Gathering Open Burning Activity Information and Limitations of the EIIP Preferred Methodology

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ABSTRACT

Emissions Inventory Improvement Program (EIIP) suggests using a survey as the preferred method for gathering residential municipal solid waste (MSW) burning and yard waste burning activity information. This paper evaluates the effectiveness of using a survey to gather open burning activity information for use in developing emission inventories for MSW burning and yard waste burning, including both brush waste and leaf waste.

E.H. Pechan and Associates, Inc. (Pechan) conducted MSW and yard waste burning surveys for the Mid-Atlantic/Northeast Visibility Union (MANE-VU). Two separate surveys were performed. One survey was designed to gather information on local control programs that were in place for open burning (e.g. burn bans). As part of the control survey, a rule effectiveness (RE) survey was conducted to estimate controlled emissions. The second survey was designed to gather activity information in areas where burning is allowed.

The survey did not find statistically-significant differences in MSW activity among urban, suburban, and rural areas. In areas allowing both brush and leaf waste burning, survey respondents could not provide separate estimates for the number of households burning each of these types of yard waste. Municipal yard waste burning results showed a higher percentage of households that burn yard waste in areas that have a municipal collection program, than in other areas, so there may be factors involved that lead to a higher incidence of both residential and municipal burning for an area. As a result of this project, there will be significant changes from the National Emission Inventory (NEI) estimates.

INTRODUCTION

In "*Volume III: Chapter 16, Open Burning,"* (EPA, 1999) the Emissions Inventory Improvement Program (EIIP) suggests using a survey as the preferred method for gathering both for residential municipal solid waste (MSW) burning and yard waste burning activity information. This paper evaluates the effectiveness of using a survey to gather open burning activity information for use in developing emission inventories for MSW burning and yard waste burning, including both brush waste and leaf waste.

E.H. Pechan and Associates, Inc. (Pechan) conducted MSW and yard waste burning surveys for the Mid-Atlantic/Northeast Visibility Union (MANE-VU). Two separate surveys were performed. One survey was designed to gather information on local control programs that were in place for open burning (e.g. burn bans). As part of the control survey, a rule effectiveness (RE) survey was conducted to

estimate controlled emissions. The second survey was designed to gather activity information in areas where burning is allowed.

Together, these surveys gathered the data necessary to form the basis of an improved open burning emissions inventory for the MANE-VU states and tribes. Members of MANE-VU include: Connecticut (CT), Delaware (DE), the District of Columbia (DC), Maine (ME), Maryland (MD), Massachusetts (MA), New Hampshire (NH), New Jersey (NJ), New York (NY), Pennsylvania (PA), the Penobscot Indian Nation, Rhode Island (RI), the St. Regis Mohawk Tribe, and Vermont (VT). The complete results of this survey are available in the report titled, "*Open Burning in Residential Areas, Emissions Inventory Development Report*" (Pechan, 2003).

In developing the emissions inventory, a merging of the activity data and control survey data was performed to estimate census tract level emissions. Pechan surveyed areas with burning rules to estimate RE and areas without burning rules to estimate the activity if there were no rules in place. This activity data was applied to all areas, except in highly-urbanized areas where activity was zeroed out. For areas where rules exist, the activity was multiplied by a control efficiency of 100 percent and the separately measured rule effectiveness. Therefore, there is a significant difference in activity between census tracts in each region based on whether or not a rule is in effect.

CONDUCTING THE SURVEYS

The Work Plan developed for this project served as a guide to implementing the survey (Pechan, 2001). Prior to conducting the surveys, Pechan classified each census tract in the MANE-VU Region as urban, suburban, or rural. An example is provided as Figure 1 for the states of MA, CT, and RI. For specific details on the survey, including the survey instruments (questionnaires), please refer to the Work Plan available at the MANE-VU website (http://www.manevu.org/pdf/combustion_project.pdf).

Activity Information

For MANE-VU states that allow residential MSW or yard waste burning, Pechan surveyed a sample of municipalities within each state. The survey was administered over the phone using the contact list compiled for the report "*Test Survey and Revised Workplan for Open Burning Emissions Inventory Development*" (Pechan, 2002; http://www.manevu.org/pdf/techmemo_MARAMA_Jan31.pdf). The potential respondents in the contact list represented individuals and/or agencies believed to be responsible for and knowledgeable about residential open burning activity within their jurisdiction (e.g. local fire chiefs). The results of the test survey indicated that it was not feasible to survey land clearing debris burning and construction and demolition burning in conjunction with MSW and yard waste surveys. Test survey respondents were not able to provide information on the land clearing debris. Construction and demolition burning permits did not include necessary information to develop emission estimates. Therefore these categories were not surveyed.

Pechan telephoned a total of 494 respondents. Of the 494 contacted, 224 respondents indicated that they were knowledgeable about open burning activity and practices within their jurisdiction, and provided responses to the survey questions.

