Development of Emission Inventories of Planned Burning Activities in the Central States Regional Air Planning Association (CENRAP)

Presented by
Dana Coe Sullivan
Sonoma Technology, Inc.
Petaluma, CA

Presented at
U.S. EPA 13th Annual Emission Inventory Conference
Clearwater, FL
June 9, 2004
Why is Open Burning Important?

- Releases fine PM and precursors to secondary PM.
- Is thought to contribute to episodes of haze and PM$_{2.5}$.
- However, emissions are poorly quantified.

April 12, 2002; 6 p.m. CDT
What are the Sources?

- Prescribed burning
- Agricultural burning
- Managed burning

- Wildfires
- Structure fires
- Waste burning

These 3 sources are being researched by other RPOs and were not included in the CENRAP-STI project.
Definitions

• *Prescribed Burning* clears undergrowth in timberlands and grasslands for wildfire prevention and land improvement.
  – Federal agencies (USFS, DOI, BIA, etc.)
  – State agencies (DNR, DFW, etc.)
  – Private entities (TNC, timber industry, etc.)

• *Agricultural Burning* and *Managed Burning* are used by farmers and ranchers to clear harvested lands and rangeland.
### Geographic Areas: MN Example

<table>
<thead>
<tr>
<th>Type of Area</th>
<th>sq. miles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forestlands, etc.</td>
<td>19,217</td>
</tr>
<tr>
<td>Deciduous Forest</td>
<td>13,328</td>
</tr>
<tr>
<td>Evergreen Forest</td>
<td>2,531</td>
</tr>
<tr>
<td>Mixed Forest</td>
<td>2,896</td>
</tr>
<tr>
<td>Shrubland</td>
<td>434</td>
</tr>
<tr>
<td>Grasslands/Herbaceous</td>
<td>28</td>
</tr>
<tr>
<td><strong>Agricultural Lands</strong></td>
<td>42,241</td>
</tr>
<tr>
<td>Row Crops</td>
<td>30,241</td>
</tr>
<tr>
<td>Pasture/Hay</td>
<td>10,062</td>
</tr>
<tr>
<td>Small Grains</td>
<td>1,938</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td>22,914</td>
</tr>
</tbody>
</table>
Prior Statuses of Planned Burning Inventories

Planned Burning Emissions in the 1999 NEI

Total PM$_{2.5}$: 110,000 tons
Prescribed: 72,000 tons
Agricultural: 38,000 tons

Total PM$_{2.5}$: 110,000 tons
Prescribed: 72,000 tons
Agricultural: 38,000 tons
Prior Statuses of Planned Burning Inventories

Planned Burning Emissions in Texas*

<table>
<thead>
<tr>
<th>Category</th>
<th>1997</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total PM$_{2.5}$</td>
<td>44,200 tons</td>
</tr>
<tr>
<td>Rangeland</td>
<td>27,600 tons</td>
</tr>
<tr>
<td>Agricultural</td>
<td>5,700 tons</td>
</tr>
<tr>
<td>Wildland</td>
<td>7,000 tons</td>
</tr>
<tr>
<td>Slash</td>
<td>3,900 tons</td>
</tr>
</tbody>
</table>

Prior Statuses of Planned Burning Inventories

Sources of uncertainty:

• The NEI is estimated on an annual average basis.

• Prescribed burning activities fluctuate dramatically from year to year.

• Burning activities depend on:
  – Local agencies’ policies
  – Individuals’ or businesses’ (largely) unregulated decisions
  – Climate conditions
  – Assessments of the density of undergrowth and fuel
Current Status of the Inventories

2002 Emissions by Pollutant

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Emissions (1000 tons/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM2.5</td>
<td>330</td>
</tr>
<tr>
<td>VOC</td>
<td>220</td>
</tr>
<tr>
<td>NOx</td>
<td>100</td>
</tr>
<tr>
<td>NH3</td>
<td>50</td>
</tr>
<tr>
<td>SO2</td>
<td>0</td>
</tr>
</tbody>
</table>

Total = 317,000 tons/year

PM$_{2.5}$ Emissions by Source Category

- Prescribed: 32%
- Cropland: 18%
- Rangeland: 50%

Total = 317,000 tons/year
Current Status of the Inventories

2002 PM$_{2.5}$ Emissions by State and Source Category

- **Prescribed**
- **Cropland**
- **Rangeland**

![Graph showing 2002 PM$_{2.5}$ emissions by state and source category.](Chart)
Current Status of the Inventories

