Environnement Canada Environment Canada

Canada

Improving spatial allocation of construction emissions in Canada

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Outline

- Improvements in the fugitive dust emissions for to air quality models.
- Resolve our spatial allocation problem.
- Improvements to the temporal allocation.

Background

- In the current Canadian emissions processing, we continue to experience high concentration of particulate matter in large populated areas.
- Road dust and construction sectors are reported:
  - area sources
  - provincial level
  - annual totals
- Transportation fraction needs to be recalculated using revised land use.
- Spatial surrogates need to be adapted to each emission source.
- Temporal allocation based mostly on default profiles need to be revised.

Fugitive Dust Inventory

- Fugitive dust inventory were subdivided into six subsectors.
- Following table shows the breakdown of PM_{10} and $PM_{2.5}$ emissions by associated source category codes (SCC):

SCC	SCC Description	PM_{10}	$PM_{2.5}$
2296000000	Dust from unpaved roads	45%	34%
2311020000	Industrial, Heavy Construction	14%	15%
2294000000	Dust from paved roads	11%	13%
2800000000	Agriculture activities	19%	5%
2311030000	Roads, Bridges and Tunnels Construction	4%	5%
2311010000	Residential Construction	0.3%	0.1%
Inventory total		93%	72%

Table 1: 2006 total PM from road dust, construction and agriculture sectors in Canada, no transportation fraction applied

Fugitive Dust Inventory

- These emission inventories are converted from province level to census division level using surrogate ratios.
  - Census division surrogate ratio is calculated using sum of surrogate fraction within a census division divided by the total surrogate within a province in which the census is located.
  - For example: “Construction sector”, surrogate ratio for a census division

$$Surrogate\ ratio_{CD} = \frac{\sum_{CD} Construction_{AREA}}{\sum_{PROV} Construction_{AREA}}$$

Transportable Fraction

- The transportable fraction is the amount of fugitive dust not captured and deposited by the surrounding land cover.
- A transportable fraction is calculated and averaged on a per county basis.
- Uses 230 soil and vegetation types from the 1km resolution BELD3 dataset and the 2000 Canadian National Forest Inventory.

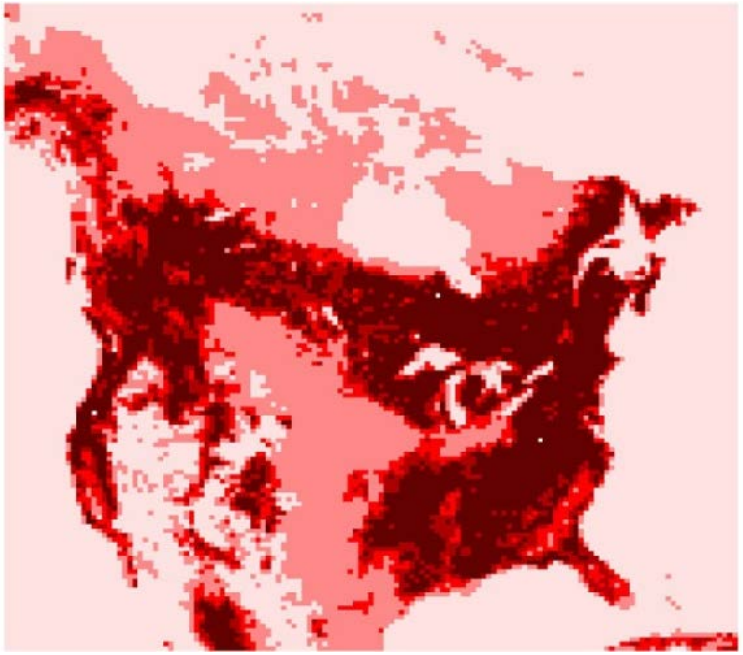


Figure 1: Gridded Transportable Fraction at 4km

LULC Category	TF
Urban	50%
Agriculture/Grassland/Shrubland	75%
Forest	0%
Barren/Water	100%

Table2: Land use categories and the associated Transport/Capture Fraction

Transportable Fraction

The transportation fraction was calculated and averaged in census division level

- To achieve mass conservation for the input emissions at all grid resolutions.
- This provides a consistent method to estimate the amount of fugitive dust across the all provinces.
- This resulted in increases or decreases in transportable fraction as function of the census division's dominant LULC category.

