Analysis of Air Toxics Emission Inventories for Area Sources in the Great Lakes Region

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ABSTRACT

The eight Great Lakes states and the province of Ontario, with the coordination of the Great Lakes Commission, have developed air toxics emission inventories of point, area, and mobile sources for calendar years 1996 and 1997 in the Great Lakes Region. The states and province of Ontario collaborated particularly on the review and preparation of area source emission estimates, in response to a lack of appropriate guidance on that source category nationwide.

The 1996 and 1997 regional inventories focused on 82 target compounds. However, data were only available to obtain emissions for 77 pollutants in 1996 and for 75 in 1997. The results show that area sources are responsible for more than one third of total emissions, about 2.8 times the point source contributions. Area sources also contribute more than or close to two thirds of the emissions for 15 PAHs and about 10 non-metal compounds (seven in 1996 and 11 in 1997), and more than 50% of the emissions for one metal compound among air toxics inventoried.

This paper describes the collaborative work among the states and province. It presents emission estimates at a regional level and prioritizes emission sources for each pollutant. Moreover, the paper

summarizes the lessons learned in the preparation of emission inventories for area sources and suggests future improvements.

INTRODUCTION

The Great Lakes Regional Air Toxic Emissions Inventory Project was established in response to recommendations in the 1986 Great Lakes Toxic Substances Control Agreement signed by the Great Lakes governors. This initiative was undertaken through a state, provincial, and U.S. federal partnership involving the eight Great Lakes states, the province of Ontario, and the U.S. Environmental Protection Agency (U.S. EPA). The objective of this ongoing initiative is to present researchers and policy makers with detailed, basin-wide data on the sources and emission levels of toxic contaminants that have the potential to impact environmental quality in the Great Lakes basin. This work will provide a strong foundation upon which to build national and bi-national strategies to reduce toxic air emissions affecting the Great Lakes. After the development of a pilot inventory for year 1993, calendar year 1996 was selected as a base year for the regional emission inventory. An updated inventory for calendar year 1997 has just been completed.

The regional inventory includes three principal source categories: point, area, and mobile. Area sources are small emission sources, but collectively release large amounts of one or more toxic air pollutants of concern. Due to the ubiquitous nature, emissions of air toxics from area sources can pose significant risks to public health in urban areas. In compiling the area source inventory, challenges were encountered due to a lack of appropriate guidance and resources. The Emission Inventory Improvement Program (EIIP) produced guidance on emission estimation for certain area source categories. However, the information is mainly for criteria pollutants, emission factors for air toxics are not provided for all categories in the EIIP documents.[1] The release of the 1996 National Toxics Inventory (NTI) documentation provides further information on emission estimation for area sources.[2] However, the NTI information is somewhat in conflict with other published guidance such as AP-42 or Factor Information Retrieval (FIRE) Data System. The following sections discuss how Great Lakes States and Ontario face the challenges and also present the results of air toxics emissions in the region.

METHDOLOGY

The Great Lakes regional air toxics emission inventory is a multi-state, regional effort. Working cooperatively through the Great Lakes Commission, inventory work is undertaken by the air quality departments of the state and provincial governments in the region.

As a regional effort, a high level of coordination and communication was necessary to ensure consistency among the eight states and Ontario in terms of data management, methodology, calculation methods and other issues. The Great Lakes Commission provided project management and secretarial services. A Technical Steering Committee is composed of representatives from each of the air management programs from the eight Great Lakes states as well as Ontario and observers from U.S. EPA.

The Technical Steering Committee, first, reviewed the EIIP documents, FIRE data system, the 1996 NTI documentation, and other available information, then selected the potential area source categories that would be inventoried. Each state or province took the lead on examining the feasibility and developing emission inventory protocols for one or two categories. Sixteen area source categories were finally selected for the 1996 and 1997 regional emission inventories.

- Agricultural Pesticide Application
- Architectural Surface Coatings
- Auto Body Refinishing
- Chromium Electroplating

- Consumer and Commercial Solvent Use
- Dry Cleaning
- Gasoline Marketing
- Graphic Arts
- Industrial Surface Coating
- Landfills
- Marine Vessel Loading, Ballasting, and Transit
- Public Owned Treatment Works
- Residential Fuel Combustion
- Residential Wood Combustion
- Solvent Cleaning
- Traffic Markings

The protocols have been included in the Report of the Great Lakes Regional Air Toxics Emission Inventory.[2] By focusing on the procedures that the participating jurisdictions must follow to compile their portion of the database, the protocol for each area source includes the guidance on the following aspects.