Open burning activity estimates recorded from the survey were used to estimate emissions for each surveyed jurisdiction. For non-surveyed areas, including tribal lands, project-specific default activity data derived from all survey responses were applied. In the future, if activity data for other jurisdictions or specific tribes are obtained (e.g. number of households that burn household waste), this data can be used to update the emissions inventory for that jurisdiction or tribe. Activity on tribal lands was assigned based on the underlying census tract classification of the tribal lands and associated default activity data. Information on tribal controls was also incorporated (e.g. the St. Regis Mohawk Tribe has a ban on MSW burning).

Control Database/Rule Effectiveness (RE)

To estimate controlled emissions for those areas where open burning was prohibited or restricted, Pechan developed a control database for each category to describe the annual or seasonal control by state, county, and by sub-county jurisdiction, where applicable. The starting point to develop the control database was a summary table listing statewide or area-specific regulations for states and tribes in the MANE-VU region. The summary table was prepared under the Phase I work plan (Pechan, 2001). If a survey respondent indicated a regulation had been enacted in their jurisdiction, Pechan used that information to update the control database to reflect the restrictions.

Since the control is typically a ban of some activity, a control efficiency (CE) of 100 percent was assigned whenever a rule was in place. For areas without a ban, CE as well as rule penetration (RP) was assumed to be 0 percent. For those surveyed areas with a seasonal ban, Pechan also obtained information on the dates during the year when the activity was banned. This information was used to adjust the RP by the length of the seasonal ban in the annual emissions calculations.

For MANE-VU areas that prohibit residential open burning, Pechan performed an RE survey. Pechan completed 90 RE surveys. Depending on the regulations that exist for a jurisdiction, the survey respondent answered questions for household waste and/or brush and leaf waste burning. In addition to estimating RE via EPA questionnaire methods, Pechan requested an estimate of the number of households that violated an open burning rule, so that RE could be calculated based on the number of households expected to perform open burning.

SURVEY EFFECTIVENESS

Activity Information

Survey respondents were not as reliable at providing activity data for household waste burning as they were for yard waste burning activity. Respondents whose jurisdictions included rural areas were best at providing activity information. The most important information from the survey was an estimate of either the number of households that burn household waste or the percentage of households that burn household waste in each area. Additional important data elements included burn frequency, amount per burn, and seasonal activity.

An analysis of the survey data was performed to determine whether regional differences in waste burning practices existed. For example, households in rural areas in the Mid-Atlantic region may be more or less inclined to burn waste than those in the northeast. Also, the availability of municipal trash collection service (MTCS) can affect waste burning practices. Only one of the household waste burning respondents indicated that MTCS was available. For yard waste burning, the existence of local yard waste recycling programs (e.g. composting) can affect the amount of yard waste burned. More discussion of the survey results is presented in the Conclusions section below.

<u>Yard Waste</u>

For yard waste burning, an assessment of regional activity showed significant differences between the Northeast and Mid-Atlantic regions. The Northeast region consisted of ME, NH, VT, MA, CT, and RI. The Mid-Atlantic region included NY, PA, NJ, DE, MD, and DC. Pechan did not find statistically-significant differences among urban, suburban, and rural areas.

For yard waste burning, survey respondents could generally provide information on burning prohibitions, the number or percentage of households burning, the frequency of burning, and seasonal variations in burning. A higher number of respondents (i.e. compared to residential MSW) provided an estimate of the average amount of waste per burn. For areas that allow both leaf and brush waste

burning, respondents typically could not provide separate estimates for the number of households burning each of these types of yard waste.

In addition to questions regarding the number or percentage of households burning yard waste, Pechan also requested information about municipal yard waste collection program availability and if that waste was burned. One might expect a lower percentage of households that burn yard waste in areas that have a municipal collection program. However, the survey results did not support this expectation. Municipal yard waste collection and burning appears to be an activity common to the Northeast (all of the responses, except one, occurred within the Northeast). Therefore, the activity data were applied only to suburban and rural census tracts in this region.

For estimating yard waste emissions, yard waste burning activity estimates obtained from the survey were used directly to estimate emissions for the surveyed jurisdictions. Default activity estimates derived from all surveyed areas were applied to all non-surveyed census tracts classified as either suburban or rural. From the control survey, control adjustments (i.e. CE, RP, and RE) were applied to areas with control programs.

MSW Burning

For residential MSW burning activity, an assessment of regional activity showed significant differences between the Northeast and Mid-Atlantic regions. Pechan did not find statistically-significant differences in residential MSW burning activity in areas designated as urban, suburban, or rural, although this lack of differentiation was expected. A larger sample size might have shown differences between these areas.

For residential MSW burning, survey respondents could provide information on burning prohibitions, the number or percentage of households burning, the frequency of burning, and the solid waste disposal options (curbside pickup, transfer station, etc.). However, most respondents could not provide the mass of waste burned in their jurisdiction, or an estimate of the average amount of waste per burn.