SCC	SCC Description	PM_{10}	$PM_{2.5}$	TF_{AVG}
2296000000	Dust from unpaved roads	14%	11%	31%
2311020000	Industrial, Commercial, Heavy Construction	5%	6%	38%
2294000000	Dust from paved roads	2%	3%	23%
2800000000	Agriculture activities	5%	1%	25%
2311030000	Roads, Bridges and Tunnels Construction	2%	2%	35%
2311010000	Residential Construction	0.1%	0.03%	30%
Inventory total		28%	22%	

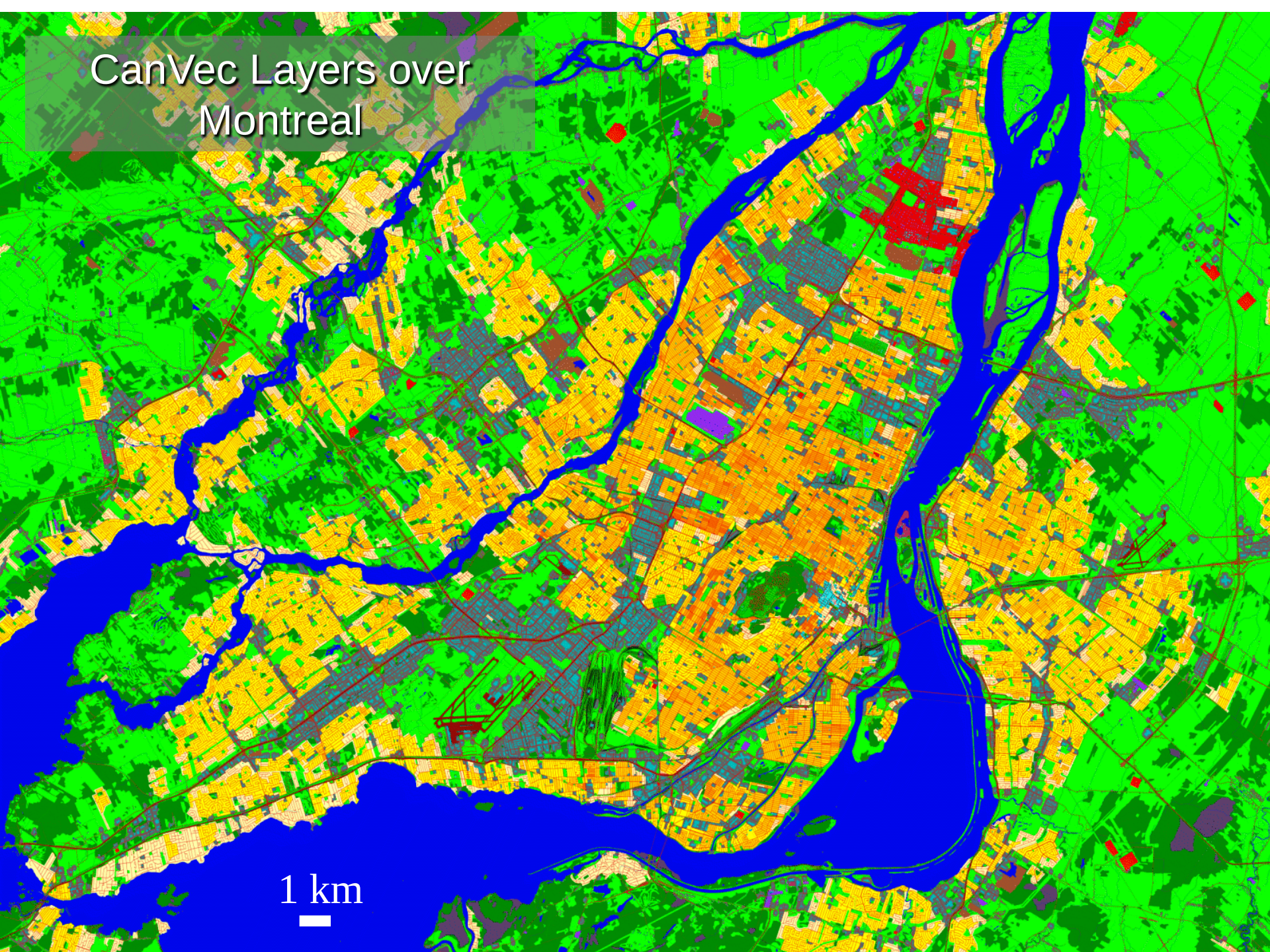
Table 3: Total PM from road dust and construction sector in Canada, TF applied for all censuses. Summary of average TF across Canada