- Identification and location of emission sources
- Identification of possible emission of air toxics
- Recommendation of suggested and alternative methods for emission inventory compilation
- Guidance on activity data collection
- Guidance on selection of specific emission estimation techniques
- Recommendation on emission factors and speciation profiles
- References

Following the guidance of these protocols, the participating states compiled their respective portion of the regional emission inventory. The results went through the state-level and the regional level quality assurance and quality control activities.

Air emissions data vary significantly from one Great Lakes jurisdiction to the next in terms of breadth, quality, and availability. Further, staffing resources vary as well and, consequently, some jurisdictions provided data in varied forms that were standardized and then incorporated into the inventory. The 1996 and 1997 inventories should not be used for jurisdictional comparisons, but rather to demonstrate the potential of such a complete and comprehensive inventory as a decision support tool.

RESULTS AND DISCUSSIONS

The 1996 and 1997 Great Lakes emissions inventories focused on a total of 82 pollutants. The list is comprised of 16 polycyclic aromatic hydrocarbons (PAHs), 53 non-metal chemicals (excluding PAHs), and 13 metal compounds. These pollutants were compiled using the International Joint Commission's list of Great Lakes critical pollutants, U.S. EPA’s list of targeted toxic chemicals defined in the U.S. Clean Air Act Amendments of 1990, section 112 (c)(6), and those pollutants suggested by the Great Lakes states.

The regional emission inventory, using 1996 and 1997 data, includes emissions from 16 area source categories. Although these categories are selected by the region, emissions of certain area source categories may not be estimated by some states and/or the province of Ontario due to the coverage of point sources and resource restrictions. For example, the category of Marine Vessel Loading, Ballasting, and Transit is covered in point sources for IL, IN, and WI. Therefore, no emissions were estimated for this area source category from these states.

The State of New York is still refining its respective portion of the 1997 emissions. Therefore, the 1997 regional emissions are based on data from the seven other Great Lakes states and Ontario. The

emission data were analyzed for relative contributions from each principle source category not the absolute emission amounts. The analyses will be updated after New York completes the 1997 inventory compilation.

Overall

Out of the 82 pollutants of interest in the regional inventory project, it was possible to obtain emissions for 77 air toxics in 1996 and 75 air toxics in 1997. Both inventories include non-zero emissions for 16 polycyclic aromatic hydrocarbons (PAHs) and 12 metal compounds, but 49 non-metal compounds for 1996 and 47 for 1997. Table 1 shows pollutant names, estimated emissions for 1996; contributions from point, area, and mobile sources for 1996; and contributions from area sources for 1997. Among the pollutants with non-zero emissions, 62 pollutants and 66 pollutants are from area sources in 1996 and 1997, respectively. Area sources contribute more than or close to two thirds of the total emissions for 15 PAHs and about 10 non-metal compounds (seven in 1996 and 11 in 1997), and more than 50% of emissions for one metal compound. Area sources are responsible for more than one third of total emissions in both calendar years. Compared with point sources, area sources account for about 2.8 times the point source emissions. Mobile sources are the most significant category of air toxics emissions, responsible for about 50% of total emissions.

Table 1. 1996 and 1997 Air toxics emissions from the Great Lakes region.

