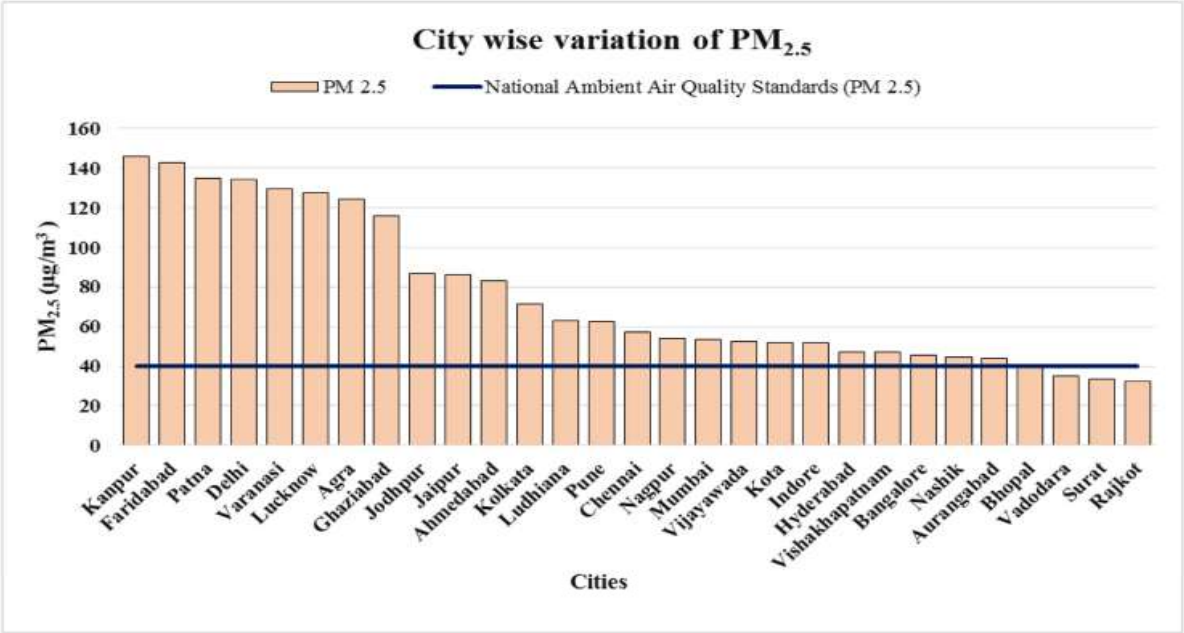
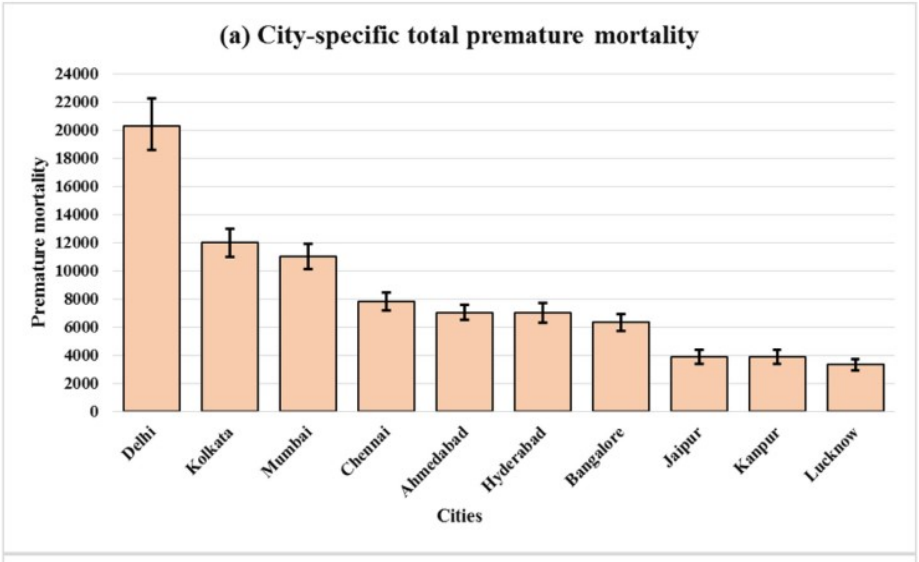
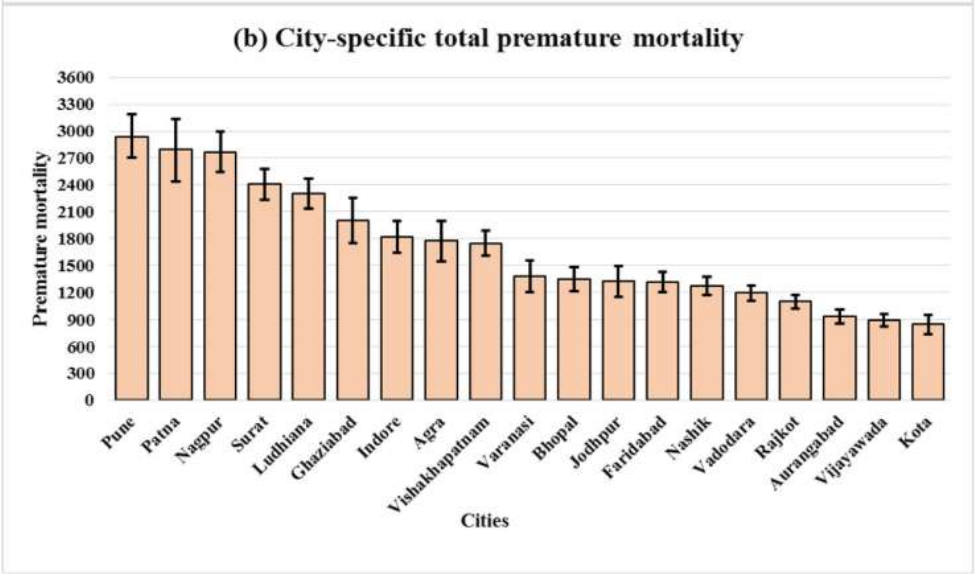
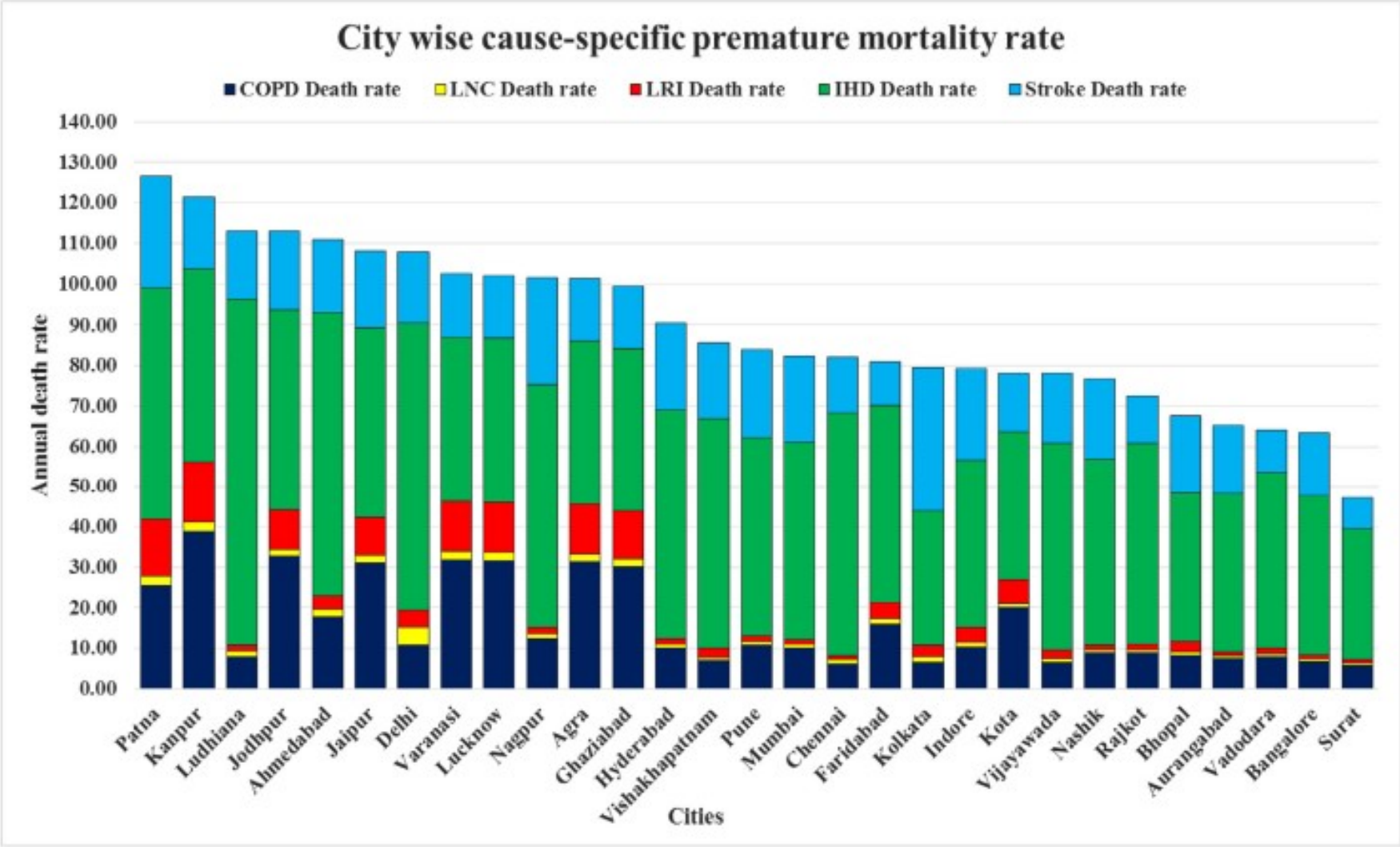




