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Air quality in India – current state and future prospects

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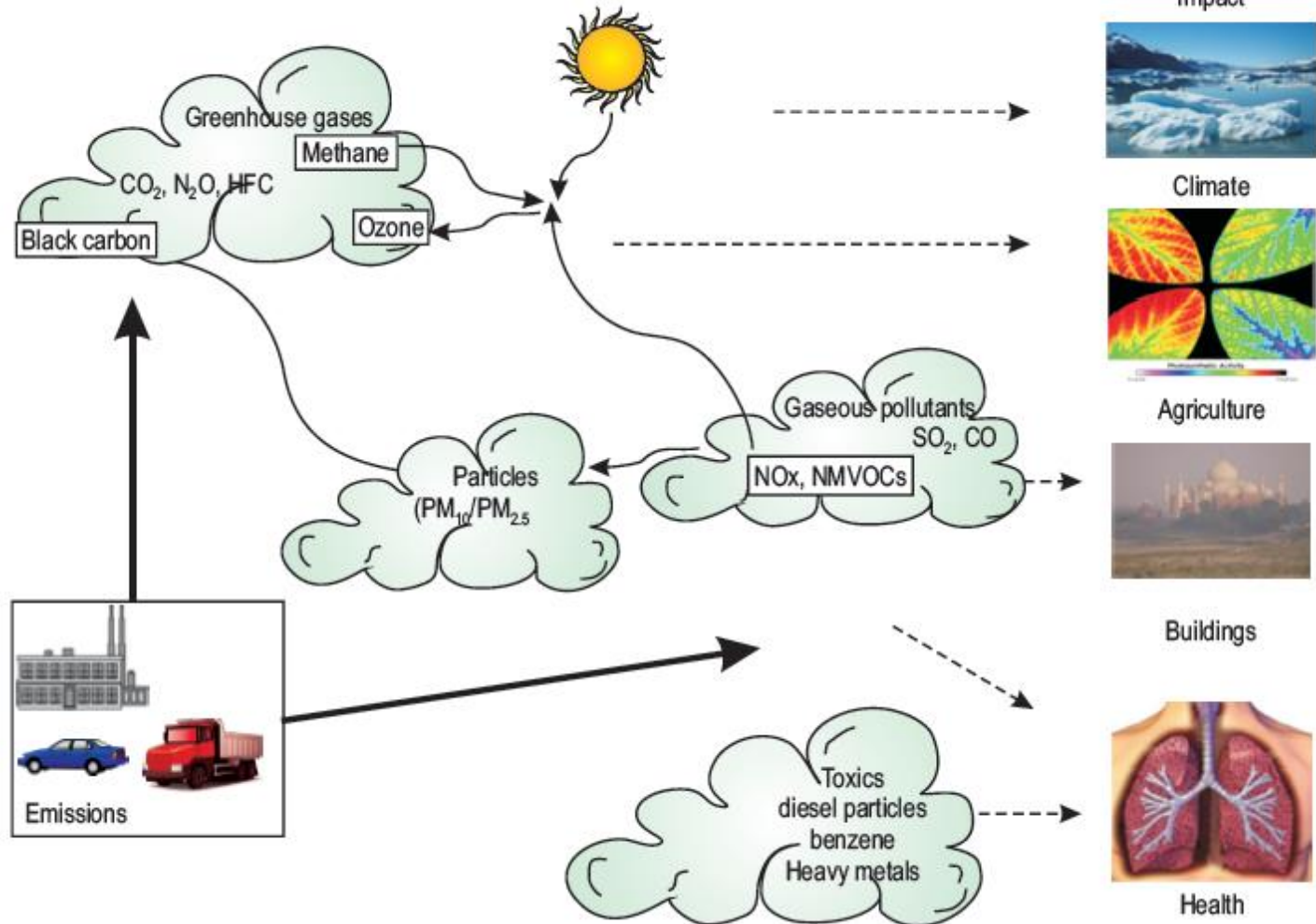


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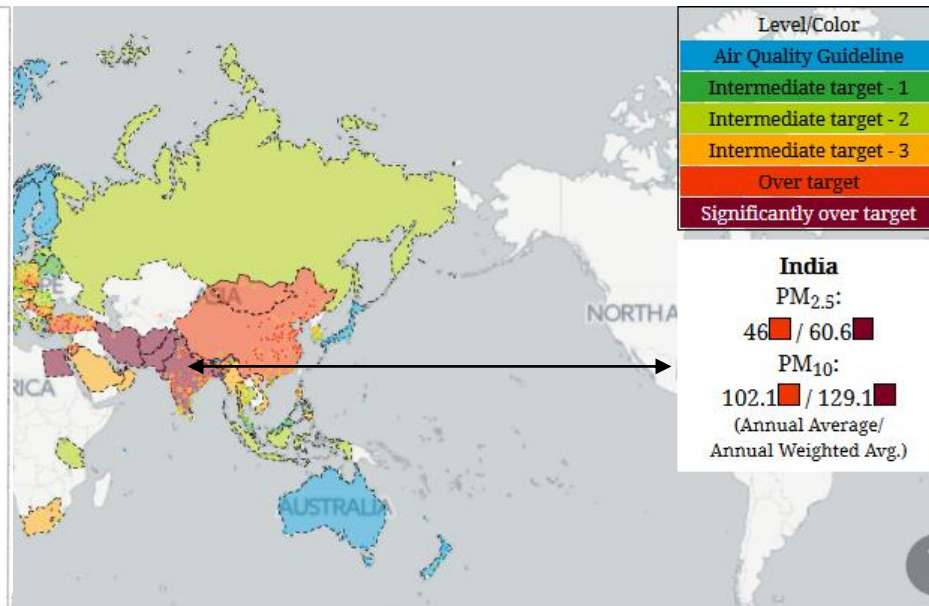
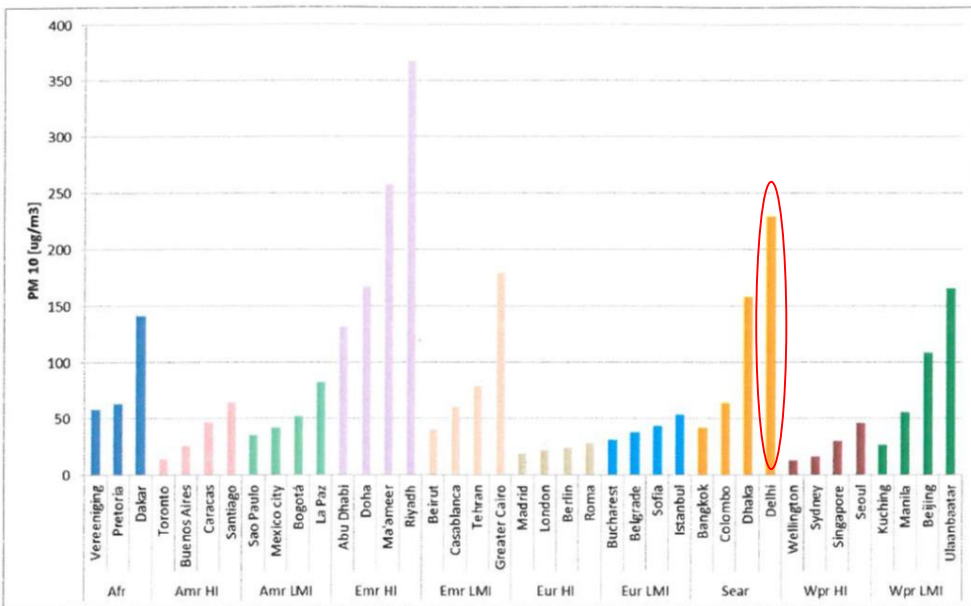