Pollutant Name	Cas No.	1996				1997
		Total (lb)	Point (%)	Area (%)	Mobile (%)	Area (%)
PAHs						
Acenaphthene	83329	245,853.29	16.71	83.29	0.00	99.87
Acenaphthylene	208968	2,634,823.24	7.70	92.30	0.00	99.94
Anthracene	120127	311,470.73	15.01	84.95	0.04	83.16
Benz(a)anthracene	56553	714,360.48	7.13	92.62	0.24	83.52
Benzo(ghi)perylene	191242	135,332.33	15.37	82.04	2.60	89.90
Benzo(a)pyrene	50328	219,272.25	35.00	64.47	0.53	28.68
Benzo(b)fluoranthene	205992	189,004.57	31.64	67.70	0.66	96.63
Benzo(k)fluoranthene	207089	59,550.95	0.02	98.10	1.88	91.46
Chrysene	218019	2,503,085.76	87.52	12.40	0.08	69.32
Dibenz(a,h)anthracene	53703	73,729.34	11.10	88.63	0.27	98.87
Fluoranthene	206440	510,171.11	25.26	74.49	0.25	63.58
Fluorene	86737	592,492.51	22.83	77.17	0.00	99.80
Indeno(1,2,3-cd)pyrene	193395	188,282.54	11.87	88.01	0.12	99.57
Naphthalene	91203	16,437,654.50	7.42	76.37	16.21	58.09
Phenanthrene	85018	6,445,075.33	7.41	92.58	0.01	99.81
Pyrene	129000	491,822.26	30.00	69.78	0.22	98.63
Non-Metal Compounds (Excluding PAHs)						
Acetaldehyde	75070	27,101,699.13	5.80	1.29	92.91	0.41
Acrolein	67641	3,225,825.28	4.29	10.19	85.52	5.87
Acrylamide	107028	1,280.42	100.00	0.00	0.00	0.00
Acrylonitrile	107131	2,342,705.57	97.47	2.53	0.00	8.31
Atrazine	1912249	9,540,401.15	0.00	100.00	0.00	100.00
Benzene	71432	144,736,836.21	4.16	40.53	55.31	24.14
1,3-Butadiene	106990	32,388,658.47	1.36	19.57	79.07	16.90
Carbon tetrachloride	56235	138,212.06	67.97	32.03	0.00	75.12

Pollutant Name	Cas No.	1996				1997
		Total (lb)	Point (%)	Area (%)	Mobile (%)	Area (%)
Chlordane	57749	0.94	100.00	0.00	0.00	0.00
Chloroform	67663	1,561,844.76	91.35	8.65	0.00	22.92
Coke oven emissions		1,926,830.47	100.00	0.00	0.00	0.00
Dichloroethyl ether (bis(2-chloroethyl) ether)	111444	923.15	100.00	0.00	0.00	0.00
Diethylhexyl phthalate (DEHP)	117817	44,639.50	100.00	0.00	0.00	97.47
Di-n-butyl phthalate	84742	5,362,721.10	0.69	99.31	0.00	0.02
Di-n-octyl phthalate	117840	8,047.87	100.00	0.00	0.00	0.01
Ethylbenzene	100414	64,519,934.95	7.92	22.45	69.63	9.33
Ethylene dibromide (Dibromoethane)	106934	5,634,134.56	99.38	0.62	0.00	61.01
Ethylene dichloride (1,2-Dichloroethane)	107062	186,326.90	88.72	11.28	0.00	20.75
Ethylene oxide	75218	4,833,488.99	4.59	95.41	0.00	78.83
Formaldehyde	50000	105,770,535.79	34.57	2.19	63.24	1.41
Glycol ethers		10,386,902.31	67.16	32.84	0.00	51.18
Hexachlorobenzene	118741	9.94	87.91	12.09	0.00	66.55
Hexachlorobutadiene	87683	8.00	100.00	0.00	0.00	0.00
Hexachloroethane	67721	876.00	100.00	0.00	0.00	93.40
Hydrazine	302012	479.84	100.00	0.00	0.00	0.00
Methyl chloroform (1,1,1-Trichloroethane)	71556	61,471,598.26	3.29	96.71	0.00	96.72
Methylene chloride (Dichloromethane)	74873	32,466,722.32	53.20	46.80	0.00	45.36
Methylene diphenyl diisocyanate (MDI)	101688	44,345.27	100.00	0.00	0.00	0.00
Pentachlorophenol	87865	20,886.33	100.00	0.00	0.00	0.00
Phenol	108952	4,747,760.83	98.35	0.43	1.22	0.87
Phosgene	75445	194.76	100.00	0.00	0.00	0.12
Styrene	100425	28,771,679.07	38.75	26.89	34.36	0.38
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	1746016	0.33	94.89	3.37	1.74	8.86
2,3,7,8-tetrachlorodibenzo-furan (TCDF)	51207319	32.64	98.02	1.98	0.00	0.59
Tetrachloroethylene (Perchloroethylene)	127184	73,669,513.07	5.77	94.23	0.00	91.43
Toluene	108883	545,821,725.75	9.88	38.70	51.42	32.59
2,4-Toluene diisocyanate	584849	10,919.81	59.08	40.92	0.00	0.00
Total polychlorinated biphenyls (PCBs)	1336363	35.39	99.76	0.24	0.00	0.04
Total polychlorinated dibenzodioxins (PCDDs)		36.11	88.50	11.50	0.00	39.16
Total polychlorinated dibenzofurans (PCDFs)		45.37	49.51	50.49	0.00	70.19
Trichloroethylene	79016	51,271,198.52	32.01	67.99	0.00	78.16
2,4,5-Trichlorophenol	95954	0.02	100.00	0.00	0.00	0.00
2,4,6-Trichlorophenol	188062	12,784.14	100.00	0.00	0.00	0.00
Trifluralin	1582098	662,346.08	0.95	99.05	0.00	99.49
Vinyl chloride	75014	884,242.02	83.36	16.64	0.00	25.92
Xylenes (includes o, m, and p)	1330207	311,317,244.44	12.27	33.02	54.71	28.88
m-Xylenes	108383	23,270,303.00	0.31	3.18	96.52	1.53
o-Xylenes	95476	58,704,829.34	0.39	33.65	65.96	21.44
p-Xylenes	106423	35,310,692.68	0.01	1.37	98.62	83.98
Metal Compounds						
Antimony	7440360	83,502.86	71.38	0.00	28.62	2.29
Arsenic	7440382	211,047.65	78.03	0.48	21.49	5.01
Beryllium	7440417	16,178.61	97.33	2.67	0.00	50.69
Cadmium	7440439	517,761.12	43.06	54.63	2.31	18.07
Chromium	7440473	986,078.18	91.45	5.47	3.08	3.15
Chromium (6)	18540299	27,805.15	77.14	22.86	0.00	0.41
Cobalt	7440484	180,886.08	18.97	80.85	0.18	1.64