The most important information from the activity survey was an estimate of either the number of households that burn household waste or the percentage of households that burn household waste. Additional important data elements include burn frequency, amount, and seasonal activity. Survey respondents were not as reliable at providing these types of activity data for household waste burning as they were for yard waste burning activity. Many survey respondents indicated that residential MSW burning was not allowed for their jurisdiction, even in states where there were no statewide restrictions. As a result, there was a smaller sample size for developing default activity estimates for residential MSW burning compared to yard waste burning.

Control Information

For those areas identified to have a control, CE was assumed to be 100 percent (since the control is typically a ban on burning activity). With very few exceptions, the survey data revealed that household waste burning in suburban and urban areas was prohibited. For MSW burning, with the exception of Pennsylvania, Pechan assigned 100 percent CE and 100 percent RP to urban and suburban areas in the MANE-VU region (i.e., even if the state did not have a statewide ban on burning). In Pennsylvania, unless a jurisdiction or county was determined via survey to have a ban, it was assumed that suburban and rural areas allow open burning. For yard waste burning, Pechan assigned 100 percent CE and RP to all urban areas in the MANE-VU region. Yard waste emissions calculated for suburban and rural areas were assumed to be uncontrolled, unless the survey data or other statewide or local control information indicated otherwise.

There were a total of 26 RE survey responses that included information on the number of violating households. To calculate RE, Pechan used the number of households violating the rule, and the number of households expected to perform yard waste burning activity (i.e., # households x fraction of open burning households by region from survey). The RE values obtained from the survey responses were used for the specific State or jurisdiction surveyed.

To estimate a default RE value for the remaining areas, the survey data were statistically analyzed. Pechan evaluated differences in RE between rural/suburban and urban areas, as well as differences in RE for MSW and yard waste burning. Analysis of variance of the survey results from these geographic subdivisions, as well as for the different open burning categories, did not show that RE values were drawn from distinct populations. Therefore, the final selection of RE reflected a value for all areas and all burning categories.

In determining annual emissions for those areas with a seasonal ban, adjustments were made to the RP value depending on the length of the seasonal ban relative to the entire year. For example, several counties/jurisdictions have burning bans in place for both MSW burning and yard waste burning during the summer (e.g., June 1 through August 31), which is 25 percent of the year. As such, a rule penetration of 25 percent was applied to these areas to calculate annual emissions. This would hold for MSW burning, whose activity was expected to occur evenly throughout the year. For yard waste burning, however, the effect of the rule would depend on how the time period of the ban overlaps with the activity profile for brush or leaf waste burning. A ban on leaf burning in the summer was estimated to have 0 percent rule penetration since residents are not expected to burn leaves in the summer anyway. Depending on the time period of the ban, coupled with the seasonal activity profile, the RP was adjusted accordingly.

CONCLUSIONS

The sub-county (census-tract level) emission estimates developed from this project serve as the basis for a more spatially-refined inventory than previous inventories. In addition, based on survey responses, temporal allocation profiles were developed to reflect monthly, weekly, and daily activity.

Tables 1-4 provide a summary of MANE-VU particulate matter less than 2.5 microns ($PM_{2.5}$) emission estimates from this project compared to estimates from EPA's 1999 National Emissions Inventory (NEI). Regional 2002 MANE-VU $PM_{2.5}$ emissions for residential MSW burning are significantly lower than the 1999 NEI estimates. This is primarily due to using more refined methods to assign activity and emissions to portions of a county, and to account for associated controls in these areas. Regional 2002 MANE-VU $PM_{2.5}$ emissions are higher than the 1999 NEI for both brush waste and leaf waste burning. However, for some MANE-VU states (e.g., CT, ME, NJ), leaf waste burning emissions decreased from the 1999 NEI. In addition, the municipal yard waste burning category was a new SCC not accounted for in the 1999 NEI, but survey results showed this to be a common activity in the northeast. Yard waste burning estimates in the 1999 NEI are developed based on national average per capita yard waste generation and burning rates, whereas these updated MANE-VU estimates reflect region-specific activity based on surveys.

Figures 2-5 show annual $PM_{2.5}$ emission estimates for the MANE-VU region for the four open burning categories covered in this project. MSW burning emissions are higher in the Mid-Atlantic region based on higher levels of activity reported from the survey. Municipal yard waste burning seems to be relatively common in the Northeast region, while only one jurisdiction reported such activity in the Mid-Atlantic region. Therefore, the default activity for municipal yard waste burning in the Mid-Atlantic region was set to zero. Leaf and brush waste burning emissions are more uniformly spread throughout the region with higher emissions occurring mainly in suburban areas (except in states and counties where burn bans are in effect).

Yard waste burning may also be prevalent in jurisdictions having other disposal options for yard waste (e.g., composting). For non-surveyed areas, these potential programs are not accounted for in the activity estimates. In the future, default activity estimates applied to non-surveyed areas could be adjusted to account for these disposal options, for areas where this was known.