**Fig. 3.** Annual ambient PM2.5 concentration levels in the cities.



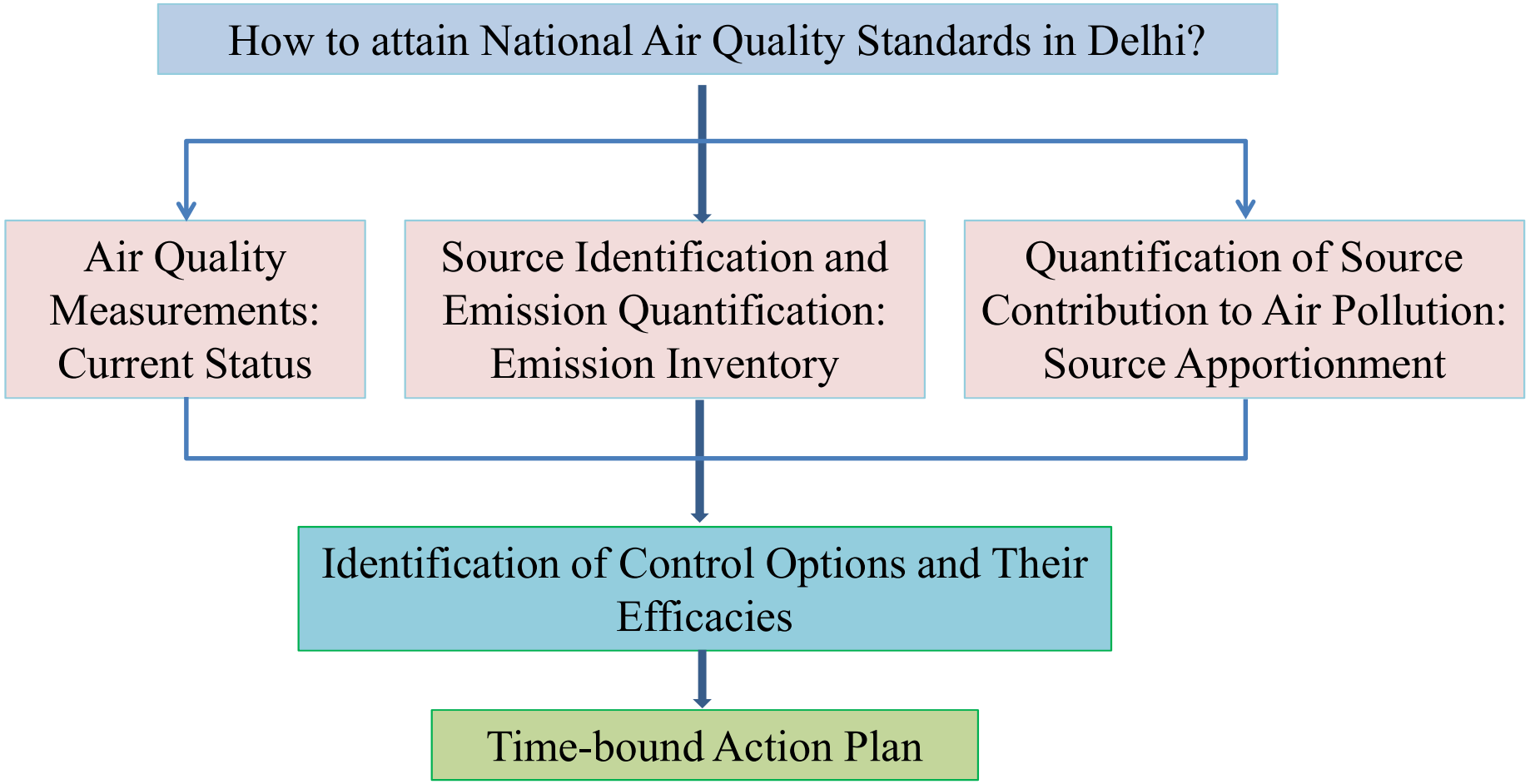



PM2.5 related mortality per 100000 population

# Source Apportionment Studies

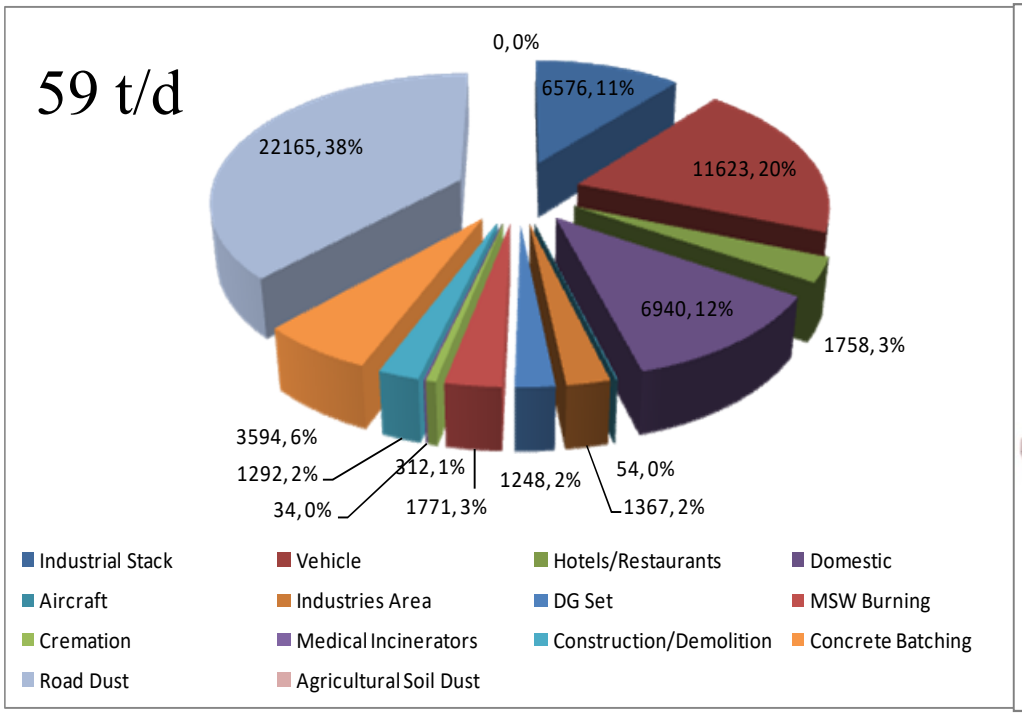
- **102 Non-attainment (PM10) cities have been identified**
- **NGT Order: Make Action Plan**
  - **Emission Inventory, Domestic source (LPG supply)**
  - **Industrial Control, Required number of AQ Stn**
  - **Vehicular control, Public Transport**
  - **Decongestion of Roads, Parking policies**
  - **Identify agencies, time-bound, Commit funds**
  - **Detailed SA study and improve action plan**
- **Detailed SA studies: Delhi, Jaipur, Agra (Taj) Completed**
- **Underway: Kanpur, Agra, Seven cities in HP, Bhilai, Gwalior**

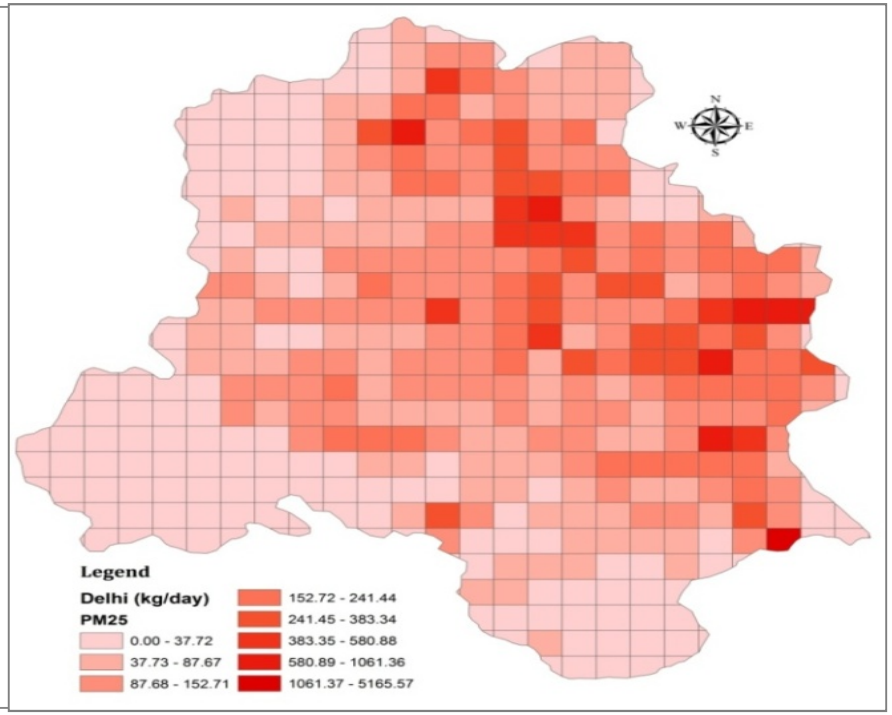
# What to do?