Poor Air Quality





Global state of ambient particulate matter

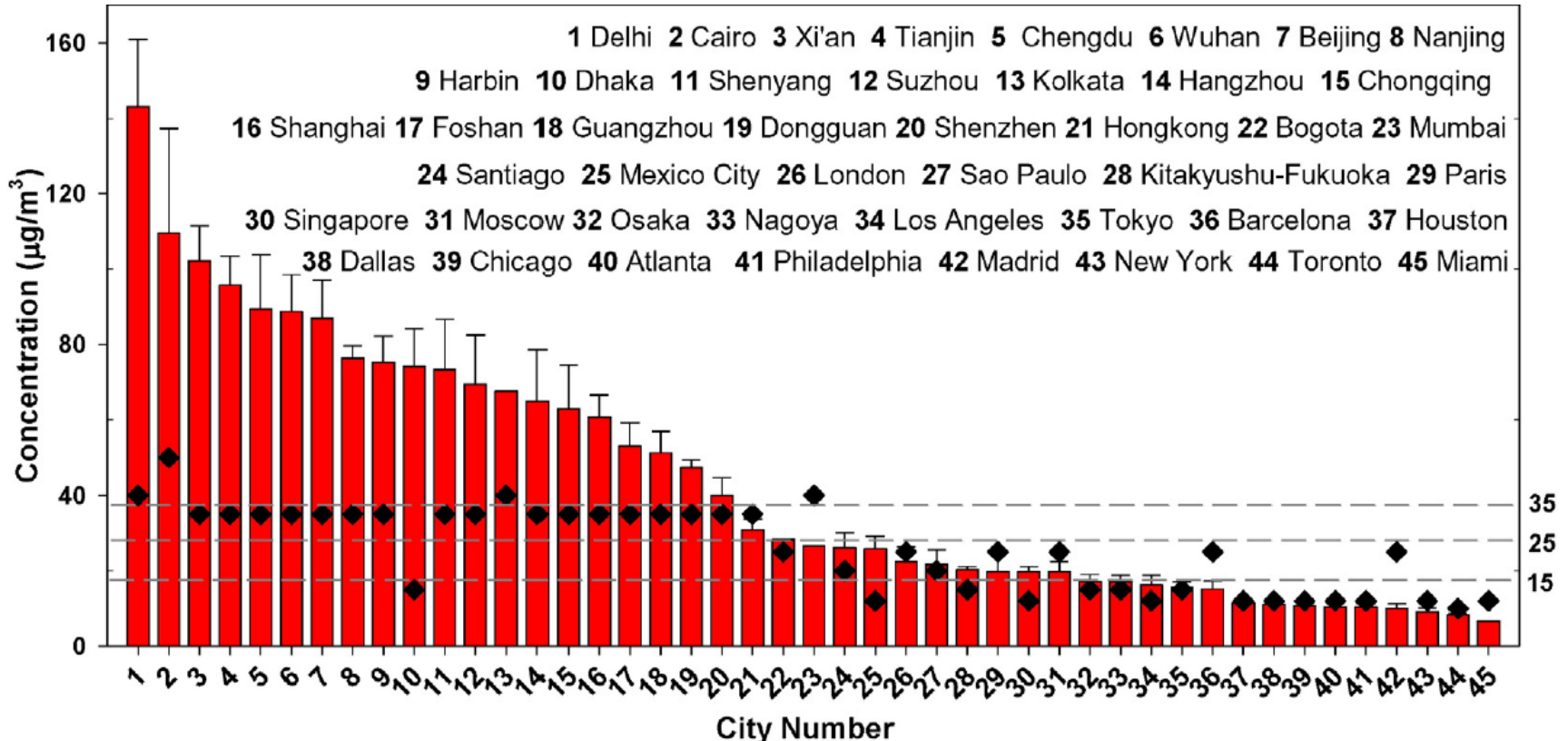


WHO (2015, 2016)

In India: More than 80% cities violate the standards of PM₁₀ (Annual standard in India 60 $\mu\text{g m}^{-3}$). (source: NAMP data, CPCB)



