Use of Travel Demand Model Data to Improve Inventories in Philadelphia

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Purpose

- Compare “top-down” and “bottom-up” inventory approaches
  - Philadelphia, in calendar year 1999
- “Top-down” -- relies on more aggregated information and default modeling inputs
- “Bottom-up” -- emission factors (EFs) and road link level vehicle activity data from a Travel Demand Model (TDM)

“Top-down” Approach

- Typically used for regional and national scale assessments
- EFs often based on default or average inputs
- Activity data are allocated from a larger geographic scale
  - Population often used as allocation surrogate (e.g. NEI)

“Bottom-up” Approach

- Uses more local inputs to estimate better emission factors
- vehicle activity data from a TDM
  - can provide more detailed information on the spatial distribution of roadway types, vehicle activity, and speeds
  - can be used to more accurately estimate emission rates at local scale
  - provides better estimates at the census tract level

Use of “Top-down” Approach in NATA

- Can affect modeled concentrations and risk estimates
  - Study in Minneapolis-St. Paul indicated overprediction at low monitored concentrations and underprediction at high concentrations.
  - NATA has been used for EJ analyses which can be impacted by mischaracterization of local emissions

Methods

- Link level inventory developed for Philadelphia area
  - Benzene, 1,3-butadiene, formaldehyde, acetaldehyde, acrolein
  - Running emissions estimated for links, non-running emissions (e.g. starts, hot soak, diurnal, resting loss) allocated to grid cells.
  - Local inputs used where available
    - Speed distributions, registration distributions, VMT fractions by vehicle class

Methods

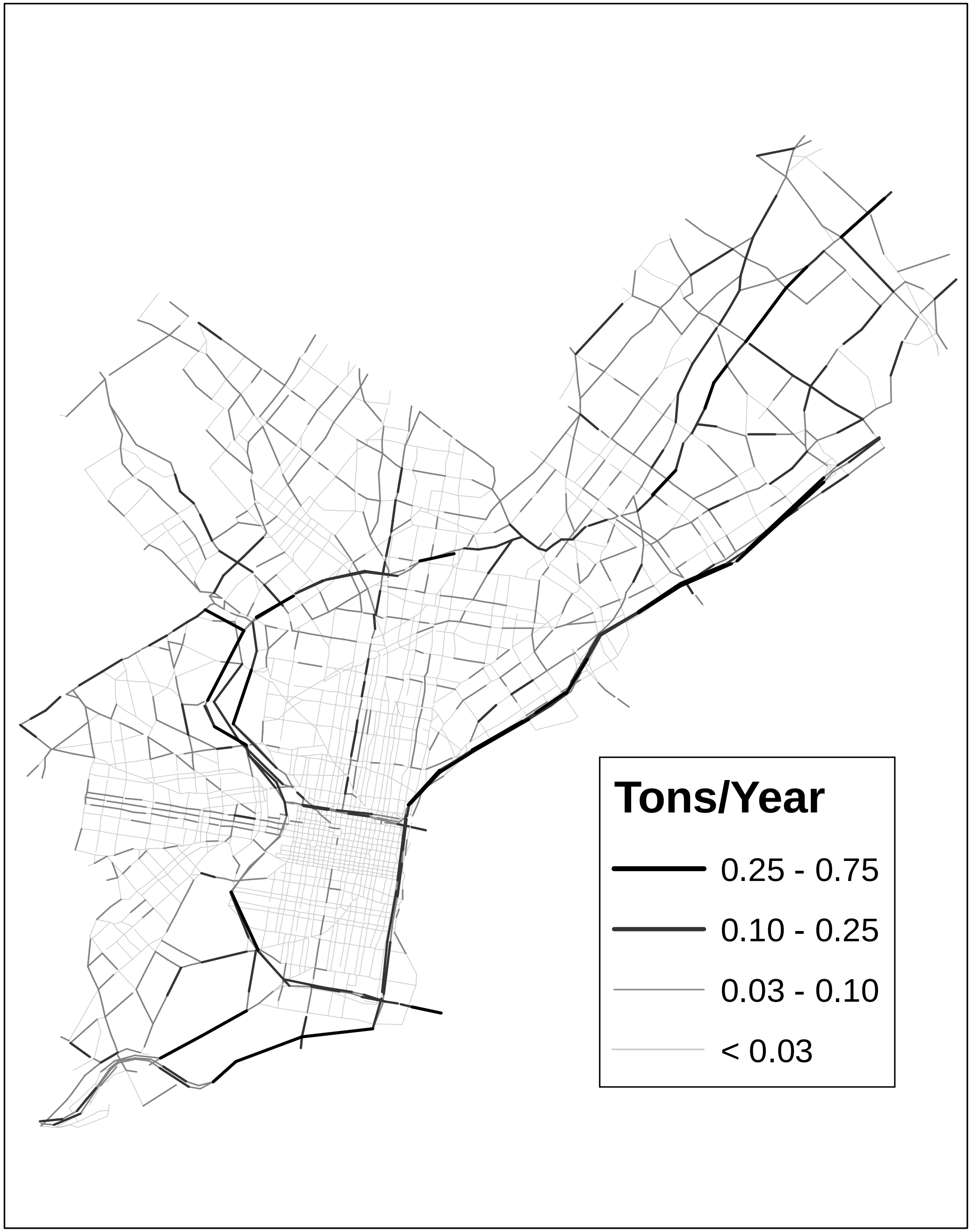
- Results compared with 1999 NEI
  - Total VMT for Philadelphia MSA allocated to counties using population
  - County inventories allocated to census tracts using roadway miles