- A Comprehensive Scientific Study: quantified causal source-receptor impact analysis, control options and their effectiveness, action plan - focus: $PM_{2.5}$, $PM_{10}$ and $NO_x$

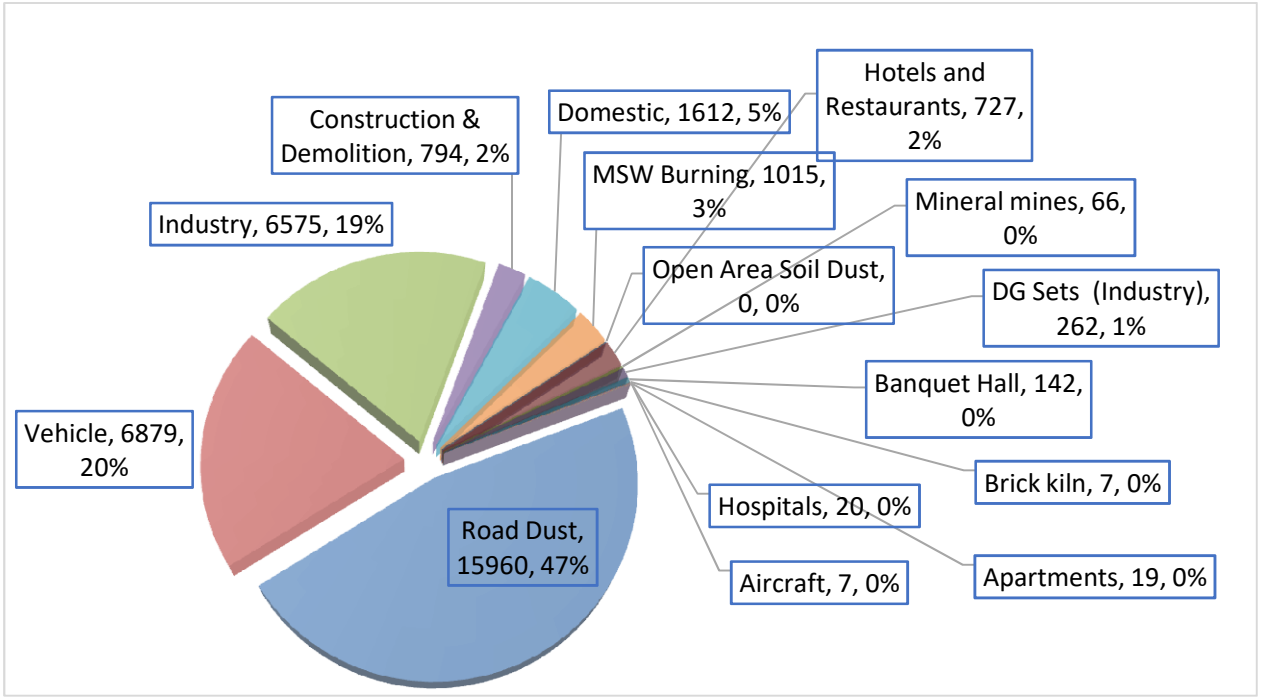
59 t/d




Delhi (2014)

PM2.5 EI

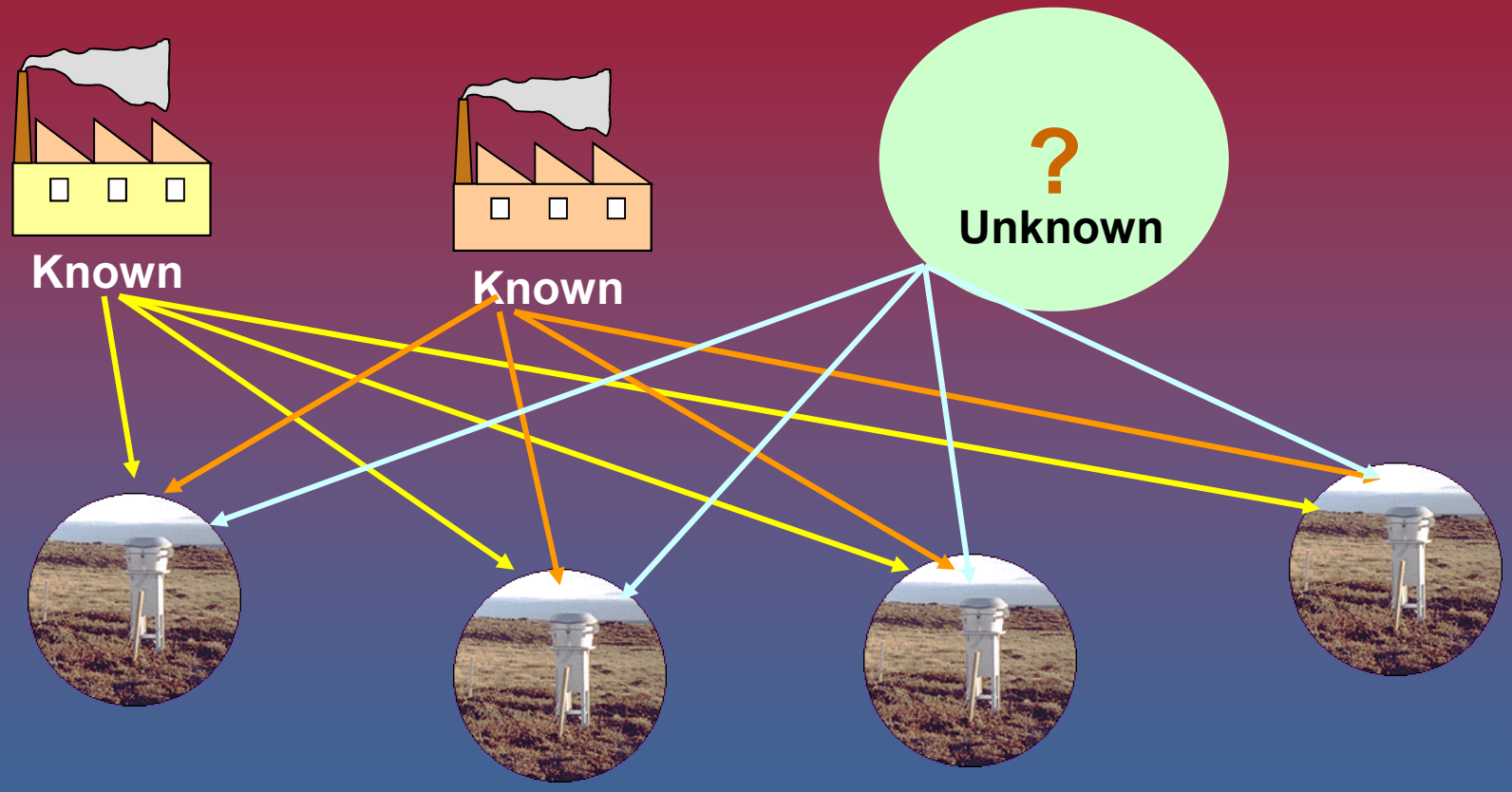



34 t/d

Jaipur (2017)