South-East Asia megacities PM_{2.5}

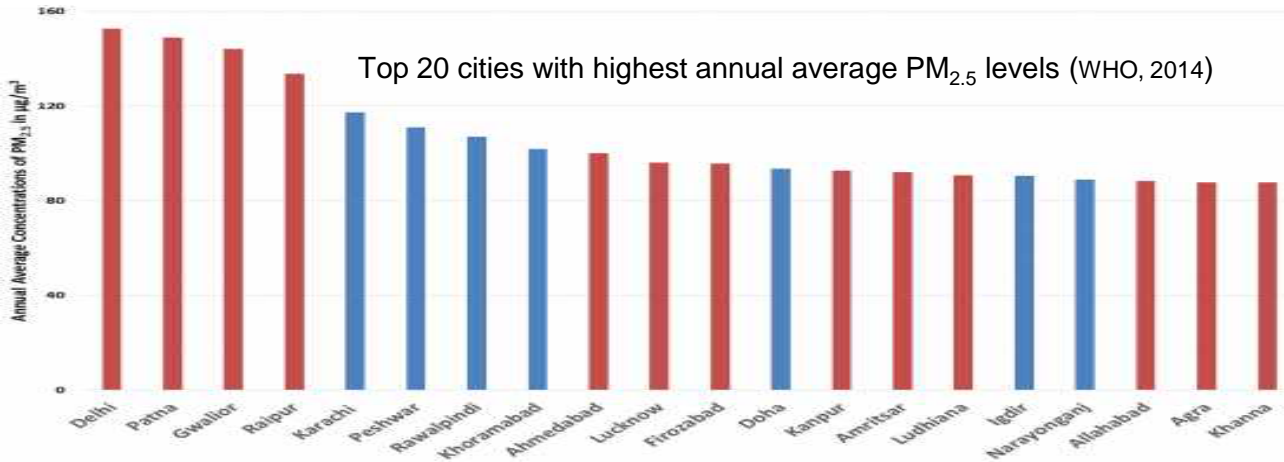


Based on the year 2013 data: The five most polluted megacities with the highest PM_{2.5} concentrations were Delhi (143.0 ± 17.8), Cairo (109.6 ± 27.7), Xi'an (102.2 ± 9.3), Tianjin (95.7 ± 7.7) and Chengdu (89.4 ± 14.4 µg/m³). Only Cairo is in Africa, while the other four megacities are in India or China, in Asia.

Cheng et al., 2016



PM_{2.5} annual concentration

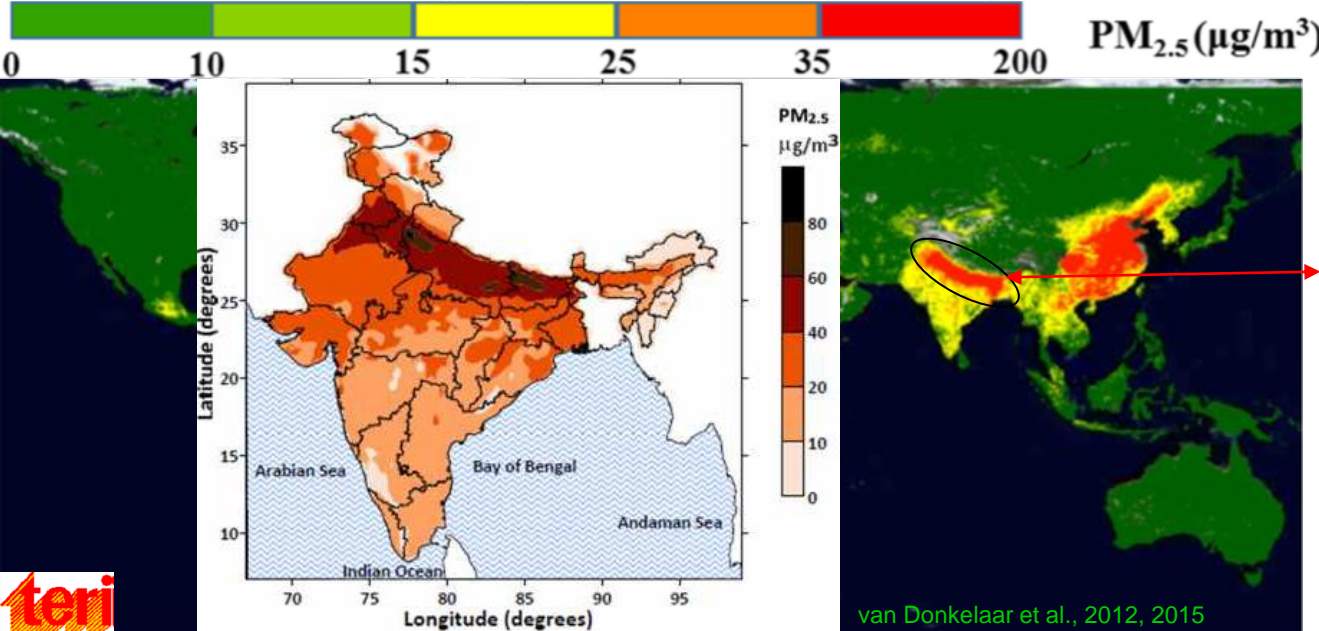


Disparity in data used for comparisons,

Delhi not ranked ONE in year 2015 data set.

WMO/NOAA:
REMOTE: CLIMATE,

National agency: Mostly Urban

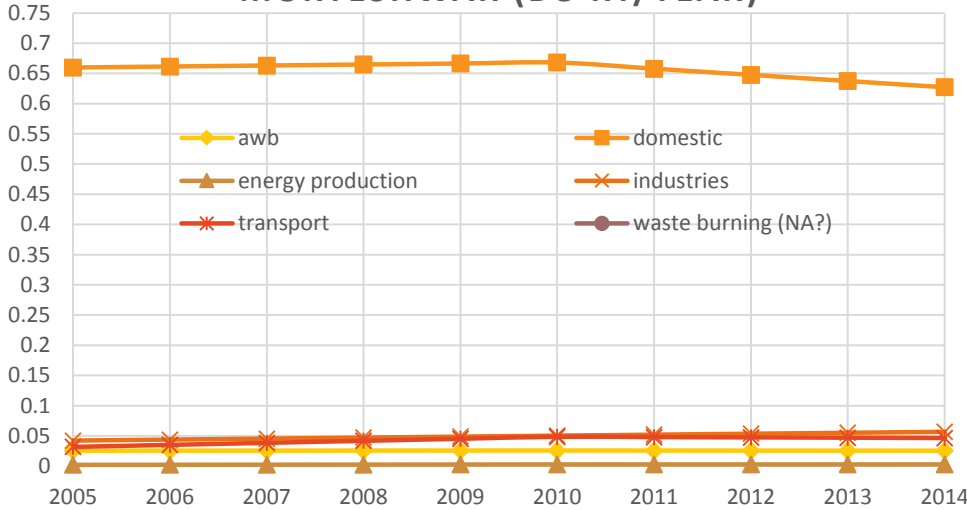


Indo-Gangetic Plains (IGP)

