Estimating emissions from Biomass Burning

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Monitoring and Assessment of GHG Emissions and Mitigation Potentials
MICCA Programme
Climate, Energy and Tenure Division (NRC)
Outline

• The FAOSTAT Emissions Database
• IPCC Guidelines
• Crop residues burning
• Vegetation burning:
  – Mapping Burned areas
  – Estimating Biomass burned
  – Estimating emissions
• Organic Soils burning
The FAOSTAT Emissions Database

& geo-referenced data

+ IPCC 2006 Guidelines

=
Emissions from Agriculture, Forestry, and Other Land Use (AFOLU): the FAOSTAT Emissions Database

<table>
<thead>
<tr>
<th>DOMAIN</th>
<th>CATEGORY</th>
<th>GAS reported</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>Enteric Fermentation</td>
<td>CH₄</td>
</tr>
<tr>
<td></td>
<td>Manure Management</td>
<td>CH₄, N₂O</td>
</tr>
<tr>
<td></td>
<td>Rice Cultivation</td>
<td>CH₄</td>
</tr>
<tr>
<td></td>
<td>Synthetic Fertilizers</td>
<td>N₂O</td>
</tr>
<tr>
<td></td>
<td>Manure applied to soils</td>
<td>N₂O</td>
</tr>
<tr>
<td></td>
<td>Manure left on pasture</td>
<td>N₂O</td>
</tr>
<tr>
<td></td>
<td>Crop residues</td>
<td>N₂O</td>
</tr>
<tr>
<td></td>
<td>Cultivated organic soils</td>
<td>N₂O</td>
</tr>
<tr>
<td></td>
<td>Burning – Savanna</td>
<td>CH₄, N₂O</td>
</tr>
<tr>
<td></td>
<td>Burning – Crop residues</td>
<td>CH₄, N₂O</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LULUCF</th>
<th>CATEGORY</th>
<th>GAS reported</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Forest land</td>
<td>CO₂</td>
</tr>
<tr>
<td></td>
<td>Cropland</td>
<td>CO₂</td>
</tr>
<tr>
<td></td>
<td>Grassland</td>
<td>CO₂</td>
</tr>
<tr>
<td></td>
<td>Burning Biomass</td>
<td>CH₄, N₂O, CO₂</td>
</tr>
<tr>
<td></td>
<td>Wetlands</td>
<td>CO₂</td>
</tr>
<tr>
<td></td>
<td>Settlements</td>
<td>CO₂</td>
</tr>
<tr>
<td></td>
<td>Other land</td>
<td>CO₂</td>
</tr>
</tbody>
</table>
IPCC and UNFCCC methodology documents

- **Revised 1996 IPCC Guidelines** for National Greenhouse Gas Inventories (3 Volumes)
- **Good Practice Guidance** and Uncertainty Management in National greenhouse Gas Inventories (2000)
- **Database on GHG Emission Factors** (EFDB) (2002)
- **Good Practice Guidance** for Land Use, Land-Use Change and Forestry (2003)
- **UNFCCC Handbooks** for Non-Annex I countries
- **2006 IPCC Guidelines** for National Greenhouse Gas Inventories (5 volumes)
- **IPCC Software**
Estimation of GHG emissions
(IPCC Guidelines for National Greenhouse Gas Inventories)

Emissions = Activity Data * Emission Factor

Activity data:
• information on the extent to which a human activity resulting in emissions or removals of GHG takes place during a given period of time
• typically derived from statistics, but also from other sources;
• availability and quality are the primary driving factors determining the accuracy and reliability of the GHG emissions inventory.

Emission factor:
• emissions or removals of a given GHG per activity unit
Estimation of GHG emissions from biomass burning

\[ E = A \cdot M_B \cdot C_f \cdot EF \]

Activity data

**Activity data** = Dry matter burned

- \( E \) = GHG emissions from fire (\( N_2O, CH_4 \)).
- \( A \) = Area burned
- \( M_B \) = Mass of fuel available for combustion (biomass, ground litter, and dead wood)
- \( C_f \) = Combustion factor (proportion of fuel actually combusted; depends on the size and architecture of fuel, e.g. leaves, tree stems)
- \( EF \) = Emission Factors for different gases (\( N_2O, CH_4 \))(g /kg dry matter burnt)
Estimation of GHG emissions from burning of crop residues (wheat, maize, rice and sugarcane)

\[ E = A \cdot M_B \cdot C_f \cdot EF \]

**Activity data** = *Dry matter burned*

\[ E = \text{GHG emissions from fire (N}_2\text{O, CH}_4) \]

\[ A = \text{Area burned obtained as a fixed 10\% of the harvested area from FAOSTAT) \]

\[ M_B, C_f, EF \]

IPCC default values (Tier 1 default values for Biomass consumption: tables 2.4/2.5 of the IPCC 2006 Guidelines, V.4, Ch.2).
Estimation of GHG emissions from burning of vegetation

\[ E = A \cdot M_B \cdot C_f \cdot EF \]