# Capabilities

## Identification of unknown sources



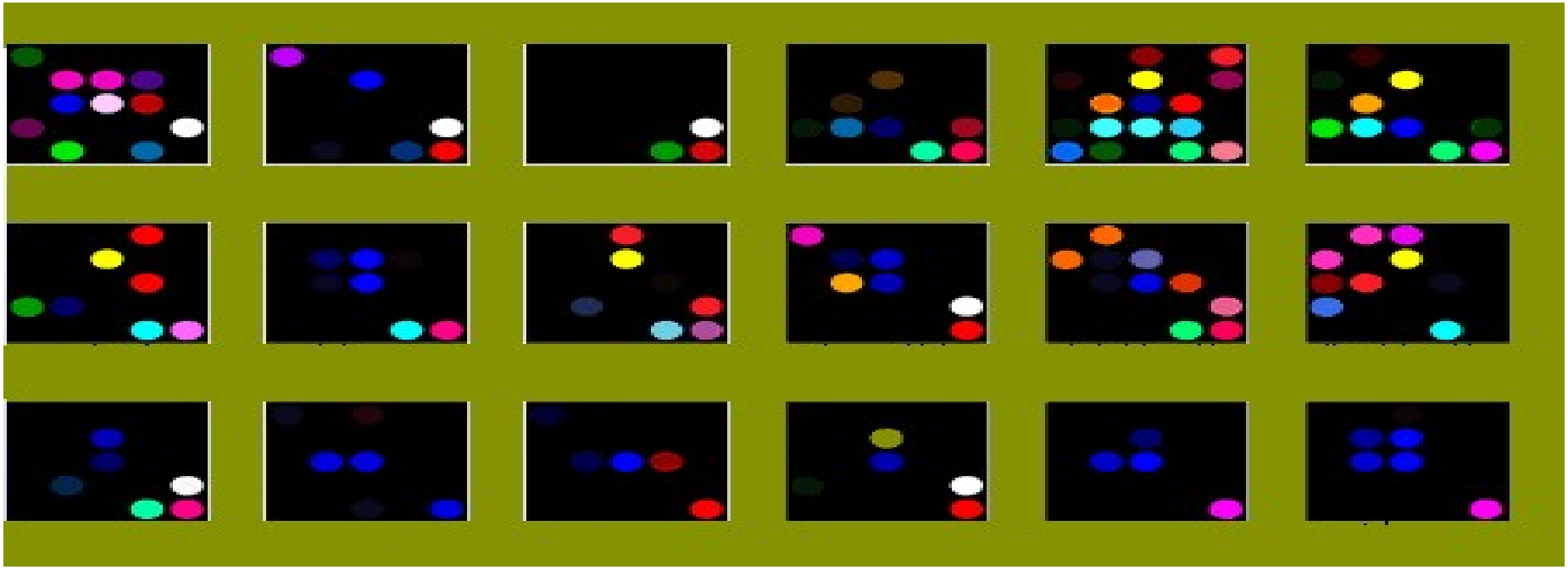

## Emission inventory of unknown sources

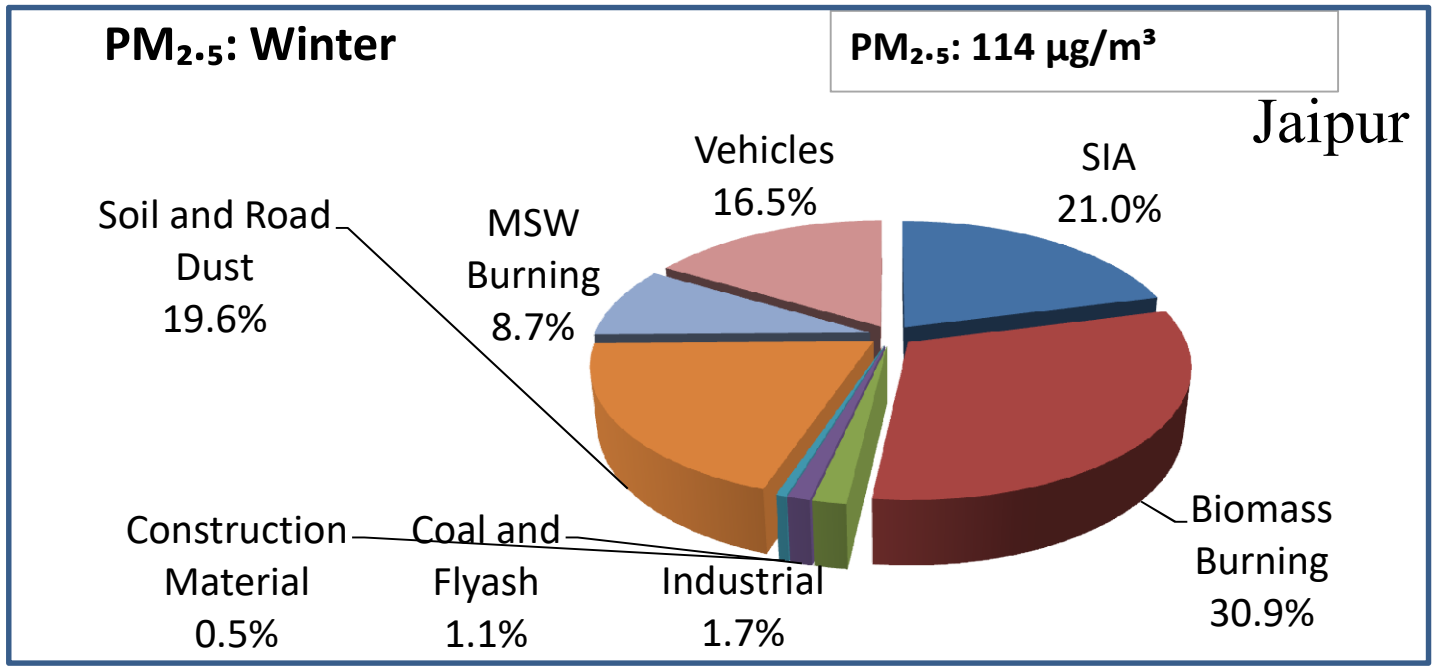
# Source Composition

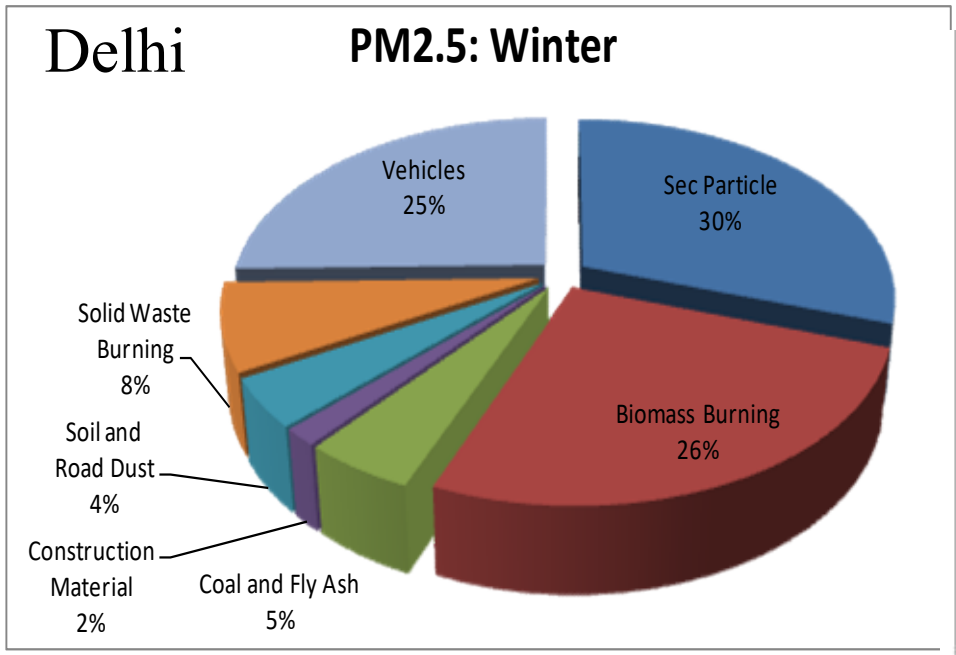
**Each source may possess unique**

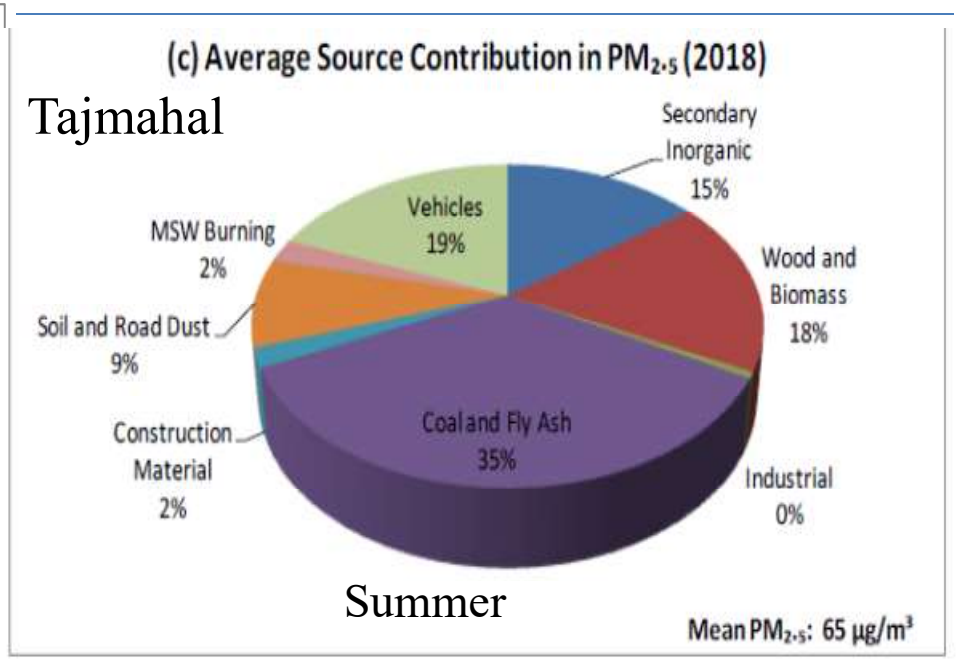
- **Chemical composition or**
- **Size distributed species**
- **Unique tracer compound**