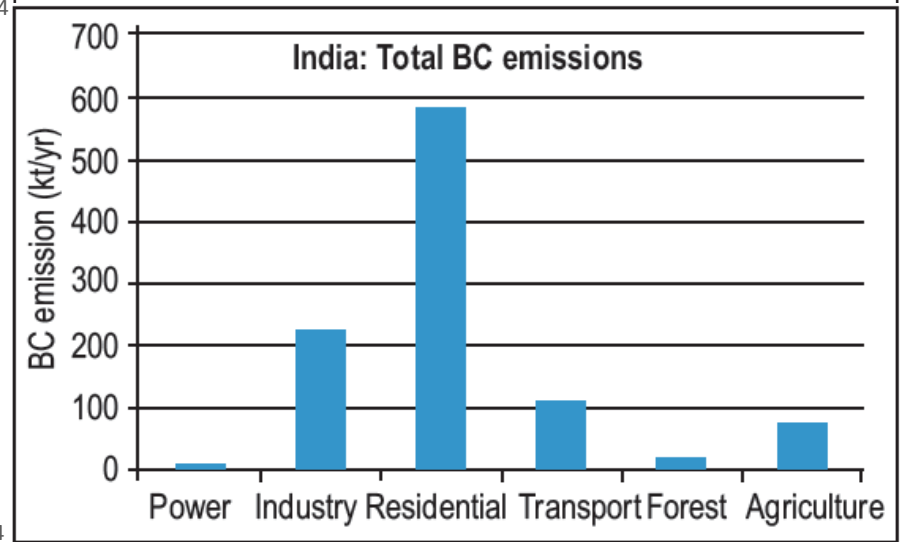
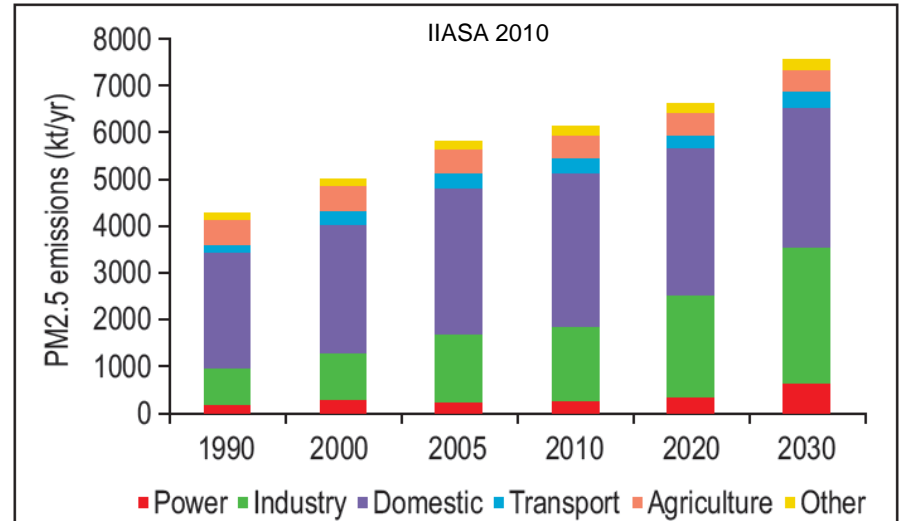
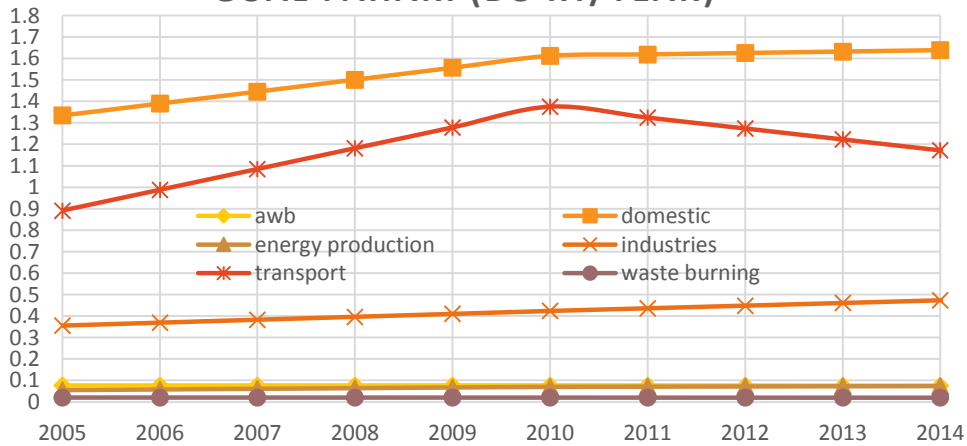


Estimates of PM_{2.5} & BC emissions in India

MUKTESHWAR (BC-KT/YEAR)



GUAL PAHARI (BC-KT/YEAR)



