VEHICULAR EMISSIONS & AIR QUALITY IN INDIA

Sumit Sharma, Sumit Kumar Gautam
TERI
OUTLINE

• Air pollution in India
• Share of transport sector
• Regional scale view of air pollution in India
• Impacts of air pollution
• Effects of introduction of advanced vehicular emission norms and improved fuel quality
• Way forward
AIR POLLUTION IN INDIA
## NAAQS

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Time Weighted Average</th>
<th>Concentration in Ambient air (Industrial, Residential, Rural and other Area)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphur Dioxide (SO$_2$), $\mu$g/m$^3$</td>
<td>24 hours*</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>50</td>
</tr>
<tr>
<td>Nitrogen Dioxide (NO$_2$), $\mu$g/m$^3$</td>
<td>24 hours**</td>
<td>80</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>40</td>
</tr>
<tr>
<td>Particulate matter (size less than 10$\mu$m) or PM$_{10}$, $\mu$g/m$^3$</td>
<td>24 hours</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>60</td>
</tr>
<tr>
<td>Carbon Monoxide (CO), mg/m$^3$</td>
<td>8 hourly</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>1 Hourly</td>
<td>4</td>
</tr>
<tr>
<td>Ozone (O3), $\mu$g/m$^3$</td>
<td>8 hourly</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>1 Hourly</td>
<td>180</td>
</tr>
<tr>
<td>Particulate matter (size less than 10$\mu$m) or PM$_{25}$, $\mu$g/m$^3$</td>
<td>24 hours</td>
<td>60</td>
</tr>
<tr>
<td></td>
<td>Annual average</td>
<td>40</td>
</tr>
</tbody>
</table>
More than 80% cities violate the standards of RSPM
• Close to the standards at many places
• Highest at Howrah, Kolkata, Delhi
CORRELATION: VEHICLES AND NOX (2007)

Graph showing the correlation between total vehicles and NOx concentration. The graph includes data points for various cities such as Delhi, Mumbai, Bangalore, and others, with an R² value of 0.73.
TRANSPORT SECTOR IN INDIA
PHENOMENAL GROWTH OF PRIVATE VEHICLES

- A developing country phenomena
- Growth in income
- Mobility demands
- Lack of efficient public transport system
- Competitive market

- 27 k two wheelers in 1951 to 26 lakhs in 1981 to 9.1 crores in 2010
- 1.5 lakh cars in 1951 to 11.6 lakh in 1981 to 1.4 crore in 2010
CONGESTION

• About 25000 two wheelers, and 5000 cars added to India’s vehicular fleet daily

• Road space almost same

• Limited transport infrastructure

• Traffic jams: waste of fuel, time, emissions, discomfort

• Reduced speeds

• 320 kl of petrol and 100 kl of diesel burnt daily due to the idling of vehicles at traffic intersections in Delhi alone (CRRI, 2003)

Data source: WSA, 2008
SHARE OF TRANSPORT SECTOR IN AMBIENT AIR POLLUTION: SOURCE APPORTIONMENT STUDY
Sector-wise NOx Emissions in India

• Share of transport sector increases if we move from PM10 to PM2.5 (finer fractions)

• In non-industrial cities, it is the largest source
SHARE OF TRANSPORT IN NOX EMISSIONS

Bangalore
- Transport: 67%
- Road Dust: 0%
- Domestic: 0%
- Industry: 0%
- Others: 0%

Pune
- Transport: 95%
- Road Dust: 0%
- Domestic: 0%
- Industry: 0%
- Others: 0%

Kanpur
- Transport: 42%
- Road Dust: 0%
- Domestic: 0%
- Industry: 0%
- Others: 47%
SHARE OF COMMERCIAL VEHICLES (BANGALORE)