**Fingerprints**




PM2.5: Winter
PM2.5: 114 µg/m³
Jaipur
Vehicles
16.5%
SIA
21.0%
Soil and Road
Dust
19.6%
MSW
Burning
8.7%
Biomass
Burning
30.9%
Construction
Material
0.5%
Coal and
Flyash
1.1%
Industrial
1.7%


Delhi
PM2.5: Winter
Vehicles
25%
Sec Particle
30%
Solid Waste
Burning
8%
Soil and
Road Dust
4%
Construction
Material
2%
Coal and Fly Ash
5%
Biomass Burning
26%


(c) Average Source Contribution in PM2.5 (2018)
Tajmahal
Secondary
Inorganic
15%
Vehicles
19%
MSW Burning
2%
Wood and
Biomass
18%
Soil and Road Dust
9%
Construction
Material
2%
Coal and Fly Ash
35%
Industrial
0%
Summer
Mean PM2.5: 65 µg/m³

# Action Plan for NCT of Delhi

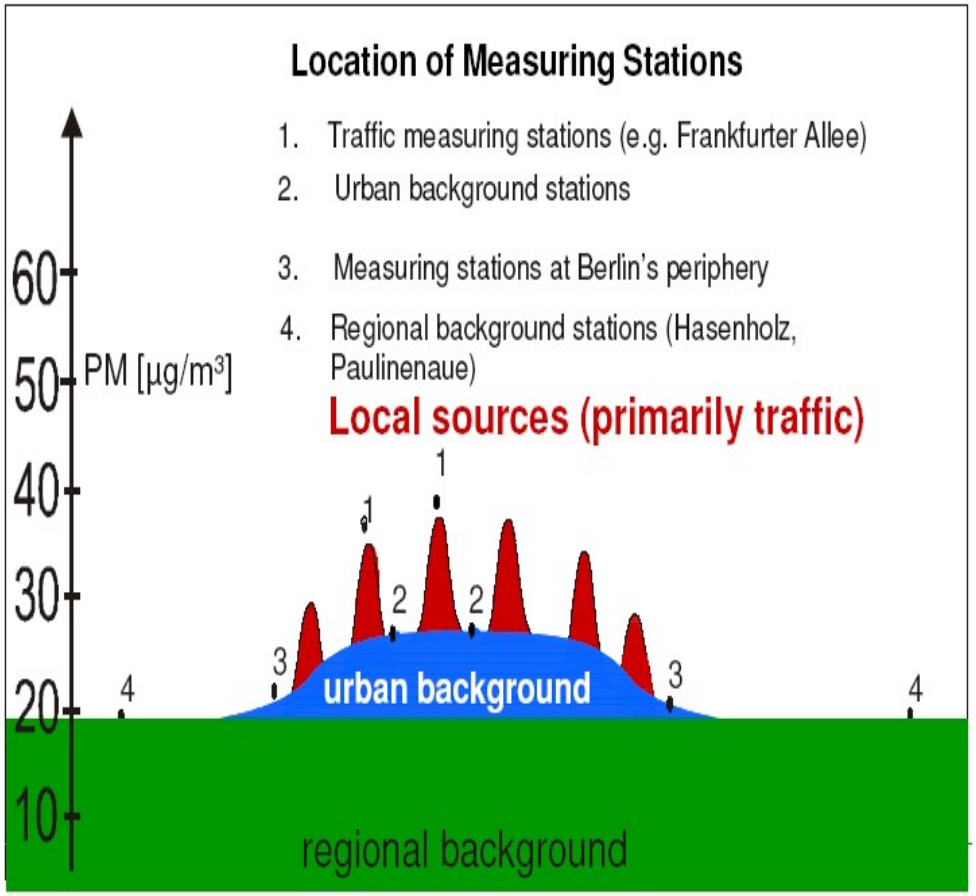
## A. Immediate Actions

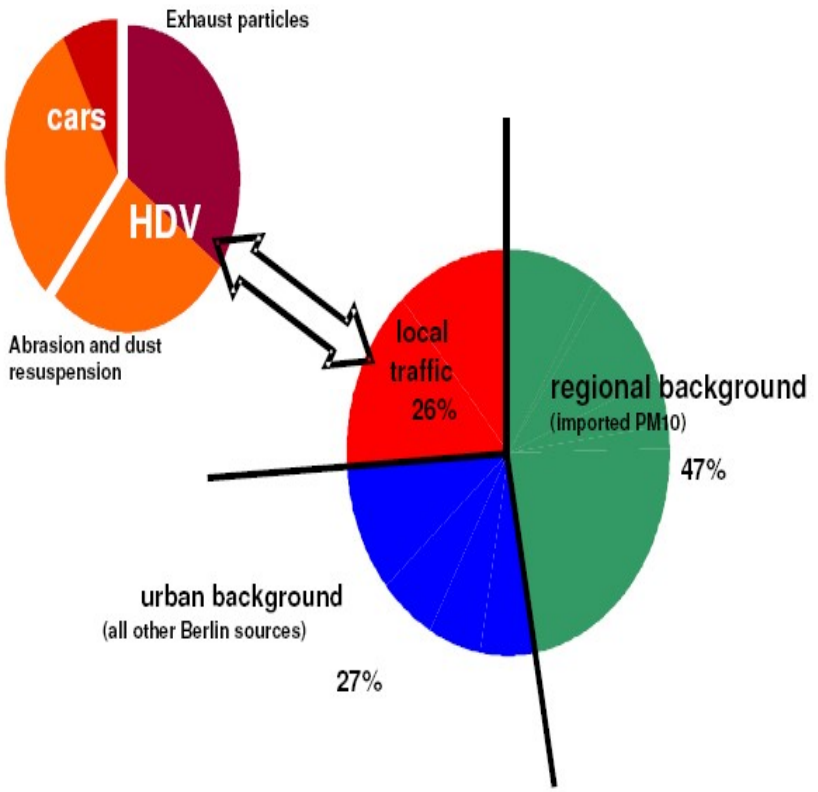
| Source | Option No. | Description Option | 2016 | 2017 | 2018 | 2019 | 2020-2023 | Percent improvement in AQ |
|---|---|---|---|---|---|---|---|---|
| Hotels/ Restaurants | 1 | Stop use of Coal | | | | | | 80.56 |
| Domestic Cooking | 2 | LPG to all | | | | | | 50.00 |
| MSW Burning | 3 | Stop MSW burning: Improve collection and disposal (landfill and waste to energy plants) | | | | | | 100.00 |
| Construction and Demolition | 4 | Vertically cover the construction area with fine screens | | | | | | 50.00 |
| | | Handling and Storage of Raw Material: completely cover the material | | | | | | |
| | | Water spray and wind breaker | | | | | | |
| | | Store the waste inside premises with proper cover | | | | | | |
| Concrete Batching | 5 | Water Spray | | | | | | 40.00 |
| | | Wind Breaker | | | | | | |
| | | Bag Filter at Silos | | | | | | |
| | | Enclosures, Hoods, Curtains, Telescopic Chutes, Cover Transfer Points and Conveyer Belts | | | | | | |
| Road Dust and Soil dust | 6.1 | Vacuum Sweeping of major roads (Four Times a Month) | | | | | | 70.00 |
| | | Carpeting of shoulders | | | | | | |
| | | Mechanical sweeping with water wash | | | | | | |
| | 6.2 | plant small shrubs, perennial forages, grass covers in open areas | | | | | | -- |
| Note: for implementation year 2016 may begin from July 2016 | | | | | | | | |

| S.No. | Status before report | Recommendation and Status After report |
|---|---|---|
| 1. | BS IV to BS V | BS IV leap frog to BS VI - Agreed |
| 2. | BS VI in 2023/2024 | BS VI 2019 now 2021/2020 |
| 3. | No road sweeping | Yes started, shoulder carpeting ? |
| 4. | Soil dust control - none | Plant small shrubs, perennial forages, grass cover (initiated) |
| 5. | No attention to MSW burning | Stop fully. Problem recognized |
| 6. | SO4/NO3 control (65 – 75%) | 90% control (change in regulation) |
| 7. | 2-W single point fuel injection | Multi point fuel injection – talked about |
| 8. | Biomass burning | energy production, biogas generation, commercial feedstock for cattle, composting, conversion in biochar |
| 9. | 10 ppm Sulfur in Diesel (2022) | Now 2019 |
| 10. | Concrete batching – no plan | Recognized – action being initiated |
| 11 | Construction activity | Being enforced |
| 12 | NCR – no plan | Implement everything of Delhi in NCR – no takers |