Sloss 2012

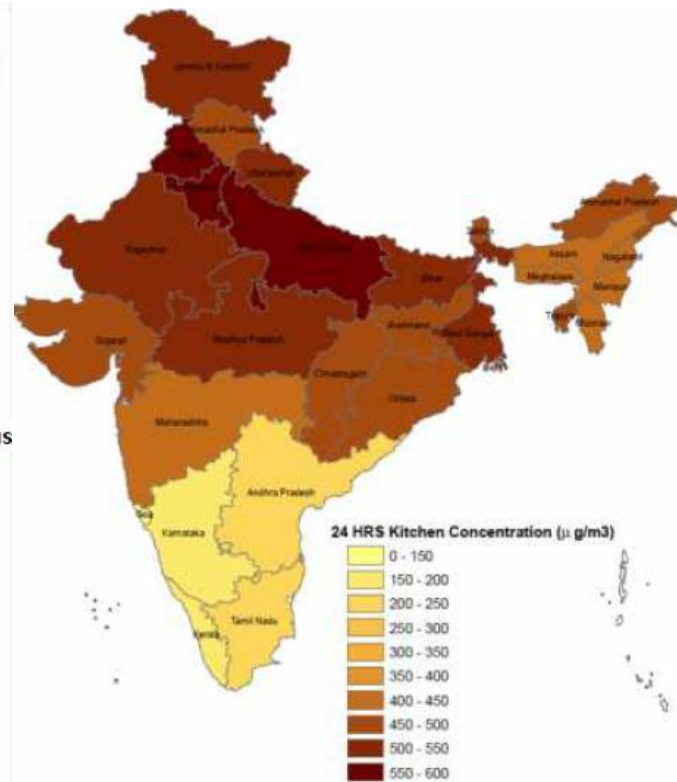
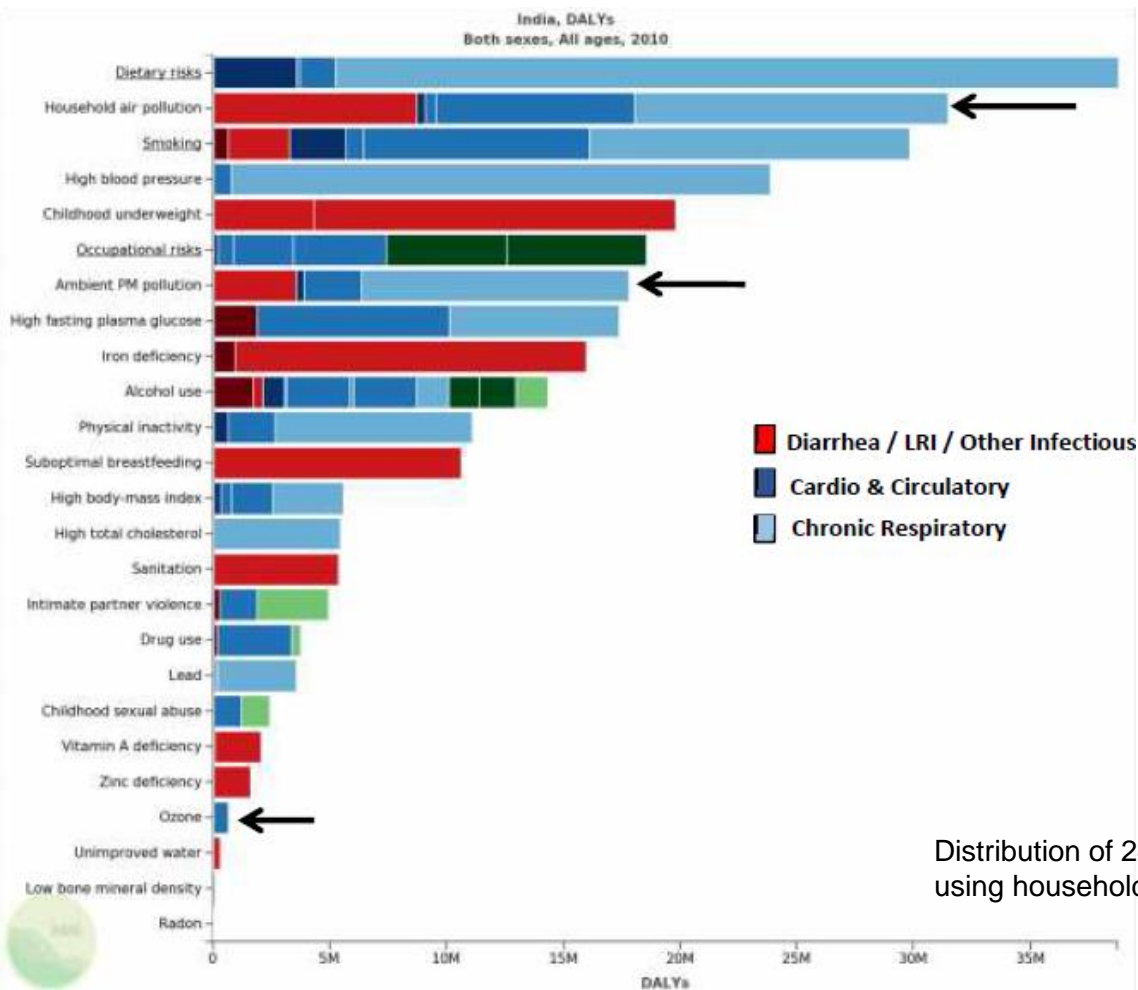


Source Attribution

- The only big official study is the multi-city study that was conducted by Central Pollution Control Board (CPCB) for six cities – Pune (IARI), Chennai (IIT), Delhi (NEERI), Mumbai (NEERI), Kanpur (IIT), and Bengaluru (TERI), at an approximate project cost of US\$6 million (CPCB 2010). This study has considered PM₁₀ and NO_x.
- The most commonly identified sources are vehicles, manufacturing and electricity generation industries, construction activities, road dust, waste burning, combustion of oil, coal, and biomass in the households, and marine/sea salt.
- Their relative contribution varies across cities.
- **For PM_{2.5}:**
 - URBAN:** Transport, road dust, domestic, secondary aerosol, energy production (PP, DG set), waste burning
 - Peri-URBAN:** Domestic, industry, power plant, brick kilns, secondary aerosol
 - RURAL:** Domestic, agriculture residue, secondary aerosol
 - REMOTE:** Long-range, biogenic, secondary aerosol
- In fine mode (PM_{2.5}), the secondary organic carbon (SOC) to total organic carbon ratio was 46% (Hooda et al., 2016)



Factors



Distribution of 24-hr average kitchen area PM_{2.5} concentrations in solid fuel using households across states (Balakrishnan et al. 2013)



Monitoring Network/Resources

URBAN

- Ambient air quality information in India is collected primarily by the National Air Quality Monitoring Programme (NAMP) administered by the CPCB, Ministry of Environment, Forests and Climate Change (MoEF&C), Government of India.
- Although there are 591 operating stations in 248 cities as of May 2015, however, there is timelag in data reporting. The latest available national level data is of year 2012 for 541 stations spread across 222 cities.
- These stations are a network established by the CPCB, in association with the states, called the National Air Quality Monitoring Programme (NAMP).
- Monitoring capacity for $PM_{2.5}$ is very limited in India.
- However, recently MOEF/CPCB have made a network of 11 cities to provide Air Quality Index and Bulletin based on Ozone, $PM_{2.5}$, PM_{10} , NO_2 among others, based on real-time data (status as on 22-06-2015).
- These cities have been connected with the official website for concurrent reporting of the air quality status and accompanying AQIs. However, CPCB has put out more recent data for cities with more than million in population in their Environmental Information System (ENVIS) website.



