Aerosol Chemical Characterization of Atmospheric Particulates Matters at Urban and Rural Areas in Bangladesh

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Emission and Air Quality in Asian Monsoon Region, 2nd ACAM Workshop, Bangkok, Thailand, 8-10 June, 2015
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Overview

- Bangladesh is a highly populated with about 150 million within the area of about 144 thousand square kilometers.

- Dhaka is the capital of the country with a population of about 15 million. Last year WHO ranked 23rd for the worst air quality situation along with other two cities in Bangladesh, Narayanganj (17th) and Gazipur (21st).

- Many sources for air pollutions in Bangladesh: Traffics emission and Jam, industries, construction activities, power plant, biomass burning, brick kilns, and winter long range transport, etc.

- Thousands of people are suffering due to the air pollution problems; more than 20 thousands people were died each year in Bangladesh due to air pollution problems.

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The year of Bangladesh can be divided into four seasons:

- **Pre-monsoon (March-May)**
- **Monsoon (June-September)**
- **Post monsoon (October-November)**
- **Winter (December-February)**

The average temperatures are varying

- **Between 8°C and 25°C in winter**
- **Between 25°C and 38°C in summer**

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Dhaka station

Roof of the Department of Chemistry, Dhaka University, Latitude: N 23° 43’40”, Longitude: E 90°23’52”, Elevation: 34.0 meters

NASA AERONET Sunphotometer, TSP (2 sets), PM2.5, SPARTAN PM2.5, Nephlometer, CO-Monitor, Aethalometer
Bhola Observatory

- About 1 km far from nearby roads
- No industrial emission
- Very low traffic emission
- Biomass burning for cooking and agricultural activities
- Long range transports during winter

Bhola is an Island of the Bay of Bengal. It is most southern part of the country and also the biggest Island of Bangladesh. It is about 300 km far the capital city.

Latitude: N 22°10'01", Longitude: E 90°45‘ 00", Elevation: 10.0 meters.

Instruments: NASA Aeronet Sunphotometer, TSP sampler, Digital PM$_{2.5}$ Sampler
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Aerosol chemical characteristics of a mega-city in Southeast Asia (Dhaka–Bangladesh)

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Aerosol chemical characteristics of an island site in the Bay of Bengal (Bhola - Bangladesh)

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Measurement of the atmospheric aerosol particle size distribution in a highly polluted mega-city in Southeast Asia (Dhaka-Bangladesh)

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Fig. 3. Time series of aerosol particle size distributions with respect to number, surface and mass distributions measured with aerodynamic particle sizer (TSI 3321, USA) spectrometer from 0.5 to 20 μm AD between January and April 2006 in Dhaka, Bangladesh.
Air mass trajectory analysis
PM$_{2.5}$ mass variation
Carbonaceous Species
Water soluble ions
Aerosol Optical Depth (AOD)
Hartal (Strike) vs non Hartal (non strike)
Typical Air mass trajectories

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Typical Loaded during Day, Night and unloaded Filters in Dhaka, Bangladesh during winter 2013.
### Emission and Air Quality in Asian Monsoon Region, 2nd ACAM Workshop, Bangkok, Thailand, 8-10 June, 2015

<table>
<thead>
<tr>
<th></th>
<th>Night</th>
<th>Day</th>
<th>Average</th>
<th>Ratio (N/D)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Average (µgm(^{-3}))</strong></td>
<td>249.1</td>
<td>134.5</td>
<td>191.8</td>
<td><strong>1.85</strong></td>
</tr>
<tr>
<td><strong>Max</strong></td>
<td>379.3</td>
<td>233</td>
<td>263.5</td>
<td>4.6</td>
</tr>
<tr>
<td><strong>Min</strong></td>
<td>157.6</td>
<td>37.9</td>
<td>105.3</td>
<td>1.0</td>
</tr>
</tbody>
</table>

[Graph showing PM2.5 mass µgm\(^{-3}\) from 27.01.2013 to 06.02.2013 with data points for Day and Night]
Variation PM$_{2.5}$ during winter 2013-2014

