A Comparison of Local and National Air Toxics Emissions Estimates: Regional Importance of Selected Source Categories

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ABSTRACT

The Olympic Region Clean Air Agency (ORCAA) recently performed a comprehensive inventory of air toxics emissions from point, onroad mobile and several important area and nonpoint source categories within its six county jurisdiction in western Washington state. Base year 1999 nonpoint and area source emissions data have been submitted to the Environmental Protection Agency for incorporation into Version 3.0 of the 1999 National Emissions Inventory.

Results of the inventory indicate that emissions of air toxics from several regionally important source categories may not be adequately represented in the national emission inventory used for modeled assessments of exposure to air toxics. This paper presents summarized inventory results for Residential Wood Combustion; Open Burning of Logging Debris and Chemical Pulp Production. The local results are compared with nationally derived estimates. The report includes a summary and comparison of pertinent results and discussion about needs for further development of emission inventory data for risk assessment work at the local level.

INTRODUCTION

In June of 2001, as part of a special projects solicitation from Region 10 of the United States Environmental Protection Agency (EPA), the Olympic Region Clean Air Agency (ORCAA) was awarded a grant to perform a comprehensive air toxics emissions inventory of sources within ORCAA's six county jurisdiction in western Washington state. The inventory will serve as the basis for future exposure modeling and health risk assessment work at the local level. The Washington State Department of Ecology (WDOE) administered the grant and provided technical assistance. This report is focused on emissions estimates for Residential Wood Combustion, Open Burning of Logging Debris (Slash Burning), and Chemical Pulp Production. Estimates for these source categories in the ORCAA inventory were compared with national scale estimates found in Version 2 of the 1999 National Emission Inventory (NEI).[1] Significant differences were found between the local and national scale estimates, as detailed below.

METHODOLOGY

The inventory estimated emissions of toxic air pollutants regulated under federal rules as Hazardous Air Pollutants (HAPs)[2] or under state rules as Toxic Air Pollutants (TAPs).[3] Area and nonpoint source emissions data developed under this project have been submitted to the EPA Emissions Factor and Inventory Group (EFIG) of the Office of Air Quality Planning and Standards (OAQPS) for incorporation into Version 3.0 of the 1999 NEI. Emissions of air toxics from all known point sources, onroad mobile sources and several of the more significant area and nonpoint sources were estimated. Point and area source emissions were estimated for base year 2000. Mobile and nonpoint source emissions were estimated for base year 1999. Details on the emissions estimation procedures used for the air toxics emission inventory are included in the following sections.

Nonpoint Sources

Residential Wood Combustion (RWC)

ORCAA emissions estimates for Residential Wood Combustion (RWC) that were reported for inclusion in Version 3.0 of the 1999 NEI have since been revised. The new estimates reported here correct errors in the original dataset which were discovered after submission, and employ the same emission factors which were used for the NEI estimates.[4] These revised emissions estimates are substantially higher than those previously reported, as detailed in the Results section below. Emissions estimates for RWC were developed using methods specified in the Emission Inventory Improvement Program (EIIP) series.[5] The EIIP preferred method is to conduct a local survey of wood burning habits for the study area and to apply the activity data to AP-42 factors for the category. The activity data for this inventory was obtained from a regional survey of wood burning habits conducted by Washington State University.[6] Resulting material use rates at the county level (in tons of wood burned by device type) were derived by the Washington State Department of Ecology and provided to ORCAA for use in the current inventory.[7]

Open Burning of Logging Debris (Slash Burning)

Emissions estimates for Open Burning of Logging Debris were developed using the EIIP preferred method.[8] Activity data for emission year 1999 was obtained from the Washington State Department of Natural Resources (DNR) in tons of slash consumed for every burn permitted by the department.[9] HAP speciation profiles for landclearing burning were used as representative of the emissions profile for slash burning, as recommended in the EIIP documents. The activity data was then summed at the county level and speciated emissions for this source category were calculated.

