Emission Inventory

Emission Inventory: Major Issues, Problem and recent development in South Asia

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Emission Inventory is one of the fundamental components of “Air Quality Management” plans to measure progress/changes over time to achieve cleaner air.
Requirement of Emission Inventory

- Chemical simulation in most of the atmospheric chemical model requires surface emissions in gridded form, which are often not available for most of developing countries like Indian geographical region.

- Emission Inventory is a comprehensive listing by source of air pollution emissions in a geographic area during a specific time period.

- Details the amount and types of air pollutants released into the air and also provide information on the types of sources that are emitting the pollutants, their location and the amount of the pollutants emitted.
Burning Fossil fuels & Bio-Fuel release both:

- Heat trapping Green House Gases (GHGs)
- Air pollutants responsible for
  - Smog
  - Health problems
  - Reduce Visibility
  - Diminished quality of life
Emission Inventory Development Approaches:

• **Top-Down**: (Rapid emission inventory estimation)
  • EFs combined with high level activity data to estimate emissions in country level.
  • Estimated value is scaled to the inventory domain based on surrogate data (economic data, geographic etc.)
  • **Uncertainty is very HIGH and loss of accuracy**

• **Bottom-Up**: (Source specific estimation)
  • Source Specific data (point Source) and category-specific data at the most refined spatial level (for non point source)
  • Emission estimated for individual sources is summed to obtain domain level inventory.
  • **Uncertainty will reduce as compared to Top-Down.**
Reliability of Emission Inventory:

- Detail of information available. (Micro level detail)
- Good Spatial and temporal resolution. (High Resolution)
- Use of Appropriate Emission factor (EFs) as per country specific.
- Information of type of Combustion used.
- Technology used information is required.
GIS Based Emission Modeling

Concept
Simpler form of GIS Methodology

**DATA COLLECTION**
- Base Map - India (Source - SoI maps through CDAC)
- Point locations (Lat/Long)
- Attribute Data: Rural & Urban population, Vehicle Density, Power plants, etc.

**DIGITAL DATA GENERATION**
- Scanning of maps
- Digitization of maps
- Attribute Data Generation
  - Layers: Outline Boundary, Bitmap, State, District Boundary
- Georeferencing: Assigning Geographic coordinates, Collection & assigning of GCPs

**MAPPING & MODELING**
- Mapping of Point Locations
- Interpolation Modeling
- Grid Overlay (1° x 1°)
- Classification of Interpolated Emission Values

**PROCESSED INFORMATION**
- Input to Air Quality Model
- Report Generation
  - Map generation
  - Tabular & Graphical presentation
- Gridwise Emission Data extraction

**GRIDDED BLACK CARBON (BC) EMISSION FROM ALL SOURCE (2001)**
- Total = 1343.78 Gg/yr
**Digital Data:** Vector-Map Of State, District and Grid Box is Generated Using GIS Tool for further use.

**GRID COVERING INDIA**

**GRIDBOX**
Emission Modeling for Gridded, Hourly, Speciated Data

- **Spatial allocation**
  Activity level database: Spatial information

- **Temporal allocation**
  Activity level database: Temporal information

- **Chemical speciation**
  Chemical speciation database
Change of Emission Scenario with Changing Emission Factors
## EMISSION FACTOR (EF) USED IN GIVEN SCENARIOS

<table>
<thead>
<tr>
<th>Major Source</th>
<th>Diff. type of Fuel</th>
<th>Scenario – ‘A’</th>
<th>Scenario – ‘B’</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Fossil</strong></td>
<td><strong>Hard Coal</strong></td>
<td>1.58 g/kg</td>
<td>0.009 g/kg</td>
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<tr>
<td></td>
<td>Coking Coal</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><em>(a)(Domestic)</em></td>
<td>2.28 g/kg</td>
<td>5.4 g/kg</td>
</tr>
<tr>
<td></td>
<td><em>(b)(Industrial)</em></td>
<td>1.10 g/kg</td>
<td>1.2 g/kg</td>
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<tr>
<td></td>
<td>Lignite</td>
<td>2.84 g/kg</td>
<td>0.02 g/kg</td>
</tr>
<tr>
<td></td>
<td><em>(brown Coal)</em></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Fossil</strong></td>
<td><strong>Gasoline,</strong></td>
<td>0.15 g/kg</td>
<td>0.43 g/kg</td>
</tr>
<tr>
<td></td>
<td><em>Diesel,</em></td>
<td>10 g/kg</td>
<td>3.6 g/kg</td>
</tr>
<tr>
<td></td>
<td><em>Kerosene</em></td>
<td>0.03 g/kg</td>
<td>0.9 g/kg</td>
</tr>
<tr>
<td></td>
<td><em>LPG</em></td>
<td>0.0002 g/kg</td>
<td>0.2 g/kg</td>
</tr>
<tr>
<td><strong>Bio-fuel</strong></td>
<td><strong>Dunk</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Agri-Residue</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Fire-Wood</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td><strong>Venkataraman et al. 2005</strong></td>
<td>Fire Wood (0.5 g/kg), Dung (0.85 g/kg) &amp; Residue (0.145 g/kg)</td>
<td></td>
</tr>
</tbody>
</table>
Scenario- ‘A’ is estimating 257 Gg/yr (49%) higher than Scenario- ‘B’
Scenario- ‘A’ is estimating 523 Gg/yr (85%) higher than Scenario- ‘B’
Scenario – ‘A’ Vs Scenario – ‘B’