**Quality Science. Sincere efforts. Massive spending. AQS Attained? NO. Why not?**

# Case study of Berlin




Clean Air and Action Plan for Berlin 2005-2010

Do we know the background? In Delhi our estimate 100 ug/m$^3$ out of total 300 ug/m$^3$

- Not all actions put to implementation
  - SIA control SO4 and NO3 power plants  industry
  - BS VI vehicle replacing old vehicle takes time
  - Road and soil dust control not fully operational
  - MSW burning not fully stopped
- Distinguish between administrative boundary and airshed
- Delhi In isolation? Surroundings put together 6/8 NY
- Identify airshed and emissions in it.
- Coordination among cities, states
- Poor emission inventories

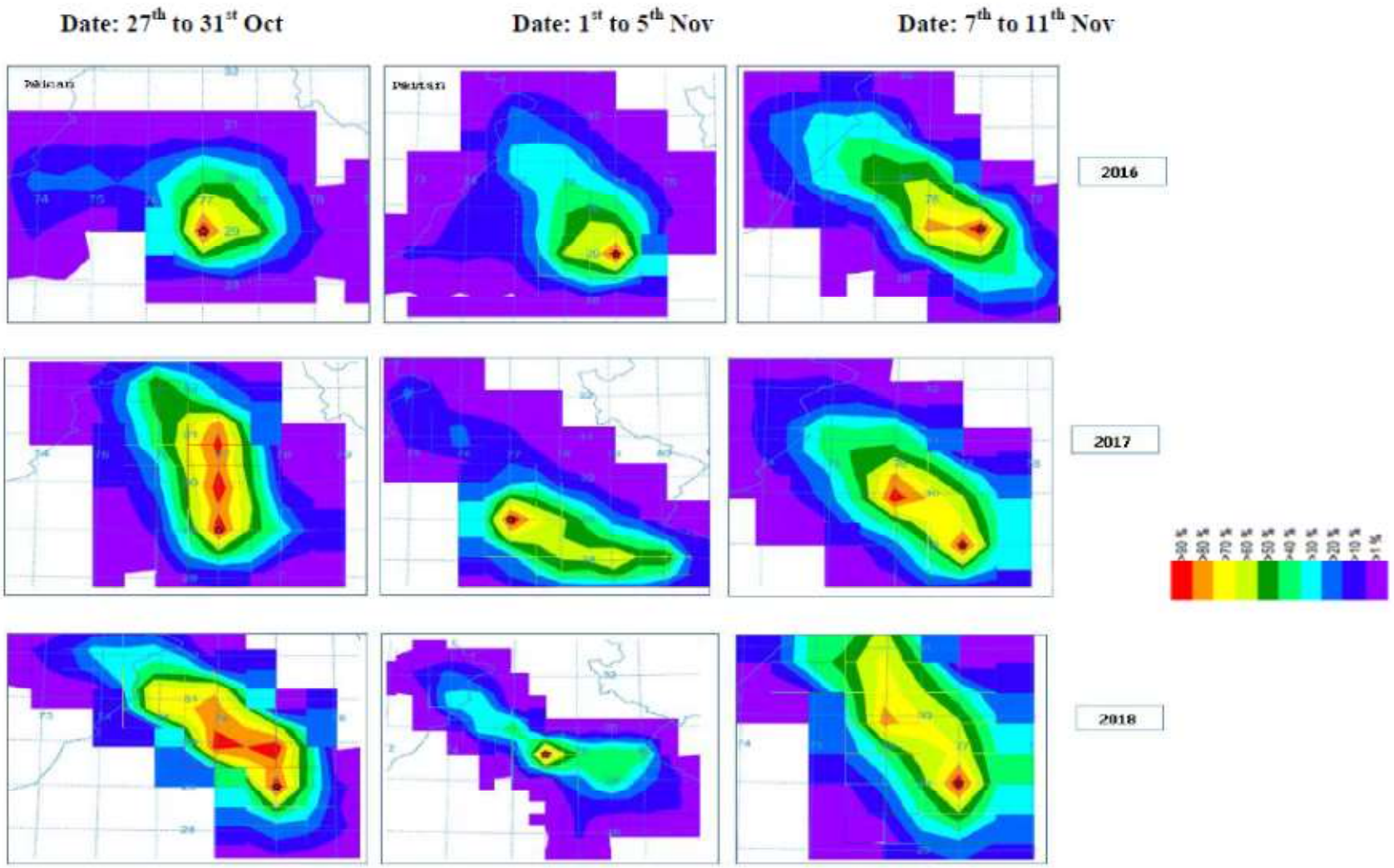
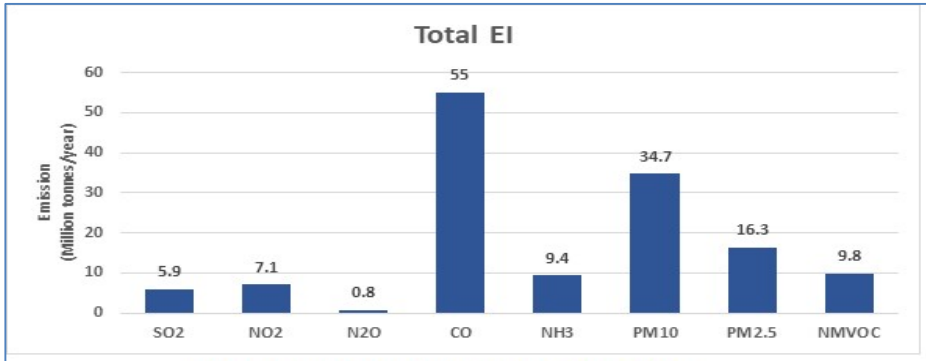
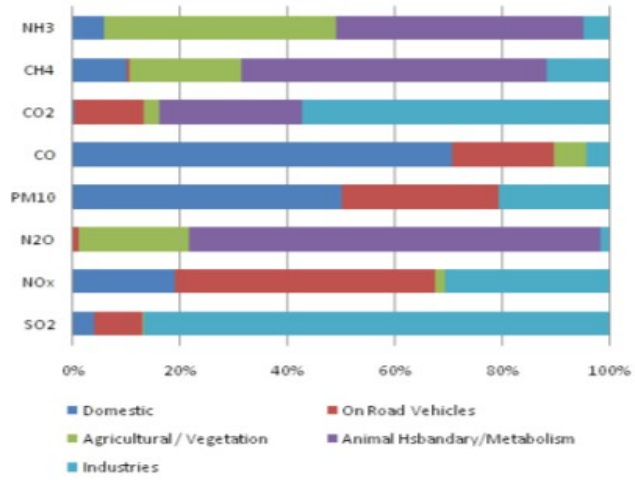



**Figure 1: Backward wind trajectories into Delhi: Number of trajectories passing through grid / Number of trajectories**

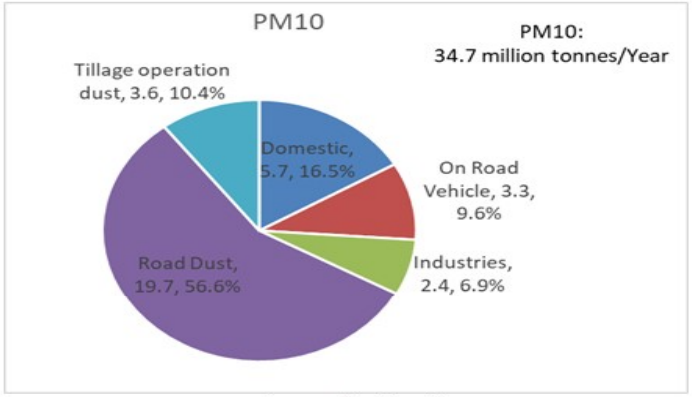
( http://ready.arl.noaa.gov/HYSPLIT.php)