Point Sources

Point source emissions for sources under ORCAA's jurisdiction were based on required annual emission inventory data reports submitted by the sources. Emissions of air toxics were estimated for all sources subject to the Title V Air Operating Permit (AOP) program, including twelve major sources and eleven synthetic minor sources. Another ten intermediate level sources not subject to federal permitting requirements were included in the point source inventory. Available toxic emissions data on file with ORCAA was supplemented by new information developed during the project. New estimates of toxic air emissions were made of all significant industrial boilers under ORCAA's jurisdiction using recently revised AP-42 HAP factors.[10] The Washington State Department of Ecology Industrial Source Section has direct jurisdiction for all Chemical Pulp Production facilities located in the state.[11, 12] Two such mills located within ORCAA's six county jurisdiction were not directly inventoried by ORCAA staff. Ecology provided ORCAA with all available air toxics data for emissions year 2000 for these sources.[13] the dataset consists of speciated emissions of ten (10) HAPs from only one of the mills, totaling fifty-nine (59) tons for calendar year 2000. The other mill did not report any HAP emissions. No documentation was provided on how these emissions were calculated or derived. At the national level, Version 2.0 of the 1999 NEI includes facility-specific estimates of air toxics emissions for this sector.[3] These estimates have been carried forward from the 1996 National Toxics Inventory (NTI)[14] and were generated by the Office of Air Quality Planning and Standards (OAQPS) in developing the Pulp and Paper Maximum Achievable Control Technology (MACT) Standard.[15]

Area Sources

Emissions were estimated for the following source categories: autobody refinishing, fiberglass reinforced plastic boat manufacture and repair, furniture manufacturing and refinishing, gasoline distribution and perchloroethylene dry cleaning. Activity data was obtained from direct mail surveys and source-reported throughput data. Operators were asked to provide detailed information on the amounts and types of materials used, application methods and any controls used. The operators were requested to provide MSDS sheets and material use rates for the predominant materials used. Emissions were estimated by material balance using reported material usage and data from the MSDS sheets. Where detailed information was not provided, materials reported by other sources in the category were assumed to be typical of materials used by the non-reporting businesses.

Mobile Sources

Mobile source air toxics emissions were estimated based on activity data and modeled emissions supplied by WDOE, and emission profiles developed for national scale air quality trends reports. WDOE provided 1996 base year criteria pollutant data from a recent run of the Mobile 6.0 model for ORCAA's counties.[7] The modeled VOC data was speciated (for HAPs only) based on national scale VOC and toxic emissions fractions.[16] The speciated 1996 data was then prorated to 1999 levels based on predicted increases in emissions due to greater Vehicle Miles Traveled (VMT) and anticipated emissions reductions attributable to new regulations.[17]

RESULTS

Emission Inventory Overview

An overview of the aggregate emissions of all HAPs and TAPs for the entire inventory dataset is presented in Figures 1 and 2, and Table 1. Point and Area source emissions are for emission year 2000 Other source category emissions are for emission year 1999. Mobile source emissions equaled fifty eight percent (58%) of all emissions inventoried. Nonpoint sources combined accounted for twenty two percent (22%) of the total. Area sources accounted for only six percent (6%) of emissions, with point sources comprising the remaining fourteen percent (14%).

Figure 1. Overview of ORCAA air toxics emissions inventory data.

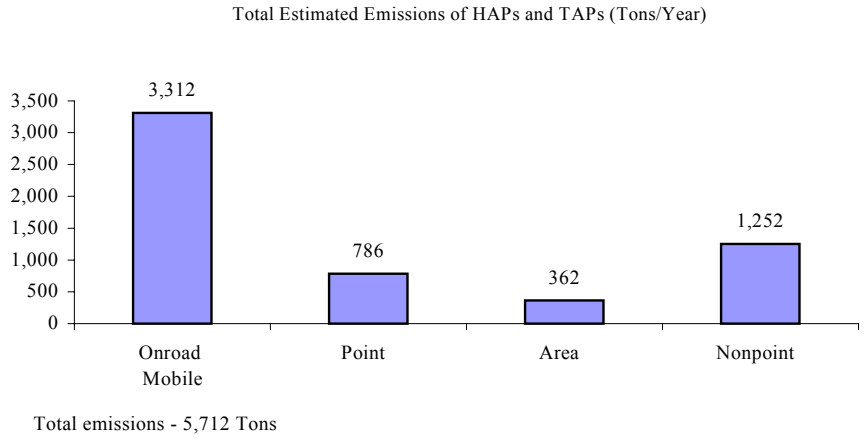
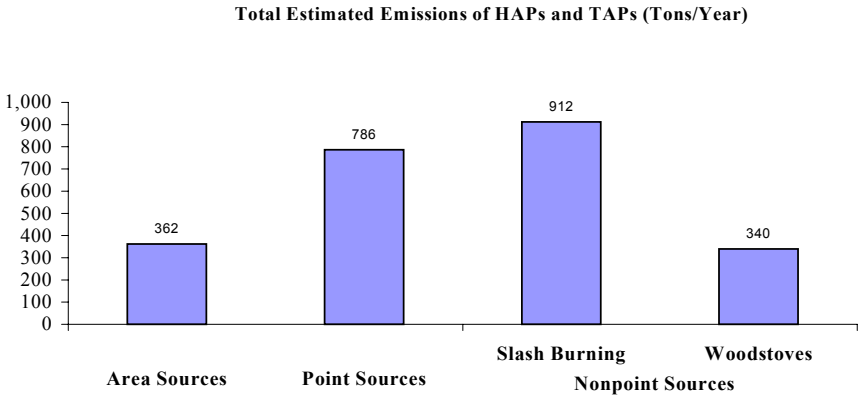