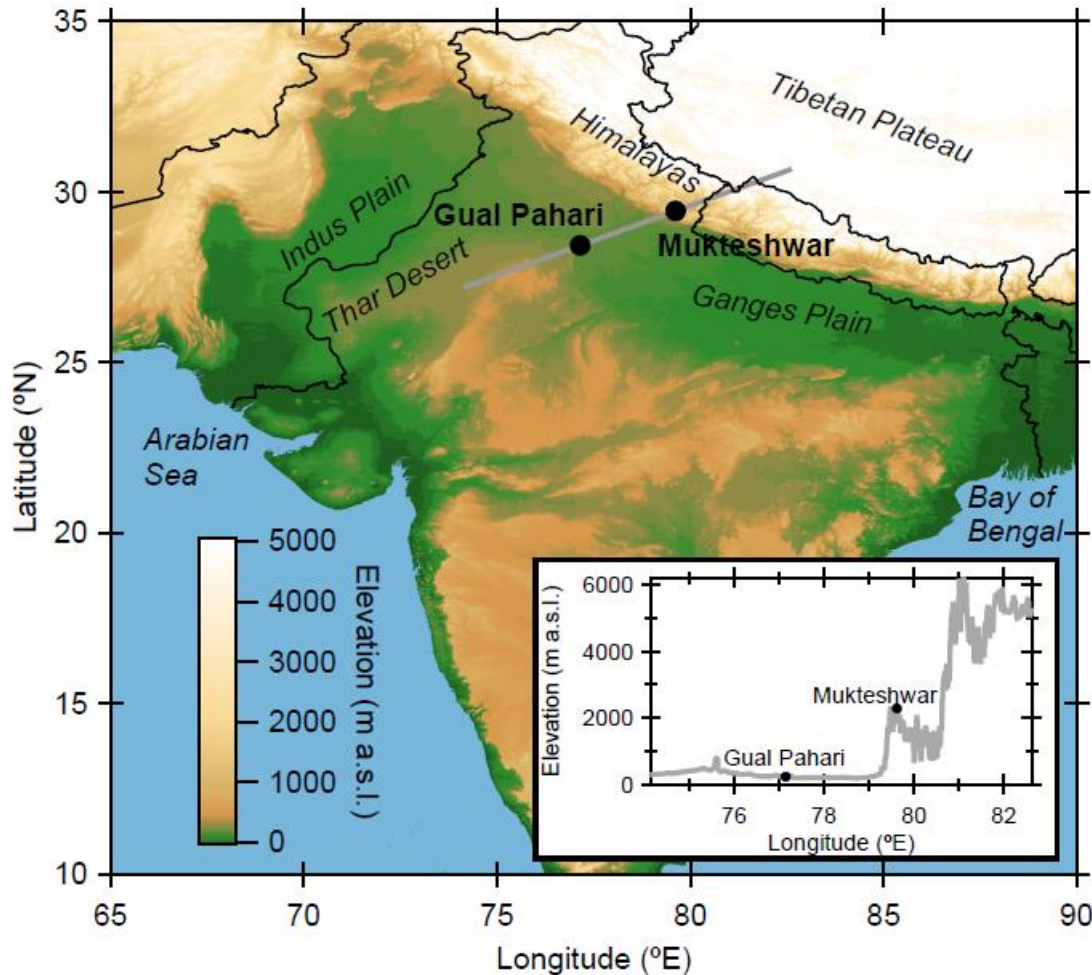
CLIMATE measurements Network/Resources

- India Meteorological Department (IMD) has established about 100 observatories and more than 200 rainfall stations in India.
- IMD has stations for ozone measurements (column ozone, vertical ozone profile, surface ozone), precipitation chemistry, atmospheric attenuation and aerosol chemical characterization at various locations in India.
- Sky-radiometer network (about 50 sites)
- NASA Aerosol Robotic Network (AERONET) stations in India
- BC measurements network (under formulation)

- Campaign/experiment based measurements
- **Systematic measurements and analysis of near-surface aerosols properties is sparse in India and mostly performed by an Indian-Finnish research initiative (FMI-TERI collaboration)** (Dumka et al., 2015).



Research sites



- Regional background site 300 km east of New Delhi (2200 m asl)
- Urban background station in Gual Pahari, 30 km south of New Delhi
- No major local sources of pollution
- To know anthropogenic effects, natural background must be known