Transport -PM

Transport NOx
## ALTERNATE SCENARIO DESCRIPTION

<table>
<thead>
<tr>
<th>Sector</th>
<th>Alternate-I</th>
<th>Alternate-II</th>
<th>Alternate-III</th>
<th>Alternate-IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
<td>Strategies to reduce the air pollution loads across various sectors.</td>
<td>Stringent scenario with many more strategies as compared to Alternate- I scenario.</td>
<td>Scenario that contains additional set of measures that are not a part of the common control options (e.g., introduction of FES, installation of (DOC/DPF)</td>
<td>Scenario with measures that are more oriented towards meeting the air quality standards in future</td>
</tr>
</tbody>
</table>
| Transport | • BS-V in 2015  
• Ban on 10 yr old commercial vehicles  
• Metro  
• PTS - diesel  
• I&M  
• DOC in BS-II buses and DPF in BS-III buses | • BS-VI in 2015  
• Ban on 10-yr old com. and 15-yr old private vehicles  
• Metro  
• PTS - CNG  
• Electric vehicles  
• I&M  
• Conversion of public transport to CNG | • BS-VI in 2015  
• Ban on 15 yr old com. vehicles in 2012 and 10 yr old in 2017  
• Metro  
• PTS-diesel  
• Electric vehicles  
• I&M  
• DOC/DPF after introduction of BS- IV fuel in 2010 to: Old Buses and Trucks  
• Fuel efficiency standards | • BS-V in 2015  
• Ban on 10 yr old com. vehicles  
• Metro  
• PTS- CNG  
• Electric vehicles  
• I&M  
• Conversion of public transport (commercial 3 & 4 w) to CNG  
• By-passing of trucks around Bangalore |
## Alternate Scenario Description (Contd.)

<table>
<thead>
<tr>
<th>Sectors</th>
<th>Alternate-I</th>
<th>Alternate-II</th>
<th>Alternate-III</th>
<th>Alternate-IV</th>
</tr>
</thead>
</table>
| **Industries**| Ban new air polluting industries in city limits | • Ban on any new air polluting industries in city limits  
• Shift from solid to liquid fuel | • Ban on any new air polluting industries in city limits  
• Shift from solid fuel to liquid fuel | • Ban on any new air polluting industries in city limits  
• Shift from solid fuel to liquid fuel |
| **DG sets**   |                                      | • Inspection and maintenance                         | • Inspection and maintenance  
• DOC and DPF applied to commercial DG sets (>12 kVA) | • No power cuts i.e. no usage of DG sets in the city |
| **Road dust re-suspension** |                                      | • Wall to wall paving                                | • Wall to wall paving                                     | • Wall to wall paving  
• Reduction of road dust re-suspension due to by-passing of trucks |
| **Construction** | • Better construction practices     | • Better construction practices                     | • Better construction practices                           | • Better construction practices                 |
### ESTIMATED EMISSIONS LOADS FOR PM10 AND NOX UNDER THE BAU & ALT SCENARIOS

#### PM emission loads (T/d)

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2007</th>
<th>2012</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAU</td>
<td>54.4</td>
<td>71.9</td>
<td>95.8</td>
</tr>
<tr>
<td>ALT-I</td>
<td>54.4</td>
<td>57.2</td>
<td>74.5</td>
</tr>
<tr>
<td>ALT-II</td>
<td>45.1</td>
<td>53.2</td>
<td>74.5</td>
</tr>
<tr>
<td>ALT-III</td>
<td>34.6</td>
<td>53.2</td>
<td>74.5</td>
</tr>
<tr>
<td>ALT-IV</td>
<td>23.5</td>
<td>42.4</td>
<td>61.6</td>
</tr>
</tbody>
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#### NOx emission loads (T/d)

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<th>2012</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>BAU</td>
<td>217</td>
<td>350</td>
<td>460</td>
</tr>
<tr>
<td>ALT-I</td>
<td>227</td>
<td>275</td>
<td>340</td>
</tr>
<tr>
<td>ALT-II</td>
<td>275</td>
<td>321</td>
<td>376</td>
</tr>
<tr>
<td>ALT-III</td>
<td>321</td>
<td>350</td>
<td>400</td>
</tr>
<tr>
<td>ALT-IV</td>
<td>275</td>
<td>321</td>
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</tr>
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#### %PM reduction w.r.t. BAU