PM$_{2.5}$ Emission Densities for the CENRAP Region

April 10, 2002
Current Status of the Inventories

Monthly Variations in Planned Burning Emissions for 2002

Percentage of Planned Burning

Month

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec
Development of the Inventories

Basic Equation

\[ \text{Emissions (lb)} = \text{Burn area (acres)} \times \text{Fuel loading (ton/acre)} \times \text{Emission factor (lb/ton)} \]
Development of the Inventory
Prescribed Burning Activity Data

Federal/Tribal Lands:
• The National Fire Plan Operations and Reporting System (NFPORS)*
• The National Interagency Fire Management Integrated Database (NIFMID)
• Data from state smoke management programs

*Minnesota and Missouri only
Development of the Inventory
Prescribed Burning Activity Data

State/Private Lands:
• State smoke management programs
• Fire marshals
• State forest services
• Other state agencies (Bureau of Wildlife, etc.)
Development of the Inventory
Prescribed Burning Activity Data

2002 Acres Burned by State (Total ~ 1 million acres)
Development of the Inventory

Prescribed Burning Emission Factors

First Order Fire Effects Model (FOFEM):

• Cross-walk developed with EPA’s Biogenic Emissions Landcover Database (BELD)
• Default fuel loadings used*
• Fuel moisture values set using day-specific Weather Information Management System (WIMS) data
• Produces vegetation-specific emission factors in lbs/acre burned

*Fuel loadings provided by the USFS were used for some burns in MN.
Development of the Inventory

Prescribed Burning Results

2002 PM$_{2.5}$ Emissions by State (Total ~ 100,000 tons)
Development of the Inventory

Prescribed Burning Results

Monthly Variations in Emissions by State

Percentage of Prescribed Burning

- MN
- Other States
Development of the Inventory
Agricultural Burning Activity Data

Acres harvested by county and crop type:
• 2002 National Agricultural Statistical Service data

Fraction of harvested acres burned per year:
• Telephone surveys of Agricultural Extension Service (AES) personnel
• 549 completed surveys out of 969 county AES offices contacted (56%)
Development of the Inventory
Agricultural Burning Activity Data

2002 Acres Burned by State and Crop

Region Total: 13 million acres
Fuel loadings and emission factors vary by crop type. Data sources:

- UC-Davis study* (emission factors for barley, wheat, rice, corn)
- AP-42 (emission factors for other crops; all fuel loadings)

Development of the Inventory

Agricultural Burning Results

2002 PM$_{2.5}$ Emissions by State and Crop

Region Total ~ 215,000 tons
Development of the Inventory
Agricultural Burning Results

Monthly Variations in Emissions by State

Percentage of Agricultural Burning

Month
Background

STI used ambient speciated PM$_{2.5}$ data from two IMPROVE stations in Arkansas to assess planned burning contributions to visibility events in Class I areas.
Pilot Ambient Data Analysis

Preliminary Findings

• Smoke constituents were not a significant fraction of the PM$_{2.5}$ mass and light extinction (ammonium sulfate is the dominant constituent).

• On some days, influences from known prescribed burns were seen, though they were generally less than 10% of the PM$_{2.5}$ mass and light extinction.
Recommendations for Further Research

Activity Data:
• Acquire NFPORS data to verify that USFS burns are accounted for (especially in KS and NE).
• Acquire National Fire Initiative (NFI) data to account for burns by private organizations.
• Investigate local regulations that restrict open/agricultural burning and their enforcement.
Recommendations for Further Research

Fuel loadings and emission factors:
• Improve FOFEM’s default fuel loadings where possible (as was done for selected fires in MN).

Ambient Data Analysis:
• Analyze data from additional IMPROVE sites, such as those in KS and MN.
• Use source apportionment tools to better quantify the influence of burning.
Recommendations for Further Research

Other:

• Alternative and newly emerging data sources such as satellite data should be explored to help characterize fire locations and day-specific activity levels
Glossary

BELD = EPA’s Biogenic Emissions Landcover Database
BIA = Bureau of Indian Affairs
CENRAP = Central Regional Air Planning Association
DFW = Department of Fish and Wildlife
RPO = Regional Planning Organization
DOI = Department of the Interior
DNR = Department of Natural Resources
FOFEM = First Order Fire Effects Model
IMPROVE = Interagency Monitoring of Protected Visual Environments
NEI = National Emissions Inventory
NFI = National Fire Initiative
NFPORS = National Fire Plan Operations and Reporting System
NIFMID = National Interagency Fire Management Integrated Database
STI = Sonoma Technology, Inc.
TNC = The Nature Conservancy
USFS = United States Forest Service
WIMS = Weather Information Management System