Yard waste burning may b e over-estimated for certain census tracts or counties with municipal yard waste burning programs, but the survey results showed a higher percentage of households that burn yard waste in areas that have a municipal collection program, so there may be other factors involved that lead to a higher incidence of both residential and municipal burning for an area.

Most MANE-VU states do not allow leaf burning. For areas that allow both brush and leaf waste burning, respondents could not provide separate estimates for the number of households burning each of these types of yard waste. Distribution information (percent by mass) provided in EPA's EIIP document was used to adjust the survey-derived average mass of total yard waste per burn. If leaf burning is known to be a significant activity, performing separate surveys in targeted areas for leaf waste and brush waste burning may result in more refined activity estimates for these SCCs. In addition, inventory preparers may want to consider performing MSW surveys separate from yard waste surveys, instead of combined in one single survey. This would reduce the length of the survey, and in asking a respondent questions focused on one category, better response rates for each category may be obtained.

States in the MANE-VU region continue to adopt new rules that prohibit the open burning of household waste. For example, as of September 2001, residential MSW burning was banned for all areas in the State of Maine. Although not reflected in the 2002 inventory, New Hampshire was also adopting a rule that prohibits residential MSW burning effective January 1, 2003. As these areas implement and enforce these rules, it is expected that the number of households burning their trash will decline for these states. The methods and databases developed during this project allow for easy updates to be incorporated as these changes occur.

As stated above, a larger sample may have allowed for greater geographic distinction of activity for the open burning categories addressed in this project. For example, in addition to the regional differences described above, Pechan anticipated that higher levels of municipal solid waste (household waste) burning activity would be found in rural versus suburban/urban areas. Statistical analyses (analysis of variance) did not show this to be the case. However, with a more robust data set (e.g. 2 to 3 times the size of this activity survey), these differences may have appeared.

When incorporated into EPA and state and tribal emissions inventories, the results of this project will improve the accuracy of air quality analyses. Periodic surveys to update information and track the results of new rules could be done regionally or by individual states. The regional approach provides more consistency, whereas a state or local survey could provide more detail and be used to help improve activity tracking by coordinating with local fire departments prior to the survey.

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Table 1. Annual $PM_{2.5}$ emissions for residential MSW burning by state for the MANE-VU region.

	$PM_{2.5}$ Emissions, tons per year	
State	**1999 NEI, Version 2**	**MANE-VU, 2002**
CT	1,165	3
DC	0	0
DE	528	8
MA	1,894	7
MD	1,420	424
ME	2,046	4
NH	1,731	61
NJ	1,472	36
NY	7,131	2,046
PA	10,369	3,795
RI	194	4
VT	1,182	2
Total MANE-VU	**29,133**	**6,390**

Table 2. Annual $PM_{2.5}$ emissions for brush waste burning by state for the MANE-VU region.

	$PM_{2.5}$ Emissions, tons per year	
State	**1999 NEI, Version 2**	**MANE-VU, 2002**
CT	24	432
DC	0	0
DE	6	31
ME	42	823
MD	22	972
MA	30	543
NH	36	400
NJ	24	176
NY	142	534
PA	198	681
RI	2	88
VT	24	230
Total MANE-VU	**550**	**4,913**

Table 3. Annual $PM_{2.5}$ emissions for leaf waste burning by state for the MANE-VU region.

	$PM_{2.5}$ Emissions, tons per year	
State	**1999 NEI, Version 2**	**MANE-VU, 2002**
CT	54	1
DC	0	0
DE	12	1
ME	93	18
MD	75	115
MA	68	12
NH	80	263
NJ	55	16
NY	319	338
PA	442	457
RI	5	59
VT	54	166
Total MANE-VU	**1,255**	**1,446**

Table 4. Annual $PM_{2.5}$ municipal yard waste burning emissions by state for the MANE-VU region.[1]

State	**$PM_{2.5}$ Emissions, tons per year**
CT	149
DC	0
DE	0
ME	170
MD	0
MA	228
NH	107
NJ	0
NY	0
PA	0
RI	27
VT	78
Total MANE-VU	**759**

[1]Emission estimates for this SCC are not included in the 1999 NEI, Version 2.0

Figure 1. Census tract designations for MA, CT, and RI based on the 2000 U.S. Census.