- No rain
- Brick kilns operation
- Air mass coming from north

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## Water Soluble ions

<table>
<thead>
<tr>
<th></th>
<th>Urban Dhaka 2014 (PM2.5)</th>
<th>Urban Dhaka 2003 (TSP)</th>
<th>Rural Island Bholo 2014 (PM2.5)</th>
<th>Rural Island Bholo 2003 (TSP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na⁺</td>
<td>0.24</td>
<td>1.27</td>
<td>0.19</td>
<td>1.17</td>
</tr>
<tr>
<td>NH₄⁺</td>
<td>5.63</td>
<td>1.86</td>
<td>0.16</td>
<td>0.47</td>
</tr>
<tr>
<td>K⁺</td>
<td>1.01</td>
<td>1.55</td>
<td>0.12</td>
<td>0.98</td>
</tr>
<tr>
<td>Mg²⁺</td>
<td>0.26</td>
<td>0.41</td>
<td>0.04</td>
<td>0.23</td>
</tr>
<tr>
<td>Ca²⁺</td>
<td>0.26</td>
<td>6.83</td>
<td>0.16</td>
<td>0.87</td>
</tr>
<tr>
<td>Cl</td>
<td>1.09</td>
<td>2.03</td>
<td>0.11</td>
<td>1.26</td>
</tr>
<tr>
<td>NO₂⁻</td>
<td>0.29</td>
<td></td>
<td>0.14</td>
<td></td>
</tr>
<tr>
<td>NO₃⁻</td>
<td>3.31</td>
<td>3.63</td>
<td>0.13</td>
<td>1.46</td>
</tr>
<tr>
<td>SO₄²⁻</td>
<td>13.2</td>
<td>11.3</td>
<td>1.02</td>
<td>3.71</td>
</tr>
</tbody>
</table>
Carbonaceous Species (PM2.5) in Dhaka

OC=40.2±17.5µgm⁻³, EC = 13.0±6.5µgm⁻³

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OC/EC ratio in Dhaka during Winter 2013-2014

Average OC/EC = 3.17

OC/EC ratio is higher than 2.0 indicating the formation of secondary organic carbon formation.

Fig. 2 The elemental ratios of the carbonaceous species (EC/TC, OC/TC, and OC/EC) in total suspended particulate (TSP) at urban Dhaka and suburban Dhaka between January and February 2004.
Comparison of the carbonaceous species with Ten Years Old Data from Urban and Rural Bangladesh

<table>
<thead>
<tr>
<th></th>
<th>Urban Dhaka (μgm⁻³)</th>
<th>Rural Island Bhola (μgm⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003 (TSP)</td>
<td>2003 (TSP)</td>
</tr>
<tr>
<td></td>
<td>2014 (PM2.5)</td>
<td>2014 (TSP)</td>
</tr>
<tr>
<td>EC</td>
<td>22.0</td>
<td>13.0</td>
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<tr>
<td></td>
<td>11.2</td>
<td>2.8</td>
</tr>
<tr>
<td>OC</td>
<td>45.7</td>
<td>4.6</td>
</tr>
<tr>
<td></td>
<td>40.2</td>
<td>2.2</td>
</tr>
<tr>
<td></td>
<td>47.2</td>
<td>2.2</td>
</tr>
</tbody>
</table>

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Clear and Hazy day

AOD at 500nm on March 19, 2013: 0.522

AOD at 500nm on January 12, 2013: 1.255
Aerosol Optical Depth (AOD) and Water content

Water Content, cm

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Comparison of AOD values between urban and rural locations at different seasons

Differences of AOD between Rural Bhola and Urban Dhaka

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Influence of traffic emissions on Carbonaceous values in Dhaka

![Bar Chart]

- **EC**
  - Non Hartal Days (n=16): 13.3 µgm⁻³
  - Hartal days (n=11): 12.5 µgm⁻³

- **OC**
  - Non Hartal Days (n=16): 41.5 µgm⁻³
  - Hartal days (n=11): 38.2 µgm⁻³
Conclusion

- Very high concentrations of particulate matters (PM$_{2.5}$) in Urban Dhaka.
- Night time PM$_{2.5}$ mass is about double than Day time in Urban Dhaka.
- There is no significant changes in the water soluble ions concentrations compared than 10 years back study.
- AOD concentrations at the Island Bhola is one of the highest as a rural background location in the World during winter time.
- There are some other sources contributed in BC concentration except traffic during Winter.
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- ACAM and ICIMOD
Fun trip of our group members, family and collaborators
Thanks!
Questions and Comments