Pollutant Name	Cas No.	1996				1997
		Total (lb)	Point (%)	Area (%)	Mobile (%)	Area (%)
Copper	7440508	1,105,819.54	73.82	0.42	25.76	0.25
Lead	7439921	890,764.49	90.49	0.70	8.81	2.38
Manganese	7439965	3,335,800.14	96.85	0.63	2.52	2.04
Mercury	7439976	220,251.64	94.91	3.09	2.00	12.82
Nickel	7440020	693,258.26	80.32	7.75	11.92	2.82
Total		**229,192,589.30**	**14.59**	**40.23**	**45.18**	**34.20**

Comparison of Area Source Emissions between Calendar Year 1996 and 1997

The difference of area source contributions between the two calendar years is within ±20% for most compounds. However, significant gaps are observed for certain compounds. There are 19 compounds with the area source contribution difference exceeding ±20%. These large differences are mainly the results of improvements to emission estimation methods, emission factors, and activity data.

For example, a large amount of cobalt emissions were estimated from Residential Fuel Combustion – Natural Gas for the 1996 inventory due to the use of a speciation profile. Emissions factors for natural gas combustion became available from FIRE 6.22 for the 1997 inventory.[4] The emission factor for cobalt in FIRE 6.22 is 4 orders of magnitude less than the one suggested in the speciation profile. Therefore, the area source contribution to cobalt emissions reduced sharply in1997.

An increase of p-xylene contribution from area sources is a good example of better speciation profiles for mobile sources. Some states used old speciation profiles for onroad vehicles in the 1996 inventory, yielding high p-xylene emissions from mobile source in the region. In the 1997 inventory preparation, the 1996 NTI speciation profiles, that do not suggest p-xylene emissions, were used for the onroad vehicles. Consequently, the contribution of area sources rose significantly.

Prioritization of Emission Sources Based on the 1996 Inventory

Analysis was also performed to prioritize emission sources for each pollutant emitted from area sources in 1996. The most significant area source categories and their contributions to the total area source emissions are listed in Table 2. The number of pollutants emitted from each area source category is listed in Table 3.

Table 2. The most significant source categories for the 1996 air toxics emissions from area sources.