Figure 2. Area and point source totals vs. nonpoint sources.



Residential Wood Combustion

Residential woodstove emissions were nearly equal to total toxics emissions from all area source categories combined. These emissions were also found to be dramatically out of range with nationally developed estimates. Aggregated emissions estimates for Residential Wood Combustion were found to be four to five times higher than estimates for this category in the NEI. A summary of the differences between local and national estimates across the six counties appears in Table 1 below.

Table 1. RWC HAP emissions (Total of all counties, tons/yr).

Pollutant	ORCAA Total	NEI Version 2.0
Acenaphthene	0.68	0.15
Acenaphthylene	11.96	3.01
Anthracene	0.89	0.20
Benz[a]Anthracene	1.20	0.29
Benzene	181.42	44.49
Benzo[a]Pyrene	0.31	0.06
Benzo[b]Fluoranthene	0.39	0.17
Benzo[e]Pyrene	0.68	0.00
Benzo[g,h,i,]Perylene	0.46	0.07
Benzo[k]Fluoranthene	0.12	0.06
Biphenyl	0.26	0.01
Chrysene	0.81	0.18
Dibenzo[a,h]Anthracene	0.06	0.00
Fluoranthene	1.22	0.29
Fluorene	1.51	0.35
Indeno[1,2,3-c,d]Pyrene	0.26	0.02
Methyl Ethyl Ketone	25.26	6.57
Naphthalene	17.99	4.17
o-Xylene	19.31	4.66
Perylene	0.02	0.00
Phenanthrene	5.79	1.17
Pyrene	1.42	0.34
Toluene	67.96	16.74
Total (tons)	340.4	83.0

Open Burning of Logging Debris (Slash Burning)

As seen In Figure 2, total emissions of HAPs and TAPs from slash burning exceeded the total emissions from all known point sources in the region. Emissions from this source category were not specifically estimated in Version 2.0 of the NEI, but the NEI draft Version 3.0 does include an estimate of emissions for "Open Burning-Prescribed Burnings", which may include slash burning as a subset. The current ORCAA inventory did not develop local data for total prescribed burning in the region, so no comparison of these data sets was attempted for this report. Speciated air toxics emission estimates for Open Burning of Logging Debris appear in Table 2 below:

Table 2. HAP emissions from slash burning (ORCAA data, sum of all counties).

Pollutant	**Total (tons/yr)**
1,3-Butadiene	15.79
Acetaldehyde	31.38
Acrolein	29.03
Benzene	43.89
Carbonyl Sulfide	14.39
Formaldehyde	99.63
Hexane	1.26
Methyl Chloride	614.49
Polycyclic Organic Matter	0.43
Toluene	43.59
Xylenes	18.53
Total	**912.41 tons/yr**

Point Sources

Aggregated point source emissions are presented in Table 3. Notably, fiberglass product manufacturing accounts for the largest portion of point source air toxic emissions in the current inventory with a total of 302 tons of HAPs.