Activity data

**Activity data** = Dry matter burned

- **E** = GHG emissions from fire \((N_2O, CH_4)\).
- **A** = Area burned obtained from the Global Fire Emission Database (GFED4) - Burned Areas dataset (based on MODIS and SPOT-VEGETATION, 13 LC classes)
- **Mb**
- **Cf**
- **EF**

IPCC default values (Tier 1 default values for Biomass consumption: tables 2.4/2.5 of the IPCC 2006 Guidelines, V.4, Ch.2).
Estimation of GHG emissions from burning of vegetation: 1 - Mapping area burned

Total Savanna burned area in 2012 (Ha)
Estimation of GHG emissions from burning of vegetation: 2 - Estimating biomass burned

Example: Savanna

<table>
<thead>
<tr>
<th>IPCC classification</th>
<th>Biomass burned/ha (IPCC default values)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savanna - Tropical</td>
<td>7</td>
</tr>
<tr>
<td>Savanna - Non Tropical</td>
<td>4.1</td>
</tr>
</tbody>
</table>

Climate zones are identified using the JRC Climate Map based on the IPCC Climatic Zones layer.

Biomass burned is estimated at pixel level by multiplying biomass burned per Ha by the area burned
Estimation of GHG emissions from burning of vegetation: 3 - Emission factors

<table>
<thead>
<tr>
<th>Category</th>
<th>CO₂</th>
<th>CO</th>
<th>CH₄</th>
<th>N₂O</th>
<th>NOₓ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savanna and grassland</td>
<td>1613 ± 95</td>
<td>65 ± 20</td>
<td>2.3 ± 0.9</td>
<td>0.21 ± 0.10</td>
<td>3.9 ± 2.4</td>
</tr>
<tr>
<td>Agricultural residues</td>
<td>1515 ± 177</td>
<td>92 ± 84</td>
<td>2.7</td>
<td>0.07</td>
<td>2.5 ± 1.0</td>
</tr>
<tr>
<td>Tropical forest</td>
<td>1580 ± 90</td>
<td>104 ± 20</td>
<td>6.8 ± 2.0</td>
<td>0.20</td>
<td>1.6 ± 0.7</td>
</tr>
<tr>
<td>Extra tropical forest</td>
<td>1569 ± 131</td>
<td>107 ± 37</td>
<td>4.7 ± 1.9</td>
<td>0.26 ± 0.07</td>
<td>3.0 ± 1.4</td>
</tr>
<tr>
<td>Biofuel burning</td>
<td>1550 ± 95</td>
<td>78 ± 31</td>
<td>6.1 ± 2.2</td>
<td>0.06</td>
<td>1.1 ± 0.6</td>
</tr>
</tbody>
</table>

Note: The “extra tropical forest” category includes all other forest types.

Note: For combustion of non-woody biomass in Grassland and Cropland, CO₂ emissions do not need to be estimated and reported, because it is assumed that annual CO₂ removals (through growth) and emissions (whether by decay or fire) by biomass are in balance (see earlier discussion on synchroly in Section 2.4.

Default emission factors are provided by the IPCC Guidelines and assigned to each pixel according to the vegetation type and to the climatic zone (JRC-IPCC Climatic Zones).
Estimation of GHG emissions from burning of vegetation: 4 - Emissions

Emissions = Activity Data * Emission Factor
Estimation of GHG emissions from burning of organic soils

\[ E = A \cdot M_B \cdot C_f \cdot EF \]

Activity data

**Activity data = Dry matter burned**

\[ E = \text{GHG emissions from fire (N}_2\text{O, CH}_4) \]

\[ A = \text{Area burned obtained using the total burned area from GFED4 and the organic soils percentage per pixel obtained from the Harmonized World Soil Database (HWSD).} \]

\[ M_B \]

\[ C_f \]

\[ EF \]

IPCC default values (Tier 1 default values for Biomass consumption: tables 2.4/2.5 of the IPCC 2006 Guidelines).
### Burning - Savanna

<table>
<thead>
<tr>
<th>ITEM</th>
<th>AREA</th>
<th>FROM YEAR</th>
<th>TO YEAR</th>
<th>AGGREGATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Savanna</td>
<td>World</td>
<td>1990</td>
<td>2012</td>
<td>Average</td>
</tr>
</tbody>
</table>

#### Emissions by country (CO2 equivalent) Average 1990 - 2012

The designations employed and the presentation of material in the maps do not imply the expression of any opinion whatsoever on the part of FAO concerning the legal or constitutional status of any country, territory or sea area, or concerning the delimitation of frontiers. South Sudan declared its independence on July 9, 2011. Due to data availability, the assessment presented in the map for Sudan and South Sudan reflects the situation up to 2011 for the former Sudan.
Thank you!

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http://faostat.fao.org/