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Projection of hazardous air pollutant emissions to future years☆

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Abstract

Projecting a hazardous air pollutant (HAP) emission inventory to future years can provide valuable information for air quality management activities such as prediction of program successes and helping to assess future priorities. We have projected the 1999 National Emission Inventory for HAPs to numerous future years up to 2020 using the following tools and data:

- the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP)
- the National Mobile Inventory Model (NMIM)
- emission reduction information resulting from national standards and economic growth data.

This paper discusses these projection tools, the underlying data, limitations and the results. The results presented include total HAP emissions (sum of pollutants) and toxicity-weighted HAP emissions for cancer and respiratory noncancer effects. Weighting emissions by toxicity does not consider fate, transport, or location and behavior of receptor populations and can only be used to estimate relative risks of direct emissions. We show these projections, along with historical emission trends. The data show that stationary source programs under Section 112 of the Clean Air Act Amendments of 1990 and mobile source programs which reduce hydrocarbon and particulate matter emissions, as well as toxic emission performance standards for reformulated gasoline, have contributed to and are expected to continue to contribute to large declines in air toxics emissions, in spite of economic and population growth. We have also analyzed the particular HAPs that dominate the source sectors to better understand the historical and future year trends and the differences across sectors.

Keywords: Hazardous air pollutants; Air toxics; Emission inventory; Emission projections

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1. Introduction

There are numerous reasons to project how emission inventories will change in future years. For criteria pollutants, emissions are projected to future years routinely by EPA, States and Regional Planning Organizations to support control strategy development for ozone, fine particulate matter and visibility. Future year emissions with and without control strategies are input into an air quality model to determine the impacts on air quality. Emission projections for hazardous air pollutants (HAPs) are not routinely done, as they are for criteria pollutants, since the inventory for HAPs is relatively new, and the programs are different. The first comprehensive air quality model-ready national inventory for HAPs containing site-specific estimates, called the National Toxics Inventory, was developed for the year 1996 (Driver et al., 1999).

Emission projections for HAPs can similarly provide valuable information for air quality management activities, such as prediction of program successes and helping to assess future priorities. We can combine the effects of rules and policies on various source sectors to see how they affect future year emissions. We can also determine, by looking at emissions growth, the emissions that could have resulted in the absence of such programs. Emission projections can be used to generate interim inventories for years for which the inventory has not yet been developed. For example, the latest final HAP inventory available in the 2005 year is the 1999 NEI (U.S. EPA, 2004a). We can use projections to approximate a 2004 inventory if needed. We can apply toxicity weighting to emission projections to estimate changes in key source categories and priority HAPs. We can also use projected emissions to help determine the impacts of various emission control strategies. For example, projected emissions of particular HAPs that are on the list of Mobile Source Air Toxics (U.S. EPA, 2001) can be used to provide information on potential strategies to further reduce toxic emissions from mobile sources.

The projections presented here include all HAPs listed in Section 112 of the Clean Air Act except mercury, dioxins, chloramben, DDE and radionuclides. The emission estimates include direct emissions of HAPs from outdoor anthropogenic sources; the wildfires source category is the only biogenic source included.

This paper discusses these projection tools, the underlying data, limitations and the results. It is intended for audiences that have some working knowledge on emission inventories and their use in air toxics characterization.

2. Overall methodology

We projected emissions for nearly all HAPs from 1999 to numerous future years up until 2020. To project emissions to these future years, we considered the effect of growth in activity, which, depending upon the source category could be positive or negative, and regulatory programs which serve to further reduce 1999 emissions. Emissions growth was primarily determined from information on projections of sector specific economic activity, population growth, fuel consumption, vehicle miles traveled and nonroad equipment populations. For stationary sources, HAP reductions were determined primarily from the regulatory programs under Section 112 such as the Maximum Achievable Control Technology (MACT) standards and Section 129 of the Clean Air Act which includes over a hundred National Emission Standards for Hazardous Air Pollutants and a number of solid waste rules. For mobile sources, HAP emissions reductions included the impact of numerous control programs addressing fuels and vehicles for highway vehicles, and nonroad sources.

The inventory was toxicity-weighted to allow for analysis of the relative potential cancer risk and noncancer respiratory hazard posed by source sectors and future year trends. The pollutant emissions were weighted as follows: (1) for noncancer respiratory effects, the emissions for each chemical affecting the respiratory system were divided by its reference concentration or similar chronic no-effect exposure level; (2) for cancer, the emissions for each chemical were multiplied by its unit risk estimate for cancer by inhalation exposure. This approach is simple to apply, and accounts for differences in toxicity among pollutants. The approach has the limitations of not considering fate, transport, or location and behavior of receptor populations, and it is capable only of estimating relative risks. Nevertheless, the toxicity-weighting technique is a partial risk analysis tool that has proven valuable for screening-level analyses.

3. Methodology for stationary sources

For nearly all stationary sources (point and non-point source inventories), we used the Emissions Modeling System for Hazardous Air Pollutants (EMS-HAP), Version 3.0 (U.S. EPA, 2004b) to apply growth and control factors to the 1999 NEI, record by record. EMS-HAP was not used to project emissions from Medical Waste Incinerators (MWI). For this category, future year emissions are assumed to remain constant at 2002 levels, so rather than use EMS-HAP, we used 2002