Pollutant Name	Most Significant Area Source Category	Contribution (%)
PAHs		
Acenaphthene	Residential Wood Combustion	100.00
Acenaphthylene	Residential Wood Combustion	100.00
Anthracene	Residential Wood Combustion	100.00
Benz(a)anthracene	Residential Wood Combustion	99.93
Benzo(ghi)perylene	Residential Wood Combustion	100.00
Benzo(a)pyrene	Residential Wood Combustion	89.58
Benzo(b)fluoranthene	Residential Wood Combustion	100.00
Benzo(k)fluoranthene	Residential Wood Combustion	100.00
Chrysene	Residential Wood Combustion	100.00
Dibenz(a,h)anthracene	Residential Wood Combustion	100.00
Fluoranthene	Residential Wood Combustion	99.99

Pollutant Name	Most Significant Area Source Category	Contribution (%)
Fluorene	Residential Wood Combustion	100.00
Indeno(1,2,3-cd)pyrene	Residential Wood Combustion	100.00
Naphthalene	Residential Wood Combustion	46.77
Phenanthrene	Residential Wood Combustion	100.00
Pyrene	Residential Wood Combustion	100.00
Non-Metal Compounds (Excluding PAHs)		
Acetaldehyde	Public Owned Treatment Works	97.61
Acrolein	Public Owned Treatment Works	97.00
Acrylamide		
Acrylonitrile	Landfills	100.00
Atrazine	Agricultural Pesticide Application	100.00
Benzene	Residential Wood Combustion	78.14
1,3-Butadiene	Gasoline Marketing	95.69
Carbon tetrachloride	Traffic Markings	47.99
Chlordane		
Chloroform	Public Owned Treatment Works	58.34
Coke oven emissions		
Dichloroethyl ether (bis(2-chloroethyl) ether)		
Diethylhexyl phthalate (DEHP)		
Di-n-butyl phthalate	Gasoline Marketing	99.71
Di-n-octyl phthalate		
Ethylbenzene	Architectural Surface Coatings	47.91
Ethylene dibromide (Dibromoethane)	Industrial Surface Coating	98.05
Ethylene dichloride (1,2-Dichloroethane)	Gasoline Marketing	56.55
Ethylene oxide	Industrial Surface Coating	81.86
Formaldehyde	Public Owned Treatment Works	47.25
Glycol ethers	Consumer and Commercial Solvent Use	65.69
Hexachlorobenzene	Agricultural Pesticide Application	100.00
Hexachlorobutadiene		
Hexachloroethane		
Hydrazine		
Methyl chloroform (1,1,1-Trichloroethane)	Solvent Cleaning	63.80
Methylene chloride (Dichloromethane)	Solvent Cleaning	47.90
Methylene diphenyl diisocyanate (MDI)		
Pentachlorophenol		
Phenol	Residential Wood Combustion	100.00
Phosgene		
Styrene	Industrial Surface Coating	91.94
2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD)	Residential Wood Combustion	94.58
2,3,7,8-tetrachlorodibenzo-furan (TCDF)	Residential Wood Combustion	97.93
Tetrachloroethylene (Perchloroethylene)	Dry Cleaning	79.65
Toluene	Industrial Surface Coating	25.61
2,4-Toluene diisocyanate	Graphic Arts	100.00
Total polychlorinated biphenyls (PCBs)	Landfills	100.00
Total polychlorinated dibenzodioxins (PCDDs)	Residential Wood Combustion	99.90
Total polychlorinated dibenzofurans (PCDFs)	Residential Wood Combustion	99.94
Trichloroethylene	Solvent Cleaning	97.57
2,4,5-Trichlorophenol		

Pollutant Name	Most Significant Area Source Category	Contribution (%)
2,4,6-Trichlorophenol		
Trifluralin	Agricultural Pesticide Application	100.00
Vinyl chloride	Public Owned Treatment Works	89.08
Xylenes (includes o, m, and p)	Auto Body Refinishing	31.04
m-Xylenes	Gasoline Marketing	47.52
o-Xylenes	Residential Wood Combustion	28.40
p-Xylenes	Solvent Cleaning	57.76
Metal Compounds		
Antimony		
Arsenic	Residential Fuel Combustion	100.00
Beryllium	Residential Fuel Combustion	100.00
Cadmium	Residential Fuel Combustion	99.55
Chromium	Residential Fuel Combustion	88.16
Chromium (6)	Chromium Electroplating	100.00
Cobalt	Residential Fuel Combustion	100.00
Copper	Residential Fuel Combustion	89.12
Lead	Residential Fuel Combustion	100.00
Manganese	Residential Fuel Combustion	69.77
Mercury	Residential Fuel Combustion	97.20
Nickel	Residential Fuel Combustion	99.73

Table 3. Number of pollutants emitted from area sources.