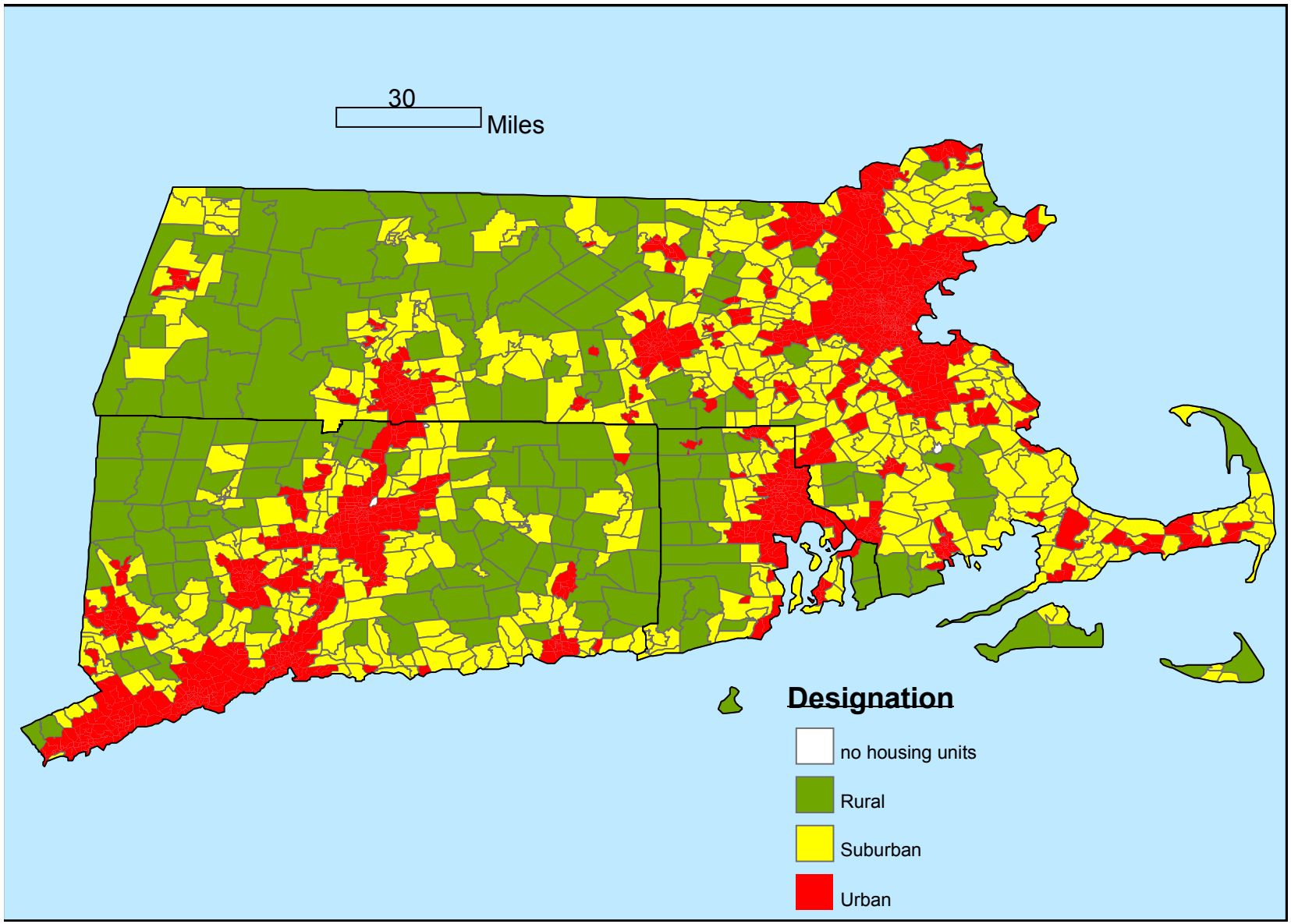


Figure 2. 2002 MANE-VU Regional $PM_{2.5}$ emission estimates for municipal solid waste burning.