Mukteshwar



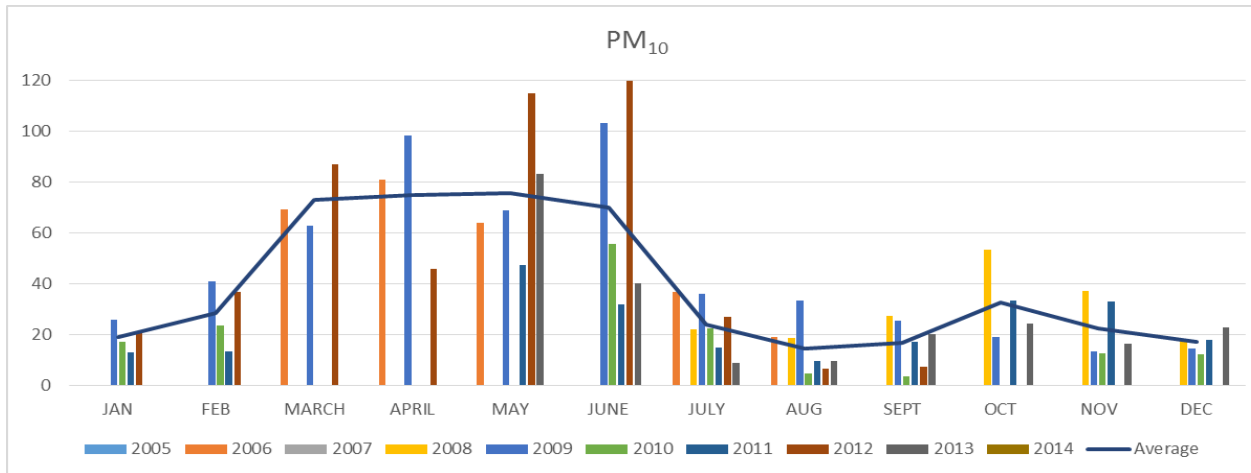
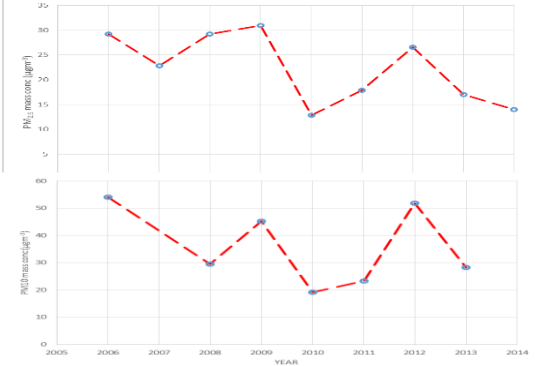
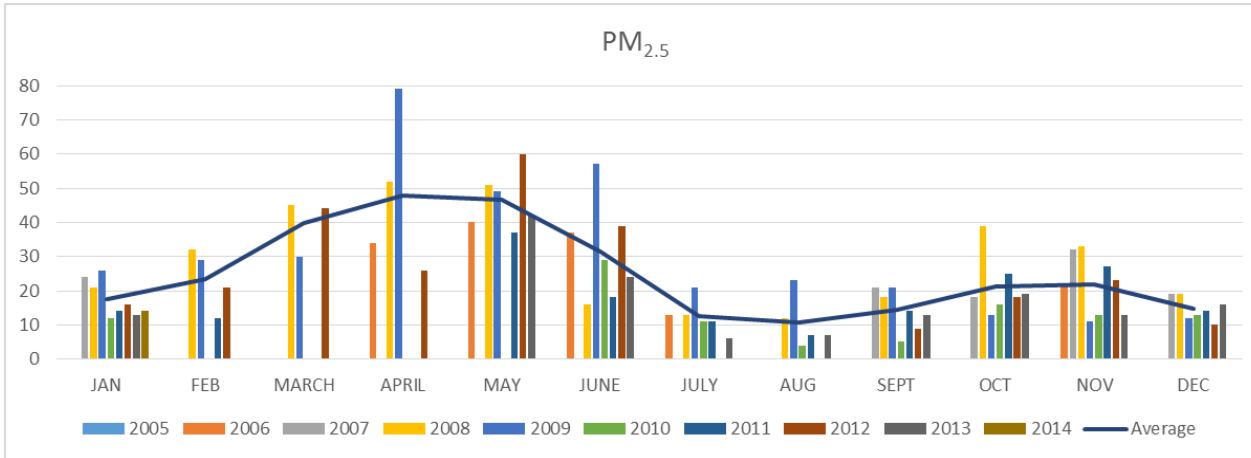
Gual Pahari





Variability/Trend

for example Mukteshwar aerosol observatory

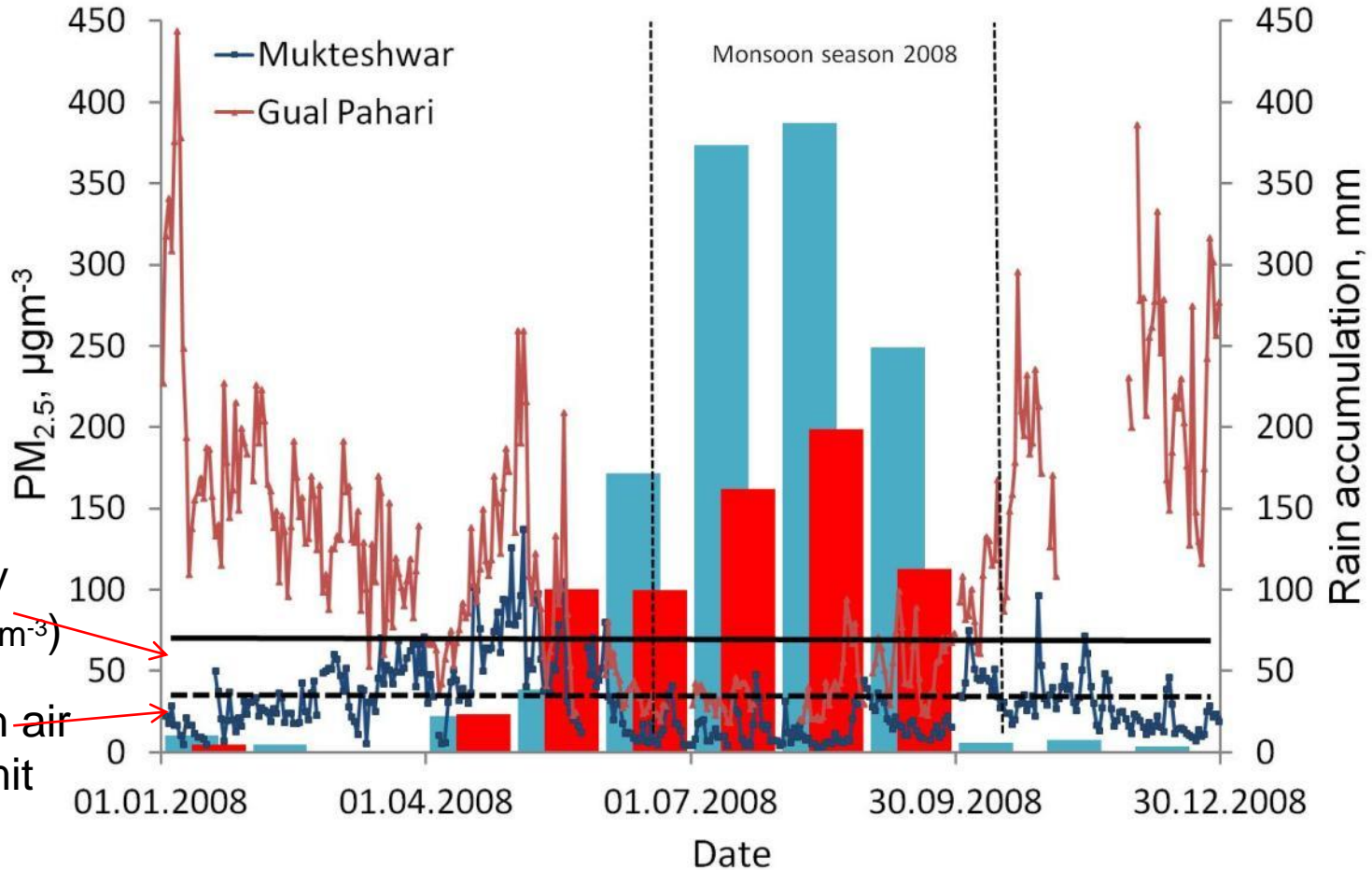


High seasonal variability

So, time is very important- the data used for international comparisons?