Table 3. Point source air toxics emissions (HAPs and TAPs) - calendar year 2000 (tons/yr)

Source Category	**Emissions (tons/yr)**
Fiberglass Products	302
Wood Products	112
Pulp and Paper Products	154*
Surface Coating (various types)	111
Total	786 tons/yr

* Source-reported chemical pulp mill emissions account for 59 tons of this amount

Actual emissions from chemical pulp production are likely to be significantly higher than the 59 tons reported for this source category. Recent estimates of pulp sector emissions by EPA indicate that total HAP emissions from a typical bleached Kraft pulp mill may be as high as 1,400 tons of HAPs per year.[13] HAP emissions of this magnitude would be greater than emissions of HAPs from all of the point sources under ORCAA's direct jurisdiction combined. Facility level estimates for the two pulp mills in ORCAA's geographic region are included in Version 2.0 of the 1999 NEI. These estimates are included alongside the source-reported data in Tables 4 and 5 on the following page to illustrate the substantial differences between local and national estimates. The Site ID numbers from the NEI emissions table are included to document the source of the data. While the total year 2000 HAP emissions reported by Mill #1 are nearly equal to the 1999 NEI estimated total HAPs for this facility, note that the two estimates consist of entirely different sets of HAPs. Also, the lack of any source-reported HAP data for Mill #2 stands in sharp contrast to the NEI estimated total volume of 667 tons of HAPs.

Table 4. Comparative HAP estimates (tons/yr) for Chemical Pulp Mill #1 (NEI Site ID # ES1626-1f0141)

Pollutant	1999 NEI Version 2.0 (1996 NTI Data)	Source-Reported Total (Year 2000 Data)
1,2,4-Trichlorobenzene	1.06	
Acetaldehyde		3.71
Acetone		5.86
Acrolein	0.09	
Benzene	0.15	
Carbon Disulfide	0.11	
Carbon Tetrachloride	11.11	
Chlorine		1.16
Chlorine dioxide		0.27
Chloroform	9.92	
Cumene	0.19	
Ethyl Benzene	0.32	
Ethylene Dichloride	1.96	
Formaldehyde		0.27
Hydrochloric Acid	10.03	
Manganese		0.17
Manganese compounds		0.10
Methanol		36.29
Methylene Chloride	17.61	
Methyl ethyl ketone		3.78
o-Cresol	0.17	
o-Xylene	0.32	
Phenol	0.21	
Propionaldehyde	0.09	
Sulfuric acid		7.70
Tetrachloroethylene	2.47	
Trichloroethylene	1.96	
Xylenes (Mixture of o, m, and p Isomers)	0.17	
Total (tons)	57.94	59.30

Table 5. Comparative HAP estimates (tons/yr) for Chemical Pulp Mill #2 (NEI Site ID # ES1626-1f0142)

Pollutant	1999 NEI Version 2.0 (1996 NTI Data)	Source-Reported Total (Year 2000 Data)
1,2,4-Trichlorobenzene	11.3	nd
Acetaldehyde	26.2	nd
Acrolein	0.9	nd
Benzene	0.1	nd
Carbon Disulfide	4.7	nd
Carbon Tetrachloride	6.7	nd
Chloroform	34.6	nd
Cumene	25.7	nd
Ethyl Benzene	15.5	nd
Ethylene Dichloride	0.6	nd
Formaldehyde	9.3	nd
Hydrochloric Acid	7.3	nd
Methanol	445.6	nd
Methyl Chloride	0.0	nd
Methyl Ethyl Ketone	14.1	nd
Methylene Chloride	0.6	nd
o-Cresol	33.6	nd
o-Xylene	7.5	nd
Phenol	9.4	nd
Propionaldehyde	6.3	nd
Tetrachloroethylene	1.3	nd
Trichloroethylene	1.3	nd
Xylenes (Mixture of o, m, and p Isomers)	4.2	nd
Total (tons)	667.0	nd

nd - no data available

DISCUSSION

1) The three source categories detailed in this report are uniquely significant contributors to emissions throughout the region. The results of the inventory indicate that emissions from these sources comprise the bulk of non-mobile source emissions in the region. The results of the inventory indicate that total emissions of air toxics from Residential Wood Combustion and Slash Burning are greater than emissions from all known point and area sources directly under ORCAA's regulatory control. Emissions from the two chemical pulp mills within ORCAA's geographic area that are regulated by the state may be greater than any source category, with the exception of mobile sources. The significance of the differences found between the emissions estimates from the ORCAA inventory and the estimates generated for the 1999 NEI in terms of assessing risks from air toxics is beyond the scope of this paper. However, the comparison of the two datasets underscores the importance of estimating, reporting and updating air toxics emissions at the local level. Without such estimates, emissions within the region may be significantly understated in national scale emission estimates that form the basis for modeling and exposure assessments, such as the National Air Toxics Assessment (NATA).