Results

- Spatial distribution of emissions differ between “top-down” and “bottom-up” approaches

Results

- Philadelphia Link Based Benzene Emissions Distribution (“Bottom-Up” Approach)



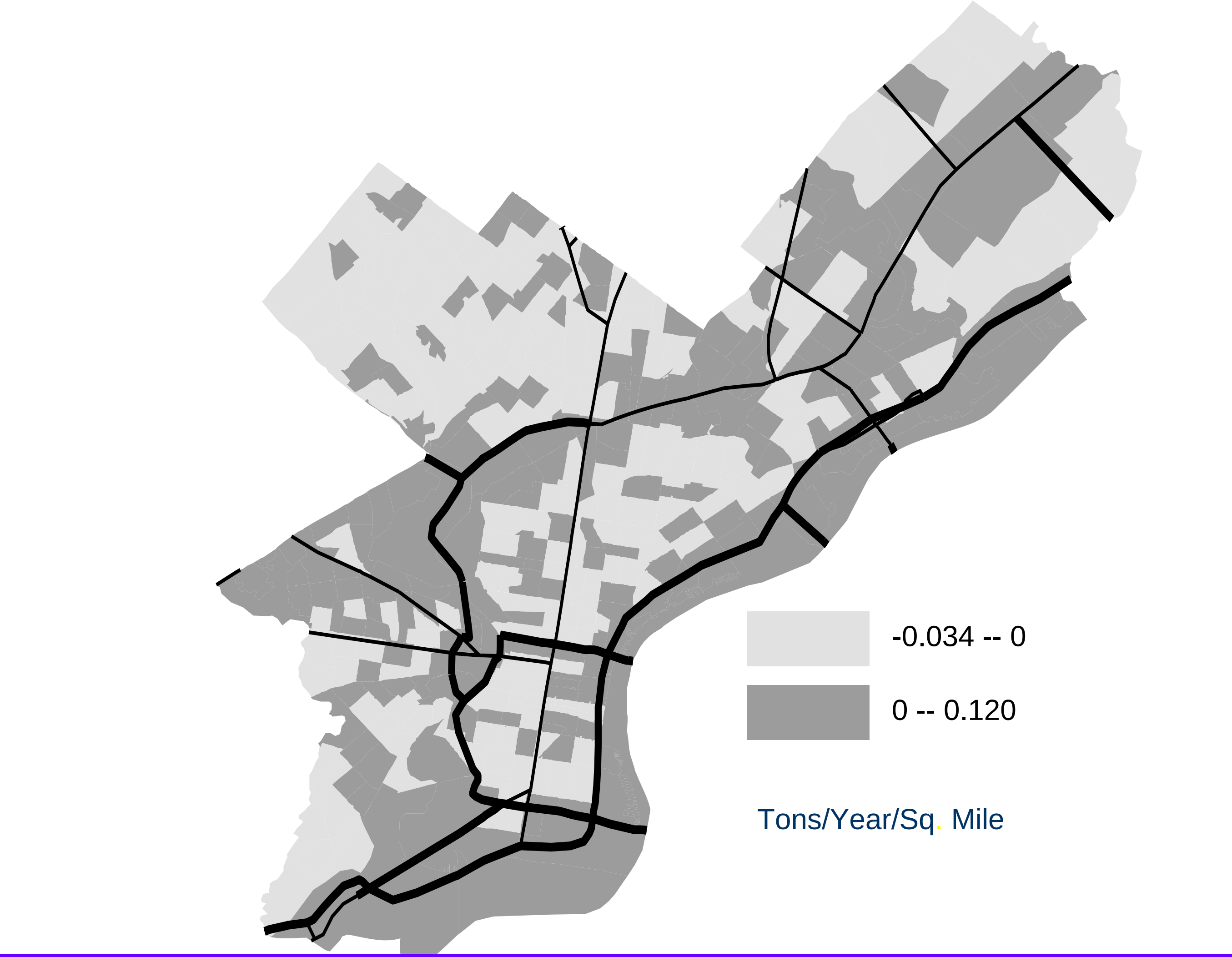
Results

- Philadelphia Tract Emissions Density from 1999 NATA ("Top-Down" Approach)

Results

- Difference in Emissions

  Density
- More emissions along major corridors



Results

- Total county emissions also differ significantly between two approaches.

Comparison of Annual 1999 Benzene Emissions (tons/year) from Two Approaches

County	"Bottom-Up" TDM	"Top-Down" NEI	Percent Difference
Camden	165	210	-27%
Delaware	162	160	1%
Gloucester	110	104	6%
Montgomery	333	209	59%
Philadelphia	255	467	-45%
Total	1,025	1,150	-12%

Results

County	1,3- Butadiene		Formaldehyde		Acetaldehyde		Acrolein	
	“Bottom-Up” TDM	“Top-Down” NEI	“Bottom-Up” TDM	“Top-Down” NEI	“Bottom-Up” TDM	“Top-Down” NEI	“Bottom-Up” TDM	“Top-Down” NEI
Camden	25	34	93	128	29	37	4	6
Delaware	21	26	79	105	24	30	3	4
Gloucester	17	17	62	66	19	19	3	3
Montgomery	44	35	165	139	51	40	7	6
Philadelphia	34	77	127	305	39	86	5	13
Total	141	189	526	743	162	212	22	32
% Difference	-25%		-29%		-24%		-31%	

Results

- Most differences in total county emissions due to VMT

Annual VMT (Vehicle Miles Traveled)

1999

County	VMT Derived from TDM (Travel Demand Model) “Bottom-Up”	VMT From Highway Statistics (used in NEI) “Top-Down”	Percent Difference
Bucks	4,878,636,990	3,710,307,400	31%
Burlington	4,187,820,178	3,567,877,700	17%
Camden	3,682,826,156	4,199,354,700	-12%
Chester	4,491,670,453	3,046,058,600	47%
Delaware	3,155,112,296	3,373,141,300	-6%
Glouster	2,524,701,655	2,195,654,200	15%