Seasonal variation, PM_{2.5}





Related projects

- **“Influence of clouds and atmospheric aerosols on solar energy in India and Finland”** 2015-2017 ongoing. The goal of the project is to quantify the solar potential influenced by rapidly progressing climate change.
- **“Climate modelling and observations”** 2014-2017 ongoing. Overall objective of the project is to reduce climate and weather related loss of life and property in India and support climate policy and decision making through improved climate research and climate services.
- **“Absorbing aerosols and fate of the Indian glaciers”** 2013-2017 ongoing. The research relies on expeditions made on a selected Himalayan glacier, available in situ and satellite measurement data, and modelling tools.
- **“Black and brown carbon influence on climate in India – from local to regional scale”**, funded by Academy of Finland–2013-2014. The overall goal aimed to advance our knowledge on brown and black carbon influence on climate
- **“Particulate air pollution over India and the ‘brown cloud’ associated with it”**, funded by MEA/Finnish Meteorological Institute–2005-2012. The project aimed to characterize the basic properties of regional background aerosols over the Indian continent, including their seasonal cycle and long-term trend. Mukteshwar is the first station in India has had longest time-series of aerosols observation at a high altitude (2180m asl).
- **“European Integrated project on Aerosol Cloud Climate and Air Quality interactions (EUCAARI)”**, funded by European Commission–2007-2010. The tasks executed were measurement of physical, chemical and optical properties of aerosols in India (including annual and seasonal variations).

- **BIO-technology Solutions for Clean Air - Proposal submitted**
- **Traffic and air quality in India: technologies and attitudes - Decision awaited**
- **Finnish Meteorological Institute (FMI) and The Energy and Resources Institute (TERI) signed MoU in October 2003.**



Policy initiatives

- **The current and future trends of aerosol concentrations in this region are very unclear: while measurements conducted in megacities show of a decrease in aerosol concentrations over the few recent years (may be due to stringent emission control measures), regional-scale measurements seem to be indicative of an increasing trend (mainly BC).**
- **So far, the initiatives (e.g., BS IV, Phasing out old vehicles, CNG shift, industries relocation, PP shutdown-Gas based) had helped during their inception years. At present, almost all the emission control measures have fallen short in keeping up with the growing local and regional emissions which led to degradation in air quality and increasing health risk.**
- **Moreover, when meteorological conditions block the dispersal of aerosols, their high concentration impairs visibility and has a respiratory health threat.**
- **The beneficial technological advances for the air quality may have been masked by the increase in local population and the energy demand partially due to the globalization of the economy.**

May be were not long-term strategies !!

So: Both SHORT ↔ LONG-TERM



Policy prospects

To control vehicular pollution by moving to Bharat VI emission norms by 2020, , **the BS VI (=Euro VI) standards will go into effect for all vehicles in these categories manufactured on or after April 1, 2020.**

Pro-active measures to **discourage use of fossil fuels** in a bid to reduce carbon foot print by levying Rs 400 per tonne green cess on coal. Moreover for Power Plants-thrust is on adopting clean coal technologies.

The proposed Compensatory Afforestation Funds Bill 2015, would unlock Rs 40,000 crores of **funds for the 'Green India'** initiative.

The **solar energy mission** envisaged 1,00,000 Mw (1Gw) of solar electricity generation by 2022 (116% increase). Solar water pump to farmers for irrigation.

LPG distribution- **The Pradhan Mantri Ujjwala Yojana scheme, which recognises the importance of clean cooking energy.** (40 million in last 60 weeks).

Bio-ethanol/Bio-fuel-**Government will soon come up with a new policy on non-conventional resources as it plans to take up ethanol blending in petrol to 22.5 % and in diesel to 15 %.**

Policies on waste management, Swachch Bharat initiative.

COP21: Global action plan to put the world on track by limiting global warming below 2 degree Celsius.

On April 2, 2016: Mr. Javadekar said climate change was a reality with 1 degree rise in temperature caused by 150 years of uncontrolled carbon emission by the developed world. He said while 30% of cumulative contribution was that of the United States, 50% by Europe, Canada and other developed world and 10% by China, India was responsible for only 3% carbon emission. The Minister further said **"though India is not part of the problem, it wants to be part of the solution. Our commitment is reflected in every programme being pursued by the Government"**.



Policy perspective (Delhi) Court Ordres-

The Delhi government had practiced this year the **odd/even rule** wherein cars with odd-numbered registration plates would ply on odd dates and those with even-numbered registration plates would do so on even dates. The idea is to reduce congestion as well as to reduce pollution resulting from vehicular emissions.

The Supreme Court had also banned the **registration of luxury SUVs and diesel cars** above 2000cc in the national capital. Diesel cars are believed to be a major source of vehicular emissions. A bench headed by the Chief Justice had noted that it was not fair for rich people to buy luxury cars and thus pollute Delhi. (Now allowed and impose green cess 1%)

The **green cess on commercial vehicles** entering Delhi has been hiked by the top court by a whopping 100 per cent. The SC-appointed Environment Pollution Control Authority has directed the Delhi government to install boards notifying the new cess in 125 toll booths across Delhi.

The top court has ordered that all taxis plying in the city must **convert to CNG**. Also, commercial vehicles which are registered before 2005 won't be allowed to enter the national capital.

The National Green Tribunal (NGT) has issued directions to all authorities to strictly implement earlier orders regarding the **ban on burning of waste and fine on emission of construction dust**.

The NGT has asked the **central and state government not to buy diesel vehicles** for its personnel. It also asked public administration departments and municipal bodies to take efforts to gradually phase out diesel vehicles.

In a separate order, the NGT directed the governments of Delhi, and near by states to **immediately ban the burning of crop residue**. In earlier orders, the NGT had noted that the practice was contributing to the rising air pollution in the NCR.



Way forward

Science-Policy

- Dense measurement network (No GAW station in India)
- Short Lived Climate Forcer (e.g. Black Carbon) -since the life times of SLCFs is short, the mitigation effect will be felt within a decade
- More research on understanding the aerosol processes
- Model formulation and parametrization (indigenous)
- Emission control optimization/strategies-OC, SO₄ vs BC/BrC (cooling : heating balancing)
- Cohort studies (Epidemiological studies)
- (air quality-health-climate linkages)
- Clean fuel technologies



Thank you for your attention!

Question/comments