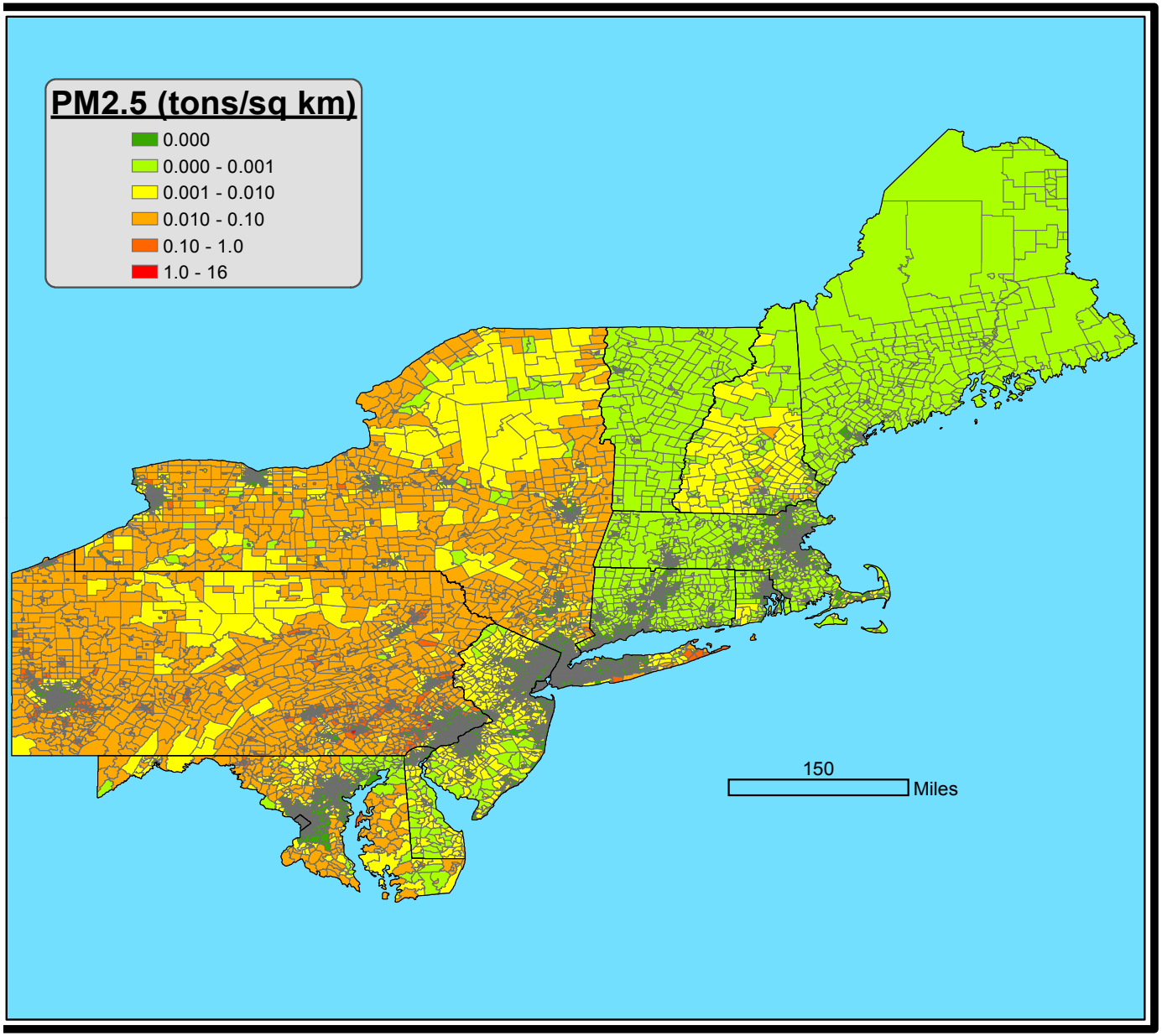


Figure 3. 2002 MANE-VU regional $PM_{2.5}$ emission estimates for leaf waste burning.

