Application of an Emission Inventory GIS-Based Tool Across the Michigan/Ontario Border

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Introduction

- Present the application of an Emission Inventory GIS-based software system (EIGIS) across an area containing Detroit, Michigan and south-western Ontario.

- Goal: Determine how EIGIS could be used to improve the current emission inventories for transboundary modelling applications.
Background

- EIGIS is a software system that computes emission inventories for area and mobile sources using a bottom-up (attribute layer) approach.

- Developed under a multi-phase contract for Environment Canada to aid in the computation of national emission inventories.

- Based upon ESRI ArcGIS technology.
In modelling, the spatial allocation of emissions can be as important as the emission themselves.

Emission processors (e.g., SMOKE), convert national EIs into hourly, spatially allocated (gridded) emissions.

AQ models (e.g., CMAQ) replicate the transport and chemical transformation of pollutants emitted to the atmosphere.

These models are only as good as their inputs!
Work performed under two independent projects that shared a number of common goals.

US EPA: evaluate different means of computing emissions, with a 2002 NEI benchmark, in three source sectors and 10 counties in Detroit area.

Environment Canada: assess and improve existing, provincially aggregated 2002 CAC EI for seven sectors and 6 census divisions in SW Ontario.
Current Techniques
South-Western Ontario

- Asphalt Plants
- Ferrous
- Non-Ferrous Foundries
- Industrial and commercial boilers
- Commercial wood burning
- Agricultural burning
- Residential garbage burning
- Garbage burning at landfills
Current Techniques
Detroit Metropolitan Area

- Residential Wood Combustion
  - Fireplaces and woodstoves
- Industrial Fuel Combustion – Coal
  - Industrial coal burning of anthracite and bituminous/sub-bituminous coals
- Charbroiling
  - Meat cooking at commercial restaurants
Concentrate on Detroit…

- Step 1: Obtain GIS Data
- Step 2: Obtain Activity Data
- Step 3: Obtain Emission Factors
- Step 4: Input into EIGIS
- Step 5: Have EIGIS Compute the EI
- Step 6: Plot EI in EIGIS for QA
- Step 7: Export to Model-ready Input Files (SMOKE ORL format)
EIGIS Methodology
Activity Data

Activity Editor

Activity Name: Residential Wood Non-EPA Fireplaces
Units: tons
Description: Tons of wood burned within non-EPA fireplaces.

Attribute Layers:
- Demographic GYRD
- Land Use GYFD
- Rail GYFD
- Roads GYRD
- Demographics
- Landcover
- Provincial Activities
- Charcoal
- Industrial Coal
- Residential Wood

Fields:
- AREA_KM2
- COUNTY
- NAME
- Fireplaces
- Non_EPA_Fireplaces
- Non_Catalytic_Fireplaces
- Catalytic_Fireplaces
- Woodstoves
- Catalytic_Woodstoves
- Non_Catalytic_Woodstoves

Values (first 50 unique):
- 2576.5733637
- 2732.70840395
- 3130.0312
- 52125441998
- 7135.305
- 9733.399
- 8736.37
- 15140.79870173
- 23320.84868448
- 33158.34120468

Formula:
ACTIVITY = [RESIDENTIAL_WOOD:Non-EPA_Fireplaces]

Options:
- Clear Formula
- Check Syntax
- Save Activity
- Calculate Activity
- Close
### EIGIS Methodology

#### Emission Factors

<table>
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<tr>
<th>Feature Layer</th>
<th>NAME</th>
<th>Non_EPA_Frplha</th>
<th>Woodstoves</th>
<th>EF</th>
<th>EF Unit</th>
<th>Activity</th>
<th>Pollutant Shortha</th>
<th>SCC Number</th>
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EIGIS Methodology
Input into EIGIS
EIGIS Methodology

Compute the EI

Please select the combination of Pollutants and Source Classification Codes (SCCs) for the selected features to be computed. By default, the pollutants and SCCs selected are those for which emissions do not exist. The pollutants and SCCs listed are those whose emission factors have been defined for the selected features.

### Pollutants
- CO - Carbon Monoxide - 630-08-0
- NOx - Oxides of Nitrogen - n/a
- PM10 - Particulate Matter less than or equal to 10
- PM2.5 - Particulate Matter less than or equal to 2
- SOx - Sulfur Dioxides - 746-09-5
- VOC - Volatile Organic Compounds - n/a

### SCCs
- 2104008002 - Stationary Source Fuel Combustion
EIGIS Methodology
Plot EI in EIGIS
EIGIS Methodology
Export to Model-ready Input Files
EIGIS Methodology
Export to Model-ready Input Files
Conclusions

- EIGIS easily adopted in the US - no code changes!
- EIGIS is effective for both high-resolution bottom-up and simple top-down techniques.
- EIGIS is effective for automating the calculation and exporting of emissions into SMOKE model-ready input files (IDA or ORL).
- Mapping feature a useful QA tool within EIGIS.
- Emissions could be further improved by incorporating higher resolution land use information with a larger number of land use types.
Ideas for the Future

- Phase III (ongoing development…)
  - Incorporate pre-computed point sources
  - Test more robust distributed environments
  - More post-processing / analysis tools
  - National EI calculations (pre-populated)
  - Integrated reconciliation functionality
- Additional testing for different geographies
- Test ability to improve emission estimates by incorporating higher resolution land use data with a larger number of land use types
Acknowledgments

• ESRI Canada
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• Environment Canada, Pollution Data Division
• Environment Canada, Pacific & Yukon Region
• Greater Vancouver Regional District
• BC Ministry of Environment

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