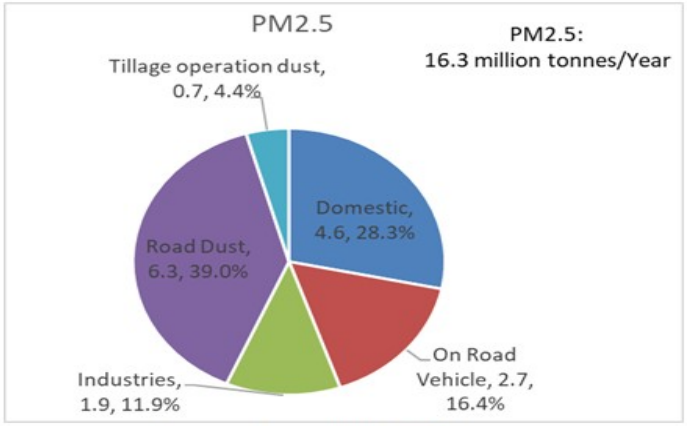

National Emission load (Million tonnes/Year) 2015



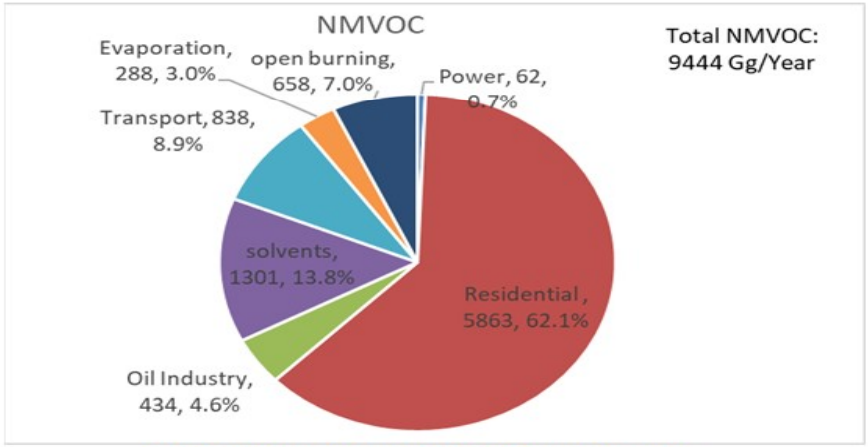

**Distribution of Emission by Source, sectors and Pollutants wise emission and growth statistics (PM10 does not include road, soil dust and tillage operations)**



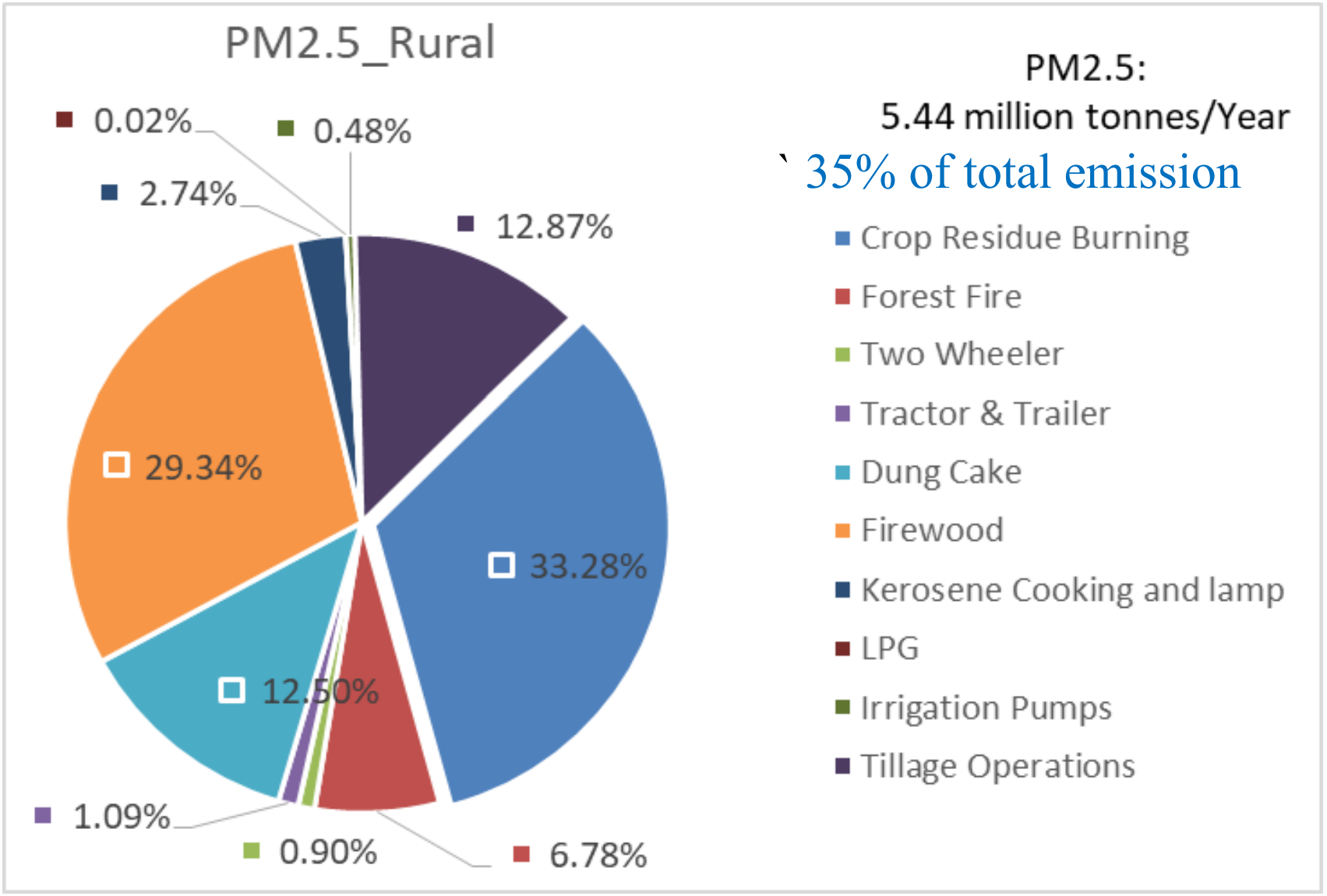

**Source-wise contribution of PM10**

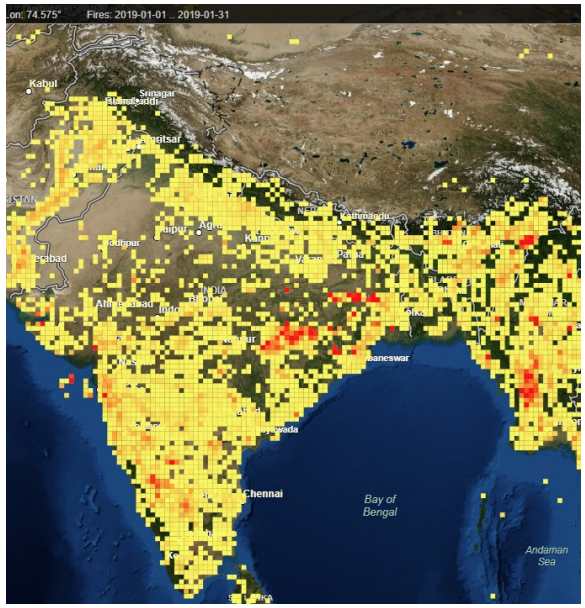



**Source-wise contribution PM2.5**

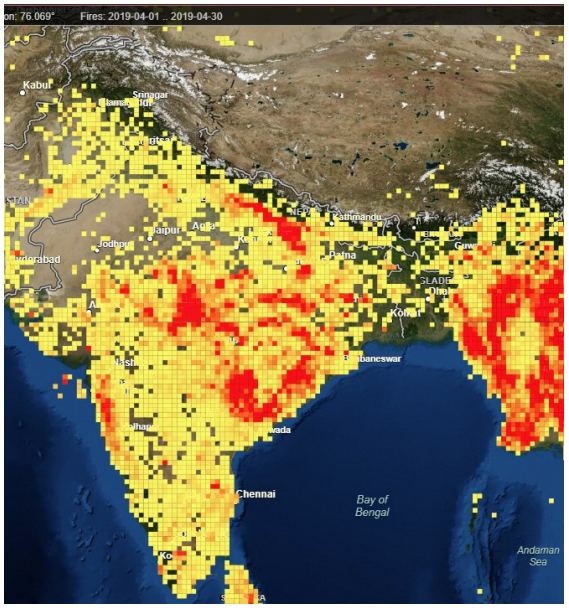



**Source-wise contribution of NMVOCs (Sharma et al, TERI)**

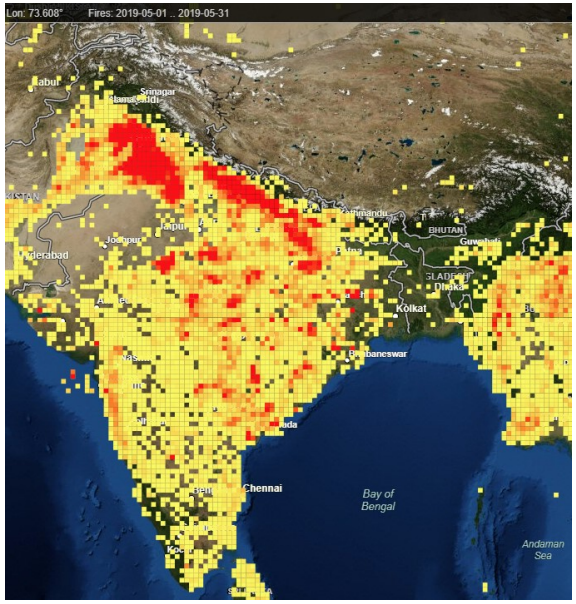

PM2.5_Rural
0.02%
0.48%
2.74%
12.87%
29.34%
33.28%
12.50%
1.09%
0.90%
6.78%
PM2.5:
5.44 million tonnes/Year
` 35% of total emission
Crop Residue Burning
Forest Fire
Two Wheeler
Tractor & Trailer
Dung Cake
Firewood
Kerosene Cooking and lamp
LPG
Irrigation Pumps
Tillage Operations