Spatial allocation

- The use of high quality digital cartographic data is an important step towards resolving the spatial allocation problem.
- CanVec is a raster land-use dataset produced by the Natural Resources Canada. http://geogratis.cgdi.gc.ca/
- The dataset covers entire Canada and includes 11 distribution themes and more than 90 categories,
- Can be adopted for emissions spatial allocation. We plan to use this to produce allocation surrogates at different grid resolutions.

Administrative Boundaries	Industrial and Commercial Areas	Transportation
Buildings and Structures	Places of Interest	Vegetation
Energy	Relief and Landforms	Water Saturated Soils
Hydrography	Toponymy	

Table 4: Canvec distribution themes


CanVec Layers over
Montreal
1 km

Spatial allocation

- Three new surrogates were processed in census division level for the construction sectors using different CanVec categories:
  - Heavy construction
  - Residential construction
  - Road construction and paved road dust

Heavy construction

- Data used to generate heavy construction surrogate:
  - High resolution land cover classes from CanVec.
  - Areas from Oil Sands regions, Oil and Gas and mining developments .
  - Population density. Major urban areas were excluded from the surrogate.

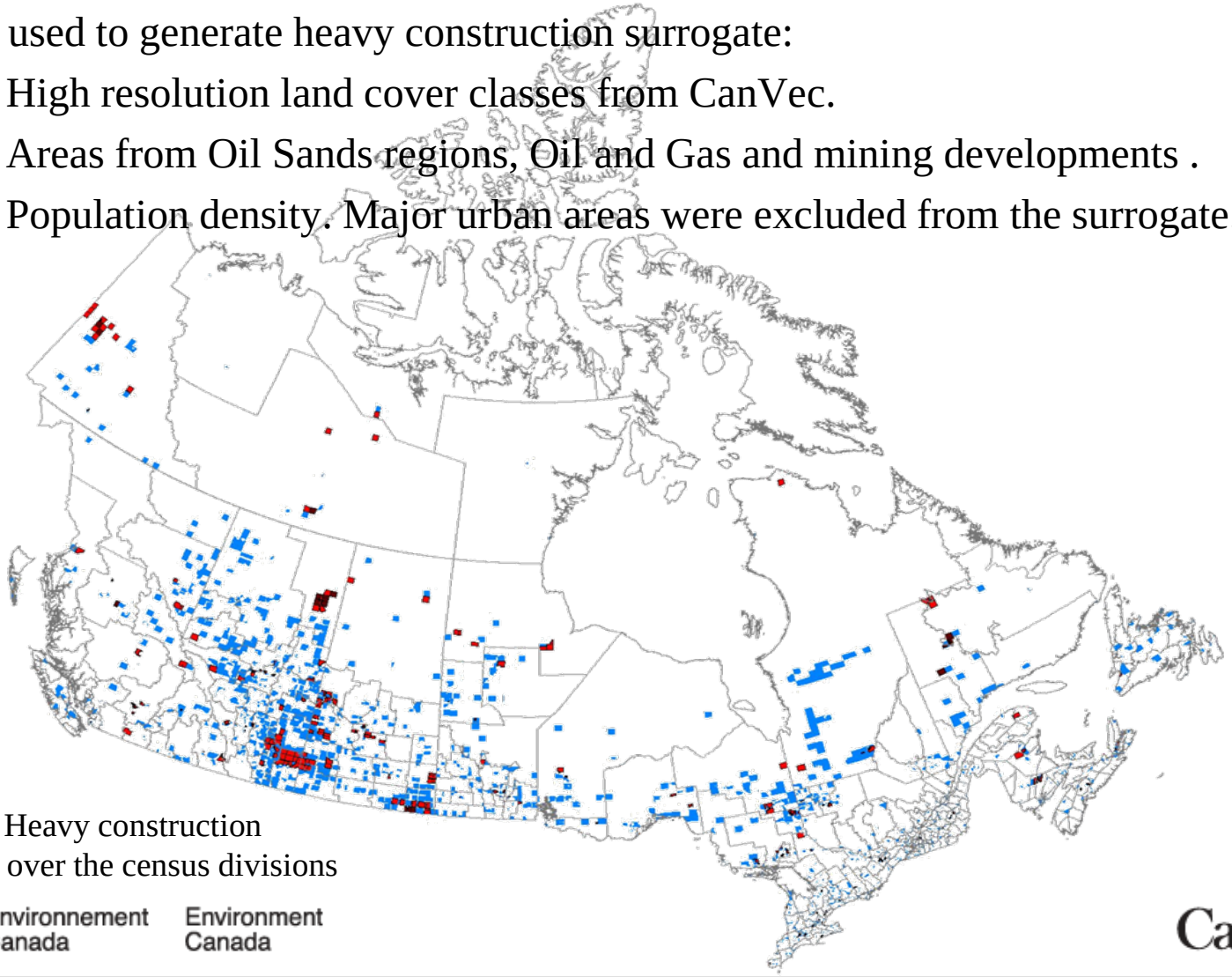
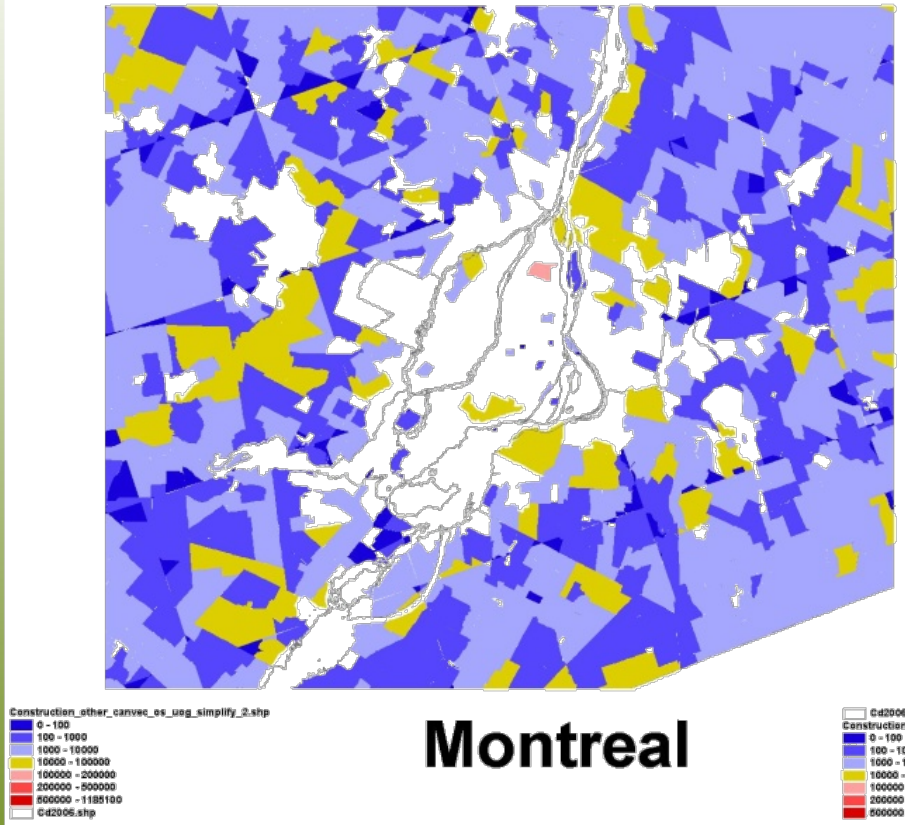
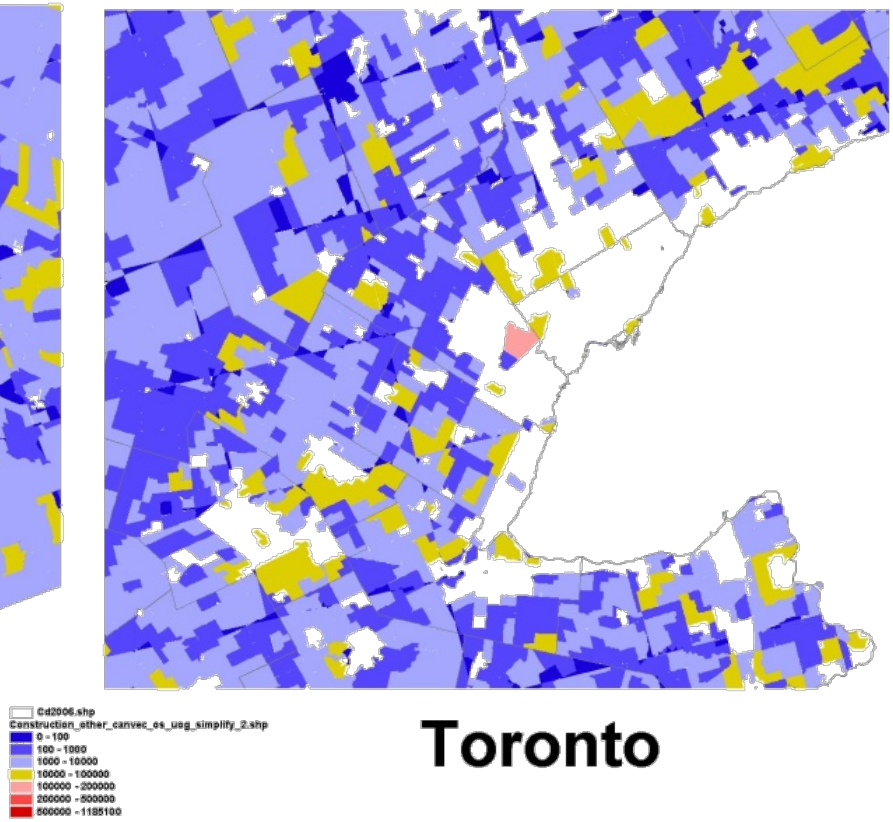