Area Source Category	PAHs	Non-Metal	Metal	Total
Agricultural Pesticide Application		3		3
Architectural Surface Coatings	1	9		10
Auto Body Refinishing	1	4		5
Chromium Electroplating			2	2
Consumer and Commercial Solvent Use	1	14		15
Dry Cleaning		1		1
Gasoline Marketing	1	11		12
Graphic Arts	1	8		9
Industrial Surface Coating	1	13		14
Landfills	5	19	1	25
Marine Vessel Loading, Ballasting, and Transit	1	6		7
Public Owned Treatment Works	1	18		19
Residential Fuel Combustion	16	9	10	35
Residential Wood Combustion	16	9	5	30
Solvent Cleaning	1	10		11
Traffic Markings	1	7		8

Agricultural Pesticide Application is the only source estimated to emit three pollutants: atrazine, hexachlorobenzene, and trifluralin.

Architectural Surface Coatings and Auto Body Refinishing are recognized as the most significant source for ethylbenzene (48%) and xylenes (31%), respectively.

Consumer and Commercial Solvent Use emits 15 pollutants in the Great Lakes region with the most noticeable contribution to glycol ether (66%).

Dry Cleaning is estimated to emit only one pollutant, tetrachloroethylene, with a contribution of 80% to the total area source emissions.

Gasoline Marketing is the primary emission source for 1,3-butadiene and di-n-butyl phthalate with a contribution of more than 95%. Gasoline Marketing also accounts for approximately one-half of the area source emissions for ethylene dichloride and m-xylenes. Please note that FIRE emission factors were used in emission estimation for this category but some emission factors appear to be incorrect. 1,3-Butadiene is formed by incomplete combustion and should not be included in the evaporative emissions. Ethylene dichloride and ethylene dibromide were additives to leaded gasoline that has been prohibited for use in highway vehicles since January 1, 1996. These emission factors were removed in the 1997 inventory estimation.

Graphic Arts link to almost 100% of 2,4-Toluene diisocyanate emissions.

Industrial Surface Coating predominates area source emissions (more than 82%) for ethylene dibromide, ethylene oxide and styrene. It is also the largest contributor to toluene emissions (26%). The emissions for this category were estimated by using speciation profiles. One of the speciation profiles used by some states resulted in erroneously high emissions of ethylene dibromide and ethylene oxide. This speciation profile was evaluated in 1997 inventory preparation and replaced by a more appropriate one. The emissions of ethylene oxide and ethylene dibromide were removed from the calculations.

Landfills contribute emissions of 25 pollutants. They are also the unique source for acrylonitrile and polychlorinated biphenyls (PCBs) emissions.

Marine Vessel Loading, Ballasting, and Transit is estimated to emit seven pollutants, but it does not have significant contributions to any of these pollutants.

The category of Public Owned Treatment Works is responsible for most emissions from area sources for five pollutants: acetaldehyde, acrolein, chloroform, formaldehyde, and vinyl chloride.

Residential Wood Combustion dominates area source emissions for all PAHs, benzene, phenol, TCDD, TCDF, PCDDs, PCDFs, and o-xylenes. In contrast, Residential Fuel Combustion shows up as a primary source for all metals from area sources except for chromium (6), for which Chromium Electroplating is the only contributing source.

Solvent Cleaning is responsible for 48 - 64% of area source emissions for methyl chloroform (1,1,1-trichloroethane), methylene chloride (dichloromethane), and p-xylenes. It also emits about 98% of trichloroethylene emissions.

Although Traffic Marking emits eight pollutants, it only contributes significantly to carbon tetrachloride (48%).

LESSON LEARNED FROM THE INVENTORY COMPILATION

Regional coordination is an effective way to compile area source emission inventories. Technical steering committee members across the Great Lakes states and Ontario have taken the excellent opportunity provided by this project to share their experiences and knowledge and broaden their skills regarding various aspects of emission inventory preparation. The achievement is far more than what any state alone can achieve in any given time period.

The emission inventory data clearly indicates the significance of area source contributions to air toxics emissions. Barriers and obstacles exist in compiling a reliable emission inventory for area sources. Following sections discuss some barriers and obstacles.

