Emissions of Biomass Burning Simulated in Open Burning Combustion Chamber

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Air Pollution in Chiang Mai, Thailand

clear sky

Smoggy sky (March 2016)
PM$_{10}$ & Hotspot number in 2016 in Northern Thailand

Thai std for 24-hr PM$_{10}$ (120 ug/m$^3$)

PM$_{10}$ data obtained from PCD, Thailand
Biomass samples were collected from 9 provinces in Northern Thailand.
Biomass Samping

- Maize residues
- Rice straw
- Leaf litter in mixed deciduous forest (MDF)
- Leaf litter in dry dipterocarp forest (DDF)
Biomass samples for burning experiment

Burning experiment
PM samples on quartz fiber filters

PM sampling
Gas analyzer

- O₂
- CO
- NO
- NO₂
- SO₂
- CO₂ **

Air flow meter

Air flow rate (m/sec)

Testo 350 XL
PM$_{2.5}$ samples were collected on quartz fiber filter.
### Emission factors of PM$_{2.5}$ from biomass burning

<table>
<thead>
<tr>
<th>Biomass</th>
<th>Efs of PM$_{2.5}$ (g/kg) (n = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice Straw</td>
<td>3.80±2.09$^b$</td>
</tr>
<tr>
<td>Maize Residues</td>
<td>2.11±0.91$^a$</td>
</tr>
<tr>
<td>Leaf Litters (DDF)</td>
<td>3.48±1.36$^b$</td>
</tr>
<tr>
<td>Leaf Litters (MDF)</td>
<td>4.20±2.74$^b$</td>
</tr>
</tbody>
</table>

The emission factors are shown in the bar chart below:

![Bar chart showing emission factors of PM$_{2.5}$ for different biomass types](chart.png)
## Emission factors of CO₂, CO and NO from biomass burning

<table>
<thead>
<tr>
<th>Biomass Type</th>
<th>CO₂ (g/Kg) (n = 3)</th>
<th>CO (g/Kg) (n = 3)</th>
<th>NO (g/Kg) (n = 3)</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rice straw</td>
<td>898±99&lt;sup&gt;a&lt;/sup&gt;</td>
<td>39.8±11.8&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.34±0.35&lt;sup&gt;a&lt;/sup&gt;</td>
<td>This study</td>
</tr>
<tr>
<td>Maize residue</td>
<td>956±116&lt;sup&gt;a&lt;/sup&gt;</td>
<td>40.5±6.9&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.42±0.34&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Leaf litter (DDF)</td>
<td>1220±96&lt;sup&gt;b&lt;/sup&gt;</td>
<td>53.8±8.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.49±0.46&lt;sup&gt;ab&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Leaf litter (MDF)</td>
<td>954±263&lt;sup&gt;a&lt;/sup&gt;</td>
<td>49.0±16.7&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.95±0.77&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td>Amazon Forest biomass</td>
<td>1565±128</td>
<td>50.3±17.1</td>
<td>2.74±0.75</td>
<td>Neto et.al. (2013)</td>
</tr>
<tr>
<td>Rice straw</td>
<td>1105.2±189.3</td>
<td>53.2±17.9</td>
<td>-</td>
<td>Zhang et.al. (2013)</td>
</tr>
</tbody>
</table>
Application of EFs

- EFs of pollutants can be used for estimation of emission rate (ER) based on hotspots and area burned.
2017-2019
HAZE FREE THAILAND PROJECT
Monitoring and Analysis of Ambient PM$_{2.5}$ Chemical Composition and Its Toxicity in Northern Thailand
Site 1
Mae Hia (MH)
Chiang Mai
Low volume air sampler (PQ200; BGI, USA) and Minivolume air sampler (MV; Air metric, USA) are used to collect PM$_{2.5}$ on Quartz filter paper (Whatman, UK).
7-SEAS; 7-South-East Asian Studies

- National Central University (NCU), Taiwan
- Laboratory for Atmospheres, Goddard Space Flight Center, NASA
- Faculty of Science, CMU
Thank you for your kind attention
## C,H,N content

<table>
<thead>
<tr>
<th>Biomass</th>
<th>% Content (n = 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>C</td>
</tr>
<tr>
<td>Rice Straw</td>
<td>34.3±1.2&lt;sup&gt;a&lt;/sup&gt;</td>
</tr>
<tr>
<td>Maize Residues</td>
<td>39.4±1.2&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Leaf Litters (DDF)</td>
<td>44.6±1.6&lt;sup&gt;d&lt;/sup&gt;</td>
</tr>
<tr>
<td>Leaf Litters (MDF)</td>
<td>42.6±2.0&lt;sup&gt;c&lt;/sup&gt;</td>
</tr>
</tbody>
</table>

Sig diff. (p<0.05)

**Diagram:**

- Blue bars represent %C content.
- Red bars represent %H content.
- Green bars represent %N content.

Legend:
- Rice Straw
- MR
- DDF
- MDF
CO and $\text{CO}_2$ concentrations during biomass burning

Amount of CO2 emitted was about 20-25 times larger than CO.