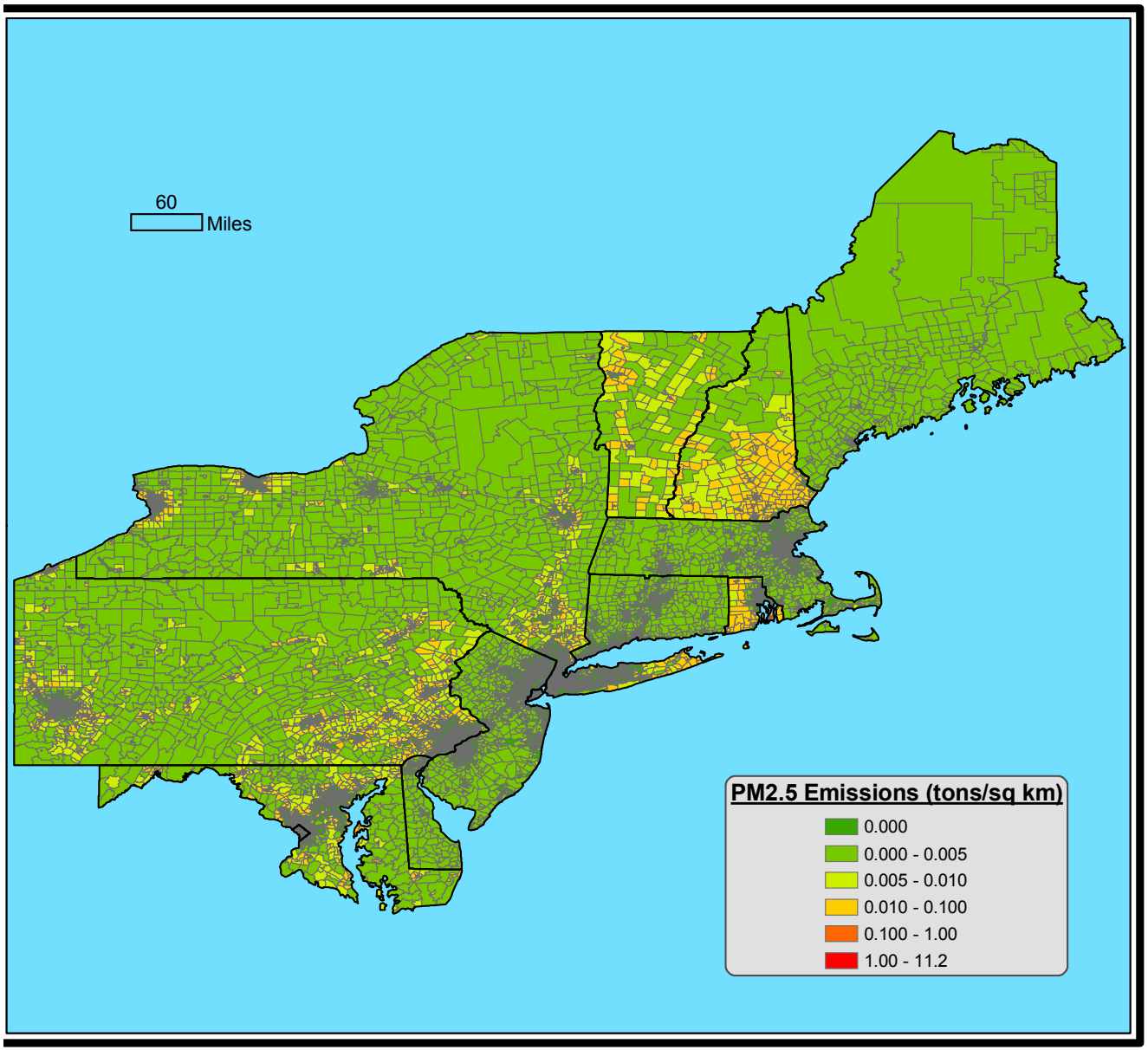


Figure 4. 2002 MANE-VU regional $PM_{2.5}$ emission estimates for brush waste burning.