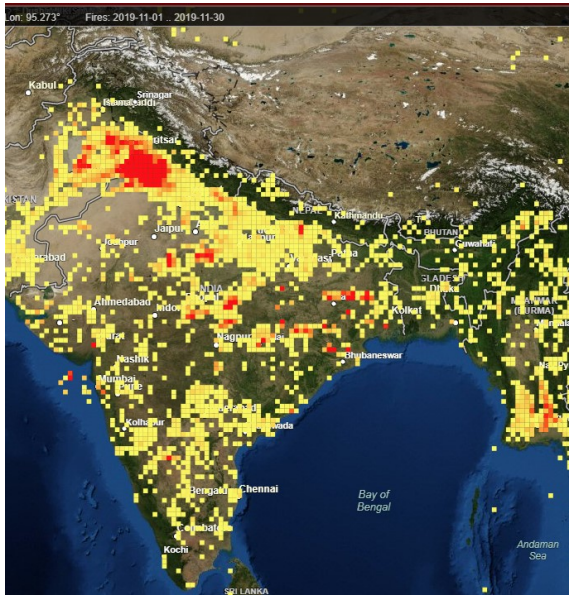

Jan




April




May

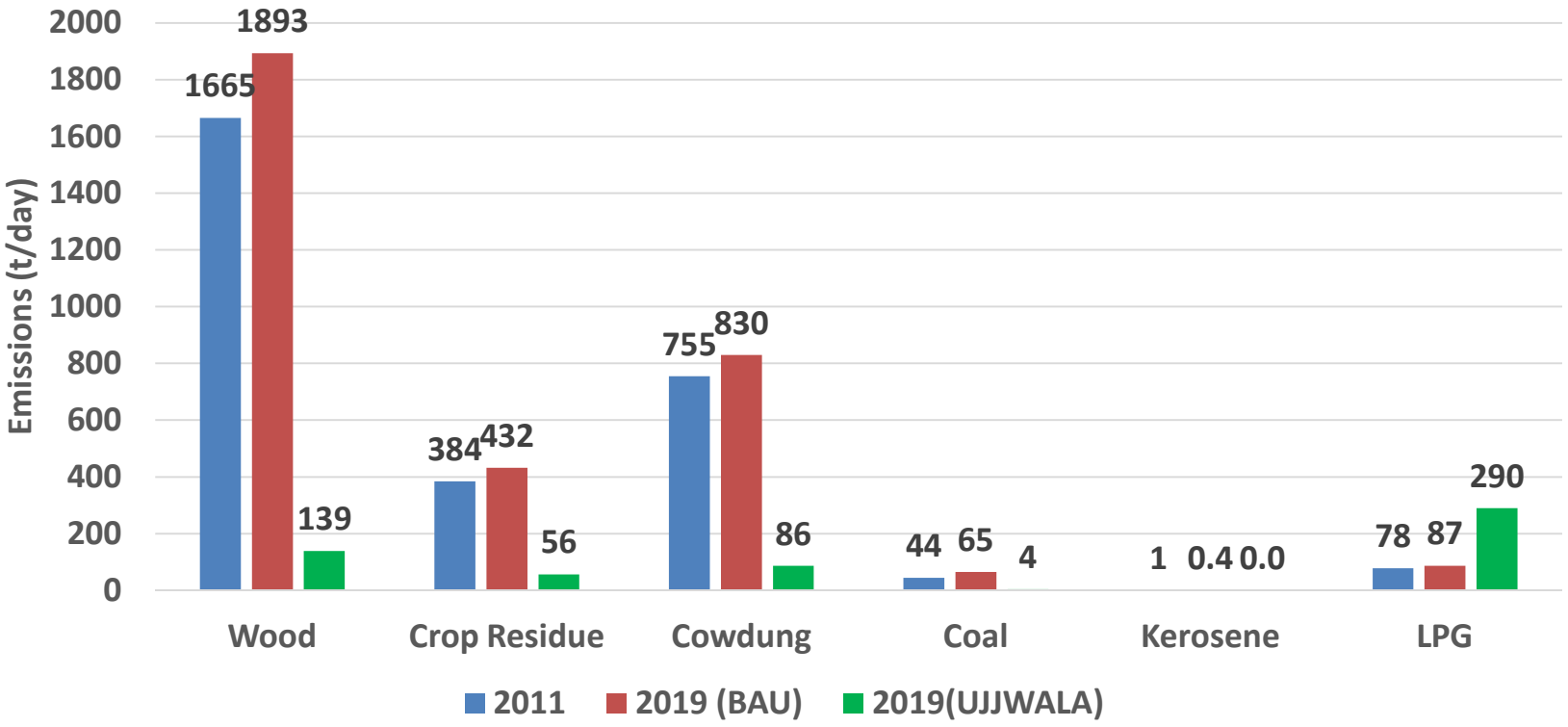



Nov

CRB

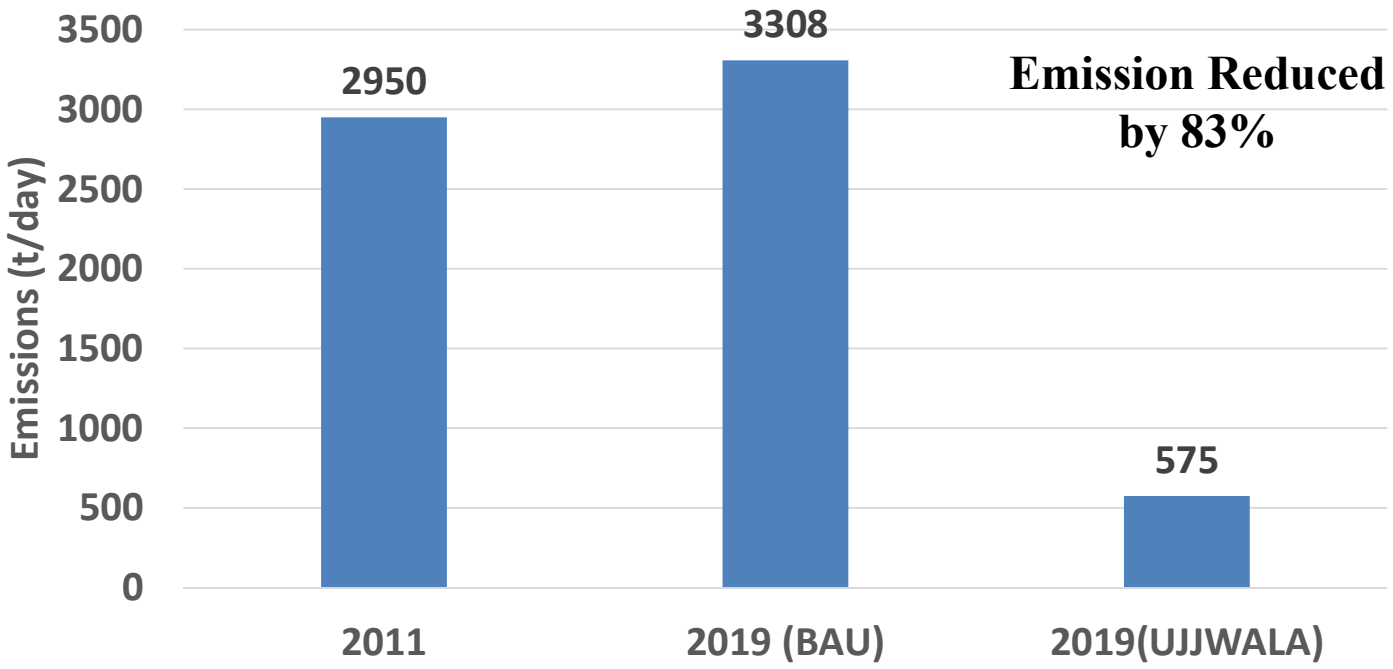
No. of fires

## PM2.5 Emission Breakup




BAU: No change in domestic fuel pattern of census of India 2011

# PM2.5 Emission Scenario



- Good things done
  - Ujjwala Scheme
  - Control of SO2 and NOx from Power Plants
  - BS VI
  - Stop Coke, FO, coal from highly polluted areas
- Challenges
  - Road Dust, rural, urban, NHs
  - NOx control at power plant (V expensive)
  - Strengthen Ujjwala more connections more usages
  - Urban areas, shift to electrical cooking
  - All Control Plans based on Airshed (coordination)
  - Road Congestion
  - Strnghten Public transport
  - Non-point fugitive sources, MSW burning
  - **Acceptable solution for CRB**

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