Definition of Area Sources and Emission Thresholds for Point Sources

The Great Lakes states and the province of Ontario made efforts to ensure the consistency of data management, methodology, and calculation methods. However, definitions of point and area sources are dependent on data collection methods, as reporting requirements for air toxics emissions are different from state to state. For example, the State of Wisconsin requires annual emission inventory reports for 546 pollutants with difference thresholds such as 91 lbs/year for acrolein and 6,000 lbs/year for toluene. A facility that emits an amount of any pollutant higher than the established threshold is classified as a point source in Wisconsin. Most Great Lakes states do not have similar emission inventory reporting requirements, and develop an air toxics emission inventory based on a criteria pollutant emission inventory. For these states, point sources are usually large, permitted facilities, but no thresholds are applied to air toxics emission estimates. Therefore, one emission source defined as an area source in one state may be covered as a point source in other states; emissions of some pollutants estimated in one state may be ignored in other states due to different reporting threshold values. The difference in reporting thresholds and source definitions makes a comparison of emissions among states difficult. It is important to clearly define area sources and determine the necessity of emission thresholds for the inventory. Decisions need to be made by not only emission inventory scientists but also policy makers and toxicologists.

Guidance on Emission Inventory Preparation for Area Sources

Uncertainties inherent in the various types of data and methods currently available are recognized. It is not expected to have perfect methods and very accurate emission factors for all sub-categories of area sources beyond the current level of our understanding. However, guidance is required for an emission inventory consistent among states.

Existing national level guidance includes the EIIP documents, FIRE data system, and the 1996 NTI documentation. The EIIP documents provide detailed instructions on source classification, data collection, emission estimation methodologies, data handling, and QA/QC procedures. However, the information is mainly for criteria pollutants, and not enough information is presented for air toxics. The FIRE data system contains EPA's recommended emission factors for air toxics. These emission factors facilitate automated emission estimation in the Regional Air Pollutants Inventory Development (RAPIDS) software system, developed for this project. Again, FIRE emission factors are not adequate for all area source categories. The 1996 NTI documentation provides emission estimation methodologies for more broad area source categories. However, the emission factors used in the 1996 NTI are somewhat in conflict with FIRE and EIIP. It is hard to judge which set of emission factors is more appropriate without full access to the technical background information and references. One example is for residential wood combustion. Both FIRE and EIIP recommended emission factors from AP-42 for residential wood combustion while NTI used controlled emission factors for electric generation boilers and industrial boilers.

Air toxics emission inventory protocols for area sources served as the guidance for the Great Lakes regional inventory. These protocols were prepared by participating jurisdictions by evaluating the national level guidance and other publications. The protocols will be updated when better information becomes available. Collaborative work between the Great Lakes jurisdictions and EPA will be even more effective regarding the use of the resources and keeping consistency in the national inventory.

Emission Trends

From the comparison of inventory data for two calendar years, as noticed in previous discussions, the differences exist mainly due to the improvement of emission estimation methods, emission factors,

and activity data. That kind of improvement is expected to continue from year to year, making analysis of emission trends difficult. A back-calculation using the most current approaches for previous years could provide emission trends, however, this is a resource intensive effort. The Great Lakes states and Ontario will not have enough resources to do it for all pollutants and all source categories in the near future. It may be possible to do a back-calculation for a few selected pollutants from certain source categories; this needs to be explored.

CONCLUSIONS

The Great Lakes regional emission inventory project has demonstrated that area sources are significant contributors to the total emissions of certain toxic air pollutants. The 1996 and 1997 emissions are available for 77 and 75 air toxins, respectively. More than 60 pollutants were emitted from area sources. Area sources contribute more than one third to the total emissions, accounting for 2.8 times the point source emissions from the region. Area source also contributed significantly to 15 out of 16 PAHs, about 10 non-metal compounds, and one metal compound. Residential Wood Combustion dominates PAH emissions from area sources, while emissions of metal compounds from area sources are mainly attributed to Residential Fuel Combustion. The most significant area source categories for non-metal compounds vary from pollutant to pollutant, but Marine Vessel Loading, Ballasting, and Transit does not dominate any pollutant emissions.

Definition of area sources and emission thresholds for point sources are important issues in compiling a consistent emission inventory across the Great Lakes Region and the nation. Guidance on emission inventory preparation for area sources is necessary. The Great Lakes jurisdictions have worked on protocols to provide guidance. Analysis of emission trends is difficult due to the change in emission estimation technology, emission factors, and activity data collections. Collaborative work with EPA is needed in the future.

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