2) The magnitude of the difference between national scale emissions estimates for Residential Wood Combustion Emissions and estimates derived for this inventory is substantial. Residential wood combustion has been implicated as the prime cause for violations of the National Ambient Air Quality Standard (NAAQS) for Particulate Matter (PM_{10}) in several areas in the region. Elevated ambient particulate matter levels have also been associated with a variety of health effects. Presumably, particulate phase air toxics from RWC contribute (albeit to an unknown degree) to these health effects. While no quantitative estimate of exposure to RWC emissions can be surmised from the data reported here, the magnitude of the difference between these estimates and those in the NEI suggests that regional health impacts from this source category are likely to be greater than previously thought.

3) Air toxics emissions estimates from the Open Burning of Logging Debris were greater than estimated emissions from all known point sources in the region, yet these emissions are not specifically incorporated into the national estimates. The data developed in this inventory needs to be compared with estimates for Prescribed Burning that have been included in Version 3 draft of the 1999 NEI to ensure that these emissions have not already been accounted for.

4) Comprehensive, facility and process-specific emissions data for the Chemical Pulp plants in ORCAA's jurisdiction needs to be developed in order to adequately assess risks from air toxics from these sources. The two Chemical Pulp facilities in the region are likely among the largest point sources of HAPs in ORCAA's jurisdiction, yet detailed, timely and verifiable emissions estimates for these facilities have not been developed to date. EPA estimates generated for MACT standard development and the NEI provide information about the relative scale of the emissions from these facilities. However, these estimates are several years old and pre-date significant changes in the industry. It is unclear how closely, if at all these estimates reflect actual processes and emissions levels in use at the two facilities in ORCAA's region.

RECOMMENDATIONS

1) *ORCAA should work with other air agencies in the region to ensure that the NEI estimates adequately represent emissions for the region.* As described in this report, current national scale estimates do not include emissions from slash burning, and seriously underestimate emissions from residential wood combustion. National scale estimates of emissions from pulp and paper production far exceed emissions estimates available at the local level.

2) *Further work needs to be done to explore the significance of, and the reasons for the differences between local and national estimates of emissions from Residential Wood Combustion.* The

regional survey that supplied the RWC activity data for this inventory shows that there is still a significant amount of wood being burned for residential heating throughout the region. The significance of the differences in emissions estimates in terms of evaluating exposure to air toxics is cannot be surmised from the emissions data alone. Assessment of the health risks from RWC emissions

3) *Emissions from slash burning should be tracked more closely, and their impact on surrounding residents and communities studied further.* These emissions are much higher than expected. During the year 2000 total emissions from slash burning exceeded the total emissions for all inventoried point sources in ORCAA's jurisdiction (Figures 3 and 4). Also, slash burning emissions were not included in the 1999 NEI Version 2.0. ORCAA emissions estimates for this category were reported to EFIG for inclusion in the upcoming 1999 NEI Version 3.0 draft.

4) *ORCAA staff should coordinate with WDOE and EPA to track and evaluate emissions estimates for the two chemical pulp mills in the jurisdiction.* As discussed above, both the local and national estimates for these facilities provide an inadequate basis for source-specific air toxics risk assessments.

5) *Inventory results should be studied in relation to recent WDOE and EPA air toxics assessment activities.* Earlier this year WDOE staff produced an assessment the relative toxicity of air pollutants aimed at identifying priority pollutants of concern. Similarly, one of the products of the 1996 NATA was a list of pollutants of concern. The inventory results should be cross-referenced with these studies to identify emissions of these pollutants to assess possible areas of concern.

6) *The inventory data should be used as a baseline for future monitoring, exposure modeling, and risk assessment work.* Data of sufficient quality has been produced by this inventory to be used in local-based hazard assessment and exposure modeling study. More detail on the temporal and spatial allocation of emissions is available for all source categories.

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KEYWORDS
air toxic
area source
biomass combustion
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Olympic Air Pollution Control Authority
OAPCA
Olympic Region Clean Air Agency
pulp
Residential Wood Combustion
risk assessment
RWC
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