Atmospheric Environment 138 (2016) 15–21

Contents lists available at ScienceDirect

Atmospheric Environment

journal homepage: www.elsevier.com/locate/atmosenv

A refined method for the calculation of the Non-Methane Volatile Organic Compound emission estimate from Domestic Solvent Usage in Ireland from 1992 to 2014 – A case study for Ireland

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HIGHLIGHTS

- Activity data was found for NMVOC emissions from Domestic Solvent Use from 1992 to 2014.
- A survey of products in Ireland was used to obtain country specific emission factors.
- Organic compounds found in the survey were analysed to assess sectorial volatility.
- This study provided a new estimate of NMVOC emissions from Domestic and Solvent Use.
- The results show a reduced emission estimate than previously reported by Ireland.

ARTICLE INFO

Article history:
Received 12 August 2015
Received in revised form
12 April 2016
Accepted 13 April 2016
Available online 3 May 2016

Keywords:
Emission inventories
NMVOC
Solvent and Other Product Use
Domestic Solvent Use
Transboundary air pollutants

ABSTRACT

This study describes a new methodology to calculate Non-Methane Volatile Organic Compounds from Domestic Solvent Use including Fungicides over the period 1992–2014. Improved emissions data compiled at a much more refined level can help policy-makers develop more effective policy's to address environmental issues. However, a number of problems were found when member states attempt to use national statistics for Domestic Solvent Use including Fungicides. For instance, EMEP/EEA (2013) provides no guidance regarding which activity data should be used, resulting in emission estimates being potentially inconsistent and un-comparable. Also, previous methods and emission factors described in the EMEP/EEA (2013) guidebook do not exactly match data collected by state agencies. This makes using national statistics difficult. In addition, EMEP/EEA (2013) use broader categories than necessary (e.g. Cosmetics Aerosol/Non Aerosol) to estimate emissions while activity data is available at a more refined level scale (e.g. Personal Cleaning Products, Hair Products, Cosmetics, Deodorants and Perfumes). This can make identifying the drivers of emissions unclear. This study builds upon Tzanidakis et al. (2012) whereby it provides a method for collecting activity data from state statistics, developed country specific emission factors based on a survey of 177 Irish products and importantly, used a new method to account for the volatility of organic compounds found in commonly available domestic solvent containing products. This is the first study to account for volatility based on the characteristics of organic compounds and therefore is considered a more accurate method of accounting for emissions from this emission source. The results of this study can also be used to provide a simple method for other member parties to account for the volatility of organic compounds using sectorial adjustment factors described here. For comparison purposes, emission estimates were calculated using the Tier 1 approach currently used in the emission inventory, using activity data and emission factors unadjusted for volatility and adjusted for volatility. The unadjusted estimate is useful, because it demonstrates the failure to properly account for volatility can produce significantly over-estimated emissions from the Domestic Solvent Usage sector. Unadjusted emissions were found to be 30% lower than the EMEP/EEA (2013) Tier 1 period in 2014. Emissions were found to reduce a further 20.9% when the volatility of the organic compounds was included. This new method shows that member parties may be significantly overestimating

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http://dx.doi.org/10.1016/j.atmosenv.2016.04.017

emissions from Domestic Solvent Use including pesticides and further work should include refining organic compound content and the sectorial adjustment factor of products.

1. Introduction

NMVOC Emissions from solvent and other product use sector have only decreased marginally despite the introduction of several legislative instruments in the European Union designed to limit and reduce both VOC emissions to the atmosphere (Solvents Directive) and the content of VOC containing products (Decorative Paints directive). Reported emissions available on the Centre for Emission Inventories and Projections (www.ceip.at) show that emissions from Transport sector within EU25 countries have decreased 79% from 1990 to 2012 while emissions from the Other Solvent and Product Use sector decreased 34%. In the case of Irish emissions, despite the impact of an economic downturn, emissions of NMVOCs decreased at a moderate rate and actually increased in Ireland from 2012 to 2013 (Duffy et al., 2015) and are likely to increase in 2014 based on preliminary figures. This emission trend is largely driven by Domestic Solvent Use including Fungicides which accounted for 52% of NMVOC emissions in 2013 based on current methodologies (Duffy et al., 2015).