<table>
<thead>
<tr>
<th>Scenario</th>
<th>2012</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALT-I</td>
<td>-20%</td>
<td>-22%</td>
</tr>
<tr>
<td>ALT-II</td>
<td>-37%</td>
<td>-44%</td>
</tr>
<tr>
<td>ALT-III</td>
<td>-41%</td>
<td>-55%</td>
</tr>
<tr>
<td>ALT-IV</td>
<td>-54%</td>
<td>-64%</td>
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#### % NOx reduction wrt BAU

<table>
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<th>2017</th>
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<tr>
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<td>-21%</td>
<td>-24%</td>
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<tr>
<td>ALT-II</td>
<td>-29%</td>
<td>-40%</td>
</tr>
<tr>
<td>ALT-III</td>
<td>-20%</td>
<td>-35%</td>
</tr>
<tr>
<td>ALT-IV</td>
<td>-59%</td>
<td>-73%</td>
</tr>
</tbody>
</table>
NOX CONCENTRATION (µG/M3) FOR BAU & ALT SCENARIOS

- Alternate scenarios show a significant decrease compared to BAU scenario (both in 2012 & 2017)
- Alt. IV scenario, has maximum reduction and all the areas in the study domain comply against the residential area standards
REGIONAL SCALE IMPACTS OF NOX

- While considerable attention paid to PM, NOx still remains almost unattended

  - Health impacts
  - Leads to secondary particulate formulations
  - Acid rain
  - Important pre-cursor to Ozone formation

- Regional scale impacts of NOx
OZONE FORMATION

• NOx is an important precursor for Ozone formation

• Ozone values higher during April and October which generally have more sunshine than the winter and monsoon months of January and July, respectively.

• Not only health but agricultural productivity is impacted
IMPACTS

- Sufficient evidence to document the causal relationship with the onset of childhood asthma, non-asthma respiratory diseases, impaired lung function, cardiovascular mortality and morbidity.

- As per TERI’s estimates, about 50,000 deaths could be attributed annually to ambient air pollution in the country.

- Institute of Economic Growth (Delhi), 2003 estimated the annual damages from the urban air pollution in 15 major cities as Rs 111392 million.

- ICCT, 2012 suggests that about 9500 excess deaths were avoided due to advancement of vehicular emission norms during 2000-2011. Moreover, by the year 2035, 48000 mortalities could be avoided annually, if stringent actions like advancement to improved vehicular emissions norms, provision of ULSD, improvement of fuel efficiency etc could be taken in the short timeframe.

- Effects on vegetation, visibility, ecology etc
EMISSIONS FROM COMMERCIAL VEHICLES
SHARE OF COMMERCIAL VEHICLES

PM10 emissions

- Bangalore
- Delhi
- Pune

Legend:
- 2W
- 3W
- Car
- Bus
- Truck
- Others
U.S. HDV GHG AND FUEL EFFICIENCY FINAL RULE

- 26% share in the transportation fuel used in the U.S.
- Sets separate standards for engines and vehicles, ensures improvements in both.
- Sets separate standards for fuel consumption, CO2, N2O, CH4 and HFCs. Fuel consumption and CO2 standards are aligned.
- Incentives for advanced technologies (e.g. EVs and Hybrids)

Benefits
- 530 million barrels less oil
- $50 billion in fuel savings
- $42 billion in net savings
- 270 MMT lower GHGs
- $8 billion in new hardware
- $49 billion in net benefits

Source: EPA
STRATEGIES TO REDUCE EMISSIONS FROM HD COMMERCIAL VEHICLES

• Technological advancements – emissions control, fuel efficiency improvements
• Fuel quality improvements
• Better I&M programs
• Effective traffic planning
  • Plying restrictions
  • Bye-passing of transit traffic
• Installation of control devices in older vehicles
• Fleet modernization programs
THANKS