Mercer	3,136,953,593	3,555,648,300	-12%
Montgomery	6,381,619,077	4,508,702,800	42%
Philadelphia	4,864,568,590	9,804,935,300	-50%
Total	37,303,908,988	37,961,680,300	-2%

Results

- Although overall metro area VMT similar for two approaches, total inventory about 12% lower with “bottom-up” approach
  - We evaluated inputs which can have a large impact on emission rates
    - Speed, registration distribution, VMT fractions for individual vehicle classes, temperature, RVP
  - Emission factors 12% to 14% lower with local registration distributions versus MOBILE6.2 defaults

Results

Impact of Local Registration Distribution on MOBILE6 Benzene Emission Factors (All Other Inputs Unchanged)

		Emission Factor (gm/mi)		
Facility	**Speed**	**Local**	**M6 Default**	**% Difference**
Arterial	10	64	74	-13
Arterial	15	51	59	-13
Arterial	20	44	51	-14
Arterial	25	41	47	-14
Arterial	30	38	44	-13
Arterial	35	37	42	-13
Arterial	40	36	42	-13
Arterial	45	36	41	-13
Freeway	10	61	71	-14
Freeway	15	47	55	-14
Freeway	20	43	49	-14
Freeway	25	40	47	-13
Freeway	30	39	45	-13
Freeway	35	38	43	-13
Freeway	40	37	43	-13
Freeway	45	37	42	-12
Freeway	50	37	42	-12
Freeway	55	37	42	-12
Freeway	60	37	41	-12
Freeway	65	36	40	-12

Conclusion

- Use of local level inputs can have a significant impact
  - Distribution of emissions
  - Magnitude of emissions
- Use of TDM and other local data can:
  - Improve the quality of local-scale assessment
  - Improve the quality of regional and national inventories
    - Use of local inputs and VMT aggregated from TDM results in “top-down” county-wide inventories which closely approximate estimates developed using “bottom-up” approach

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