Under EMEP/EEA (2013) guidebook methodologies, member parties are encouraged to conduct key category analyses to help identify the most significant emission sources and therefore inform on the choice of methodology used. Usually, Tier 2 or Tier 3 methods are recommended for key categories. However, in some instances, the Tier 2 method described in the EMEP/EEA (2013) guidebook is not easily implements. For instance, NMVOC emissions from the Domestic Solvent Use including Fungicides sector are a key category emission source in Ireland (Duffy et al., 2015). However, this emission source is currently estimated using a Tier 1 method. In the case of Domestic Solvent Usage, this requires the use of activity data and the use of default emission factors. However, methods described in the EMEP/EEA (2013) guidebook and data collected by national statistic agencies do not exactly match. Also, sufficient data is collected by national statistics agency to develop more disaggregated emission estimates. For instance, activity data was available for products contained within Cosmetics and toiletries in the form of import and export statistics (e.g. Shampoo and Lip make-up preparations). Emissions data at this disaggregation ensure a more accurate emissions estimate and allows a much more targeted approach to developing strategies to reduce emissions. Also, countries using Tier 2 methods have no described method to obtain activity data. In a sector with such a large amount of source categories (31 categories), this can lead to inconsistent and incomparable emission estimates. Lastly, industry members (Pearson and Brossier, 2014) question the definitions used to define VOCs in legislation in terms of the chemical and physical properties of organic compounds and whether they are correctly classified as volatile.

This study aims to develop a more accurate and representative emission estimate for the Domestic Solvent use including Fungicides sector. Objectives to achieve this include (1) investigate if NMVOC emissions from Domestic Solvent Use including Fungicides are overestimated (2) develop a methodology to obtain activity data from Domestic Solvent Use including Fungicides using national statistics, at a finer resolution than provided by EMEP/EEA (2013) guidebook, (3) Survey products on the Irish market and generate country specific emission factors, (4) more accurately account for volatility of organic compounds found in Irish products.

Many studies have focused on improving the methodologies used to estimate NMVOC emissions for Solvent usage (Holmengen and Kittilsen, 2009; SMED, 2006; Theloke and Friedrich, 2007; Passant, 2002). However, some studies have suggested that emission inventories of solvent usage do not match observational data. For instance, Niedojadlo et al. (2007) conducted a study to assess if the two main NMVOC emission sources (transport and Solvent Usage) were accurately inventoried. The study found that observations disagreed with the NMVOC emission inventories and stated that emissions from transport were underestimated and emissions from solvent usage were overestimated. The reasons for differences between observations and inventories are not clear. However several assumptions are used in compiling emission inventories for NMVOC emissions from Solvent Use. Of particular note is Domestic Solvent use including Fungicides (2.3.D.a) which member parties often estimate using per capita emission factors (Tier 1 method). Few studies (Tzanidakis et al., 2012; Atlantic Consulting, 1995; European Commission, 2002) have examined the methods used to calculate emissions from this sector. As the 2nd largest emission source among Other Solvent and Product Use emission sources reported among EU25 countries (CEIP, 2015) and the largest emission source in the Irish NMVOC Other Solvent and Product Use emission inventory from 1990 to 2013, a high degree of accuracy is required. As a key category emission source, a Tier 2 or equivalent approach is recommended by EMEP/EEA (2013) guidebook. However, several problems are encountered for inventory compilers when developing a method that meets the Tier 2 requirements. While data collected by national state statistics agencies (import/export data) can be used to calculate emissions from this sector, the EMEP/EEA (2013) guidebook describes methods/emission factors that do not exactly match the format of data collected by state agencies. Table 1 shows the categories which the EMEP/EEA (2013) provides emission factors.

Table 2 shows the categories which are collected by national statistic agencies in the Eurozone area. These statistics are available directly from state agencies or at ec.europa.eu/Eurostat. While activity data can be aggregated to match the categories described in the EMEP/EEA (2013), this may distort emission estimates by ascribing broad unrealistic emission factors to sub sectors (e.g. Personal Cleaning Products).

Another problem encountered when compiling emission inventories from domestic solvent use relates to the chemical and physical properties of the organic compounds used in these products. Several definitions of NMVOCs have being developed under EU and international legislation and this has lead to several differing chemical properties and conditions being used to describe NMVOC's:

- *Under CLRTAP, Non-methane volatile organic compounds (NMVOCs) are defined as any organic compound, excluding methane, having a vapour pressure of 0.01 kPa or more at 293.15 K, or having a corresponding volatility under the particular conditions of use. For the purpose of these Guidelines, the fraction of creosote which exceeds this value of vapour pressure at 293.15 K should be considered as an NMVOCs* (UNECE, 2008)