Figure 3: Heavy construction surrogate over the census divisions

Heavy construction over urban areas



Montreal



Toronto

Road dust and road construction

For road construction and paved/unpaved road dust, spatial surrogate was build using the 2007 National Road Network (NRN) v2.0 from Natural Resources Canada. http://www.geobase.ca/

- Unpaved road dust surrogate was built using
  - + Unpaved roads network in rural areas.
  - – All urban unpaved roads were excluded to reduce the amount of dust from urban centers.
- Paved road dust and road construction share the same surrogate.
  - + All paved and unpaved roads from urban and rural areas.
  - – We excluded urban streets as their total length creates emissions "hot spots" in urban centers.

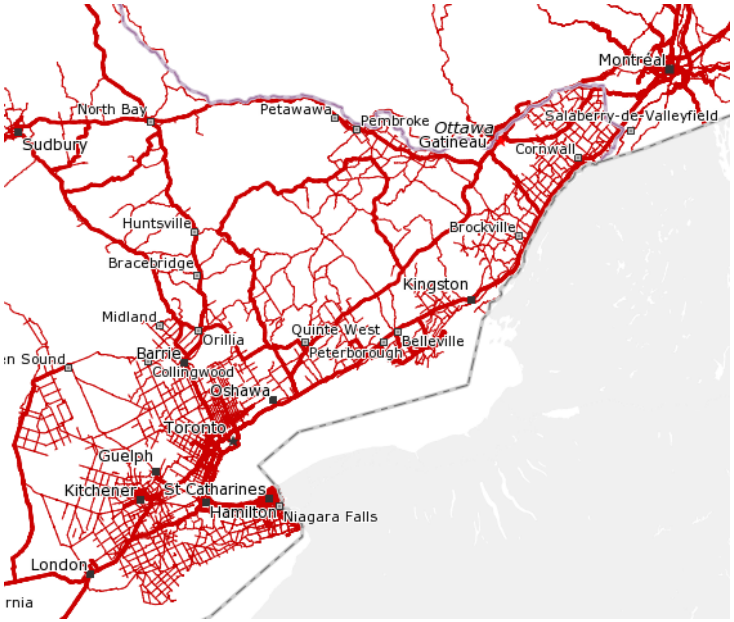


Figure 4: National Road Network (NRN) version 2.0

Residential construction

- Nearly 90% of Canadian population growth between 2006 and 2011 take place in metropolitan areas.
- We built a spatial surrogate based on population growth by using the population counts from the Canadian 2011 census. http://www.statcan.gc.ca/ :