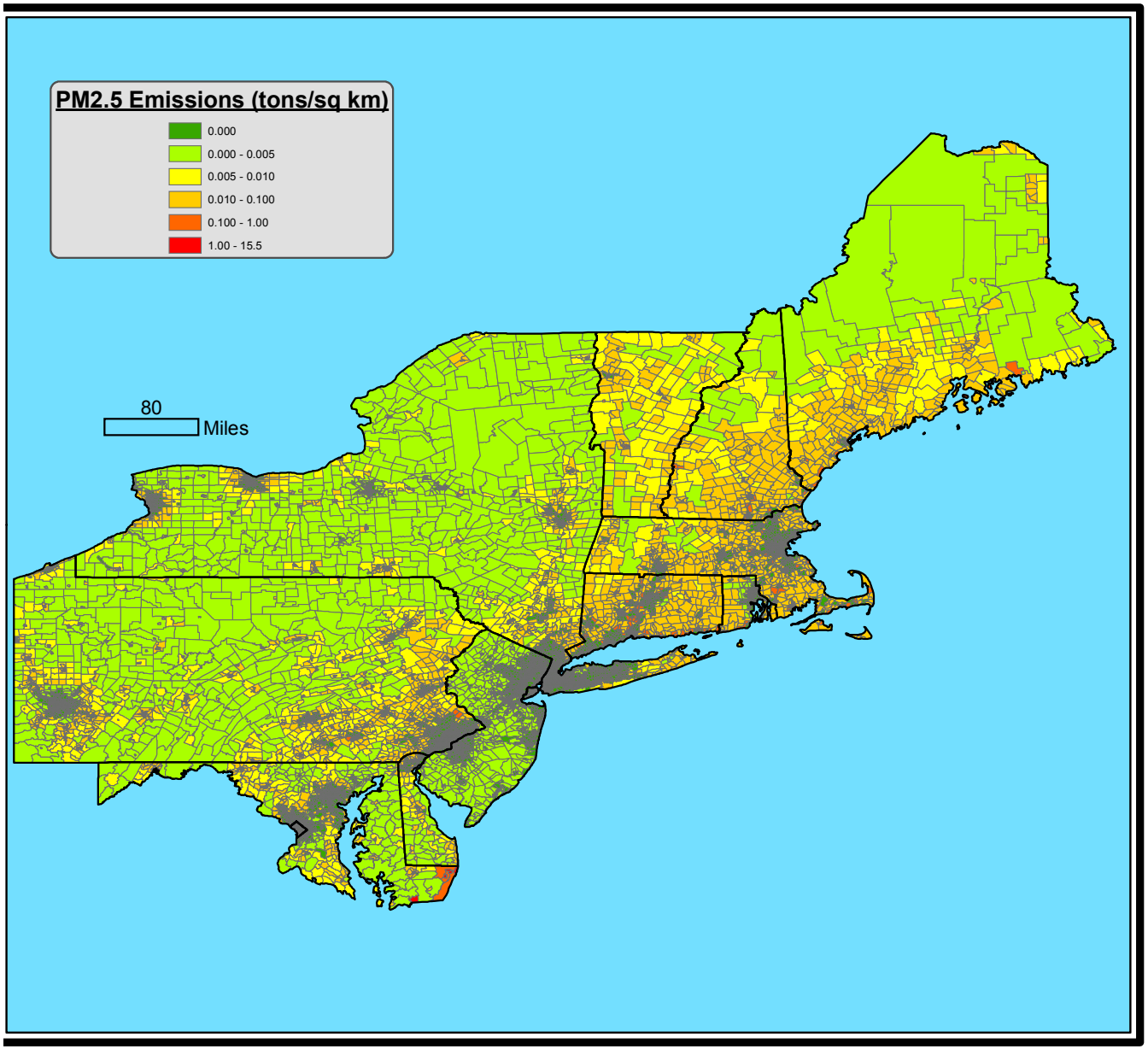
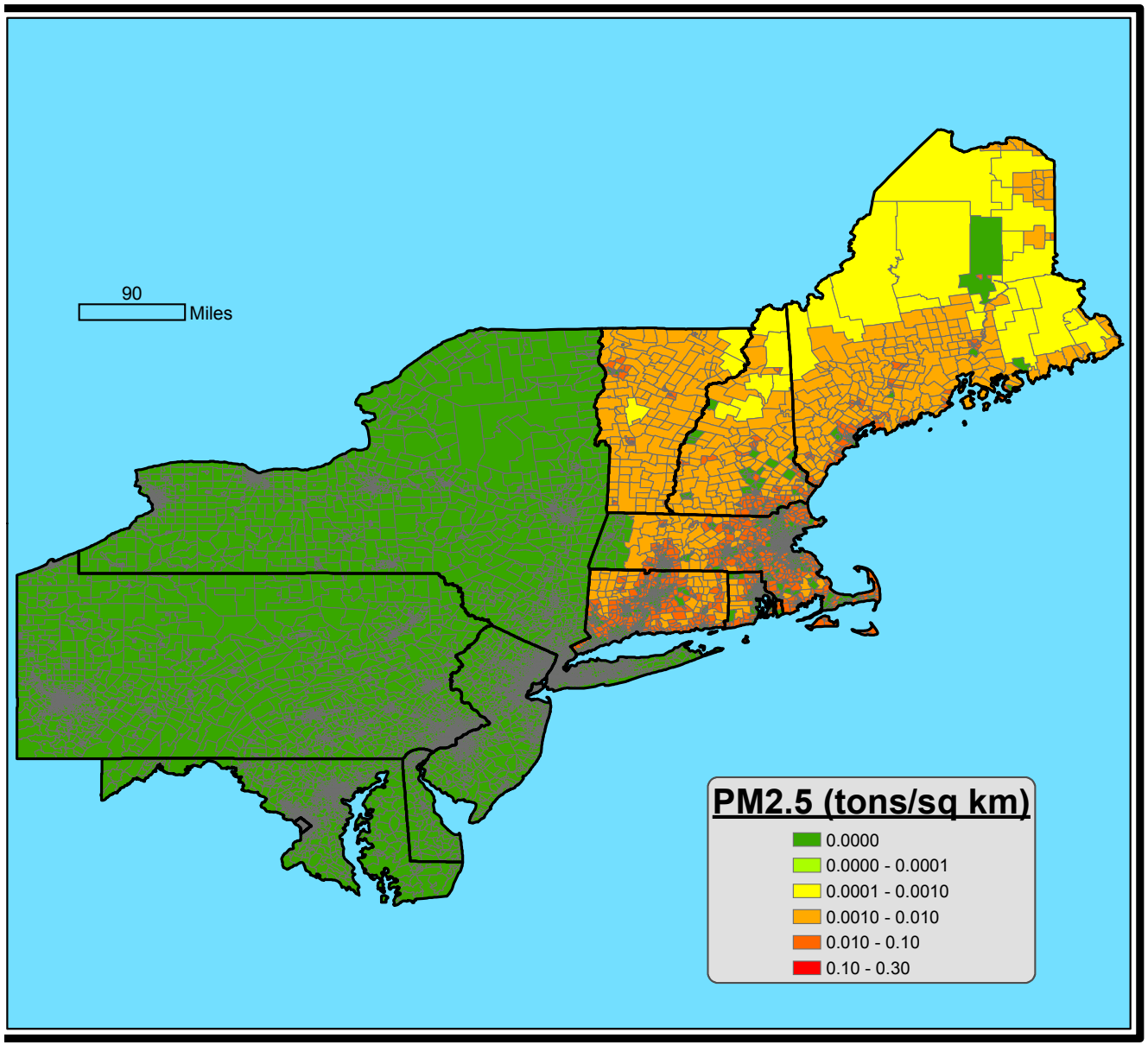


Figure 5. 2002 MANE-VU regional $PM_{2.5}$ emission estimates for municipal yard waste burning.



KEY WORDS

Emission Inventories
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