Total = 782 Gg/yr (1991)
- Bio-fuel: 21%
- Coal: 52%
- Petrol & Diesel: 27%

Total = 525.5 Gg/yr (1991)
- Bio-fuel: 32%
- Coal: 52%
- Petrol & Diesel: 16%

Total = 1134 Gg/yr (2001)
- Bio-fuel: 15%
- Coal: 51%
- Petrol & Diesel: 34%

Total = 611 Gg/yr (2001)
- Bio-fuel: 28%
- Coal: 47%
- Petrol & Diesel: 25%
Decadal change of BC during 1990s:

- Maximum change is over the IGP, Western India and Eastern part of central India.
- Top 10% emitting districts contributing more than 50% of total BC emissions for the year 2001 and 1991.
- Growth of BC from vehicular source is maximum (112%) followed by coal (57%).
- Metropolitan cities like Delhi, Mumbai, Chennai, Kolkata and some districts of Western and South-eastern India shows higher value of BC due to high Vehicles density.
Decadal Growth of Black Carbon Emission in India (2001-2011)

The Growth of 71% is due to demand of Coal consumption which has increased by more the two folds during 2000s followed by vehicular sources.
Estimated BC emission from different sources

1991
Total = 835 Gg/yr
- Bio-Fuel: 20%
- Petrol & Diesel: 26%
- Coal: 54%

2001
Total = 1344 Gg/yr
- Bio-Fuel: 13%
- Petrol & Diesel: 34%
- Coal: 53%

2011
Total = 2293 Gg/yr
- Bio-Fuel: 8%
- Petrol & Diesel: 28%
- Coal: 64%

Legend:
- **Yellow**: Coal
- **Red**: Petrol & Diesel
- **Blue**: Bio-Fuel
Emerging pattern of NOx emission and its growth over Indian geographical region during 1990s and 2000s
Why NOx:

- Indirect GHGs like NOX can have a significant role in contributing to climate change and is the main component of ground level O3 which contribute to global warming.

- Ozone concentration depends on NOX concentration which decreases with increase in NOx concentration.

- However, Ozone is not only a GHG but also a significant source of tropospheric hydroxyl (OH) radical which act as cleaner and plays an important role in the chemistry of several trace gases and determines the lifetime of reactive GHGs.
Estimated NOx emission from different sources

1991
Total = 2606 Gg/yr

- Coal: 42%
- Petrol & Diesel: 34%
- Bio-Fuel: 24%

Growth: 110%

2011
Total = 6905 Gg/yr

- Coal: 53%
- Petrol & Diesel: 44%
- Bio-Fuel: 9%

Growth: 107%

2001
Total = 4227 Gg/yr

- Coal: 57%
- Petrol & Diesel: 44%
- Bio-Fuel: 15%

Growth: 110%
Uncertainty due to **Emissions** in Tropospheric Ozone Pollutants (EDGAR v/s New Indian)
EDGAR-Emissions (A)  

Surface  

New Indian-Emissions (B)  

EDGAR-Overestimates Absolute Difference (A - B)
EDGAR-Emissions (A) vs. New Indian-Emissions (B)

EDGAR-Overestimates Absolute Difference (A - B)
Conclusion:

- This study is intended to provide more insight and understanding of development of emission Inventory.

- This gridded emission inventory could be able to provide detailed information about emission scenario (such as “Hot spots”) and the relative contribution of various sources.

- Gridded emission database would form an input to Atmospheric chemical model.

- This inventory will not only improve the understanding on emission scenarios in the country with their possible impact but also can be used in national interest for the future emission strategies.
Conclusion:

- Maximum BC & NOx growth is found over the IGP, Western India and Eastern part of Central India.

- IGP accounts only 15% of the total Indian geographical region but contribute more than 35% of total BC emission.

- Top 10% emitting districts contributing more than 50% of total BC emissions for the year 2001 and 1991.

- Growth of BC from vehicular source is maximum (112%) followed by coal (57%) in 1990s and the scenarios will be nearly reverse in by 2011.

- All metropolitan cities of India shows higher value of BC & NOx due to high Vehicles density and demand of power.
**Conclusion:**

- IGP accounts only 15% of the total Indian geographical region but contribute more than 30% of total NOx emission in the year 1991 & 2001 which will be 27% by 2011.

- Top 10% emitting districts contributing nearly 54% of total NOx emissions for the year 2001 and 1991.

- Growth of NOx from coal source will be maximum (108%) followed by vehicular (45%) by 2011.

- All metropolitan cities of India shows higher value of NOx due to high Vehicular density and demand of power.

- Contribution of fossil fuel related NOx emission will be 75% in 1991, 85% in 2001 and will be around 90% by 2011.

- This inventory will not only improve the understanding on emission scenarios in the country with their possible impact but also can be used in national interest for the future emission strategies.
Thank You