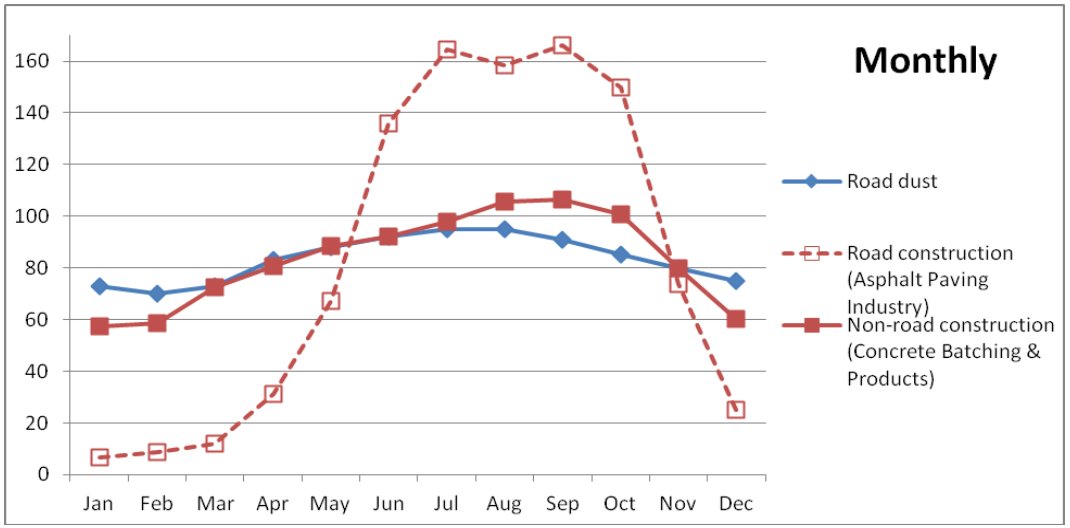
Name	Population 2011	Population 2006	Pop growth, 2006 to 2011	Land area km2
CAN	33,476,688	31,612,897	5.6%	9,017,699
ON	12,851,821	12,160,282	5.4%	907,574
QC	7,903,001	7,546,131	4.5%	1,356,367
BC	4,400,057	4,113,487	6.5%	924,815
AB	3,645,257	3,290,350	9.7%	640,045
MB	1,208,268	1,148,401	5.0%	552,370
SK	1,033,381	968,157	6.3%	588,276
NS	921,727	913,462	0.9%	52,917
NB	751,171	729,997	2.8%	71,355
NF	514,536	505,469	1.8%	370,495
PEI	140,204	135,851	3.1%	5,684

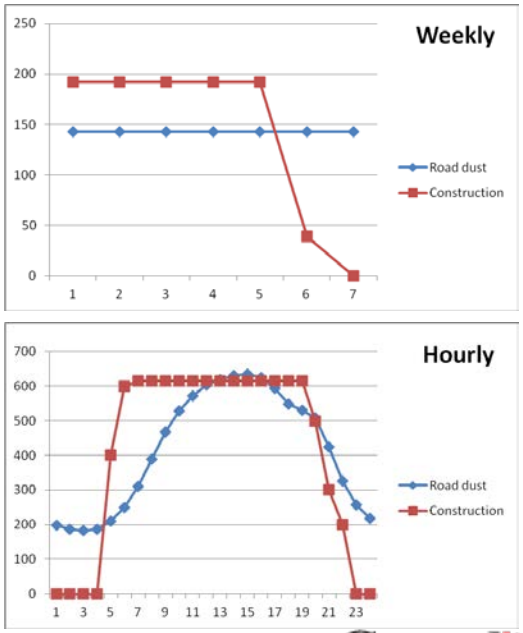
Table 5: Population count, for census subdivisions (municipalities), 2006 & 2011

Temporal profiles

The temporal profiles were modified from the default that was assigned in SMOKE:

Sector	Monthly profile
Road construction	Asphalt Paving Industry (PS)
Residential and non-residential construction	Concrete Batching & Products (PS)
Paved & unpaved road dust	Road dust





Temporal Allocation for Road dust and Construction sector in Canada

Conclusion

- The improvements to the 2006 Canadian construction emissions for air quality model applications are the following:
- Updated Transportable Fraction by census divisions calculated on a fine grid using BELD3.
- More detailed spatial surrogate for construction and road dust using high resolution cartographic data, 2011 Statistic Canada censuses and 2007 National Road Network data.
- A revised temporal allocation for construction and road dust.
- These improvements in the generation of Canadian emissions modeling files show significant changes in the gridded particulate matter emissions in urban areas and will be used for the next 2010 modeling platform.