Emerging Contaminants 2 (2016) 14–25

Contents lists available at ScienceDirect

Emerging Contaminants

journal homepage: http://www.keaipublishing.com/en/journals/emerging-contaminants/

Research article

Inventory of primary emissions of selected persistent organic pollutants to the atmosphere in the area of Great Mendoza

David Allende*, María Florencia Ruggeri, Belén Lana, Karina Garro, Jorgelina Altamirano, Enrique Puliafito

Universidad Tecnológica Nacional, Facultad Regional Mendoza, Atmospheric and Environmental Studies Group, Rodriguez 273, Argentina

ARTICLE INFO

Article history:
Received 8 September 2015
Received in revised form
3 December 2015
Accepted 9 December 2015
Available online 5 January 2016

Keywords:
Atmospheric emission inventory
POPs
Emission factor
Great Mendoza
Open burning of municipal solid waste

ABSTRACT

The setting up of a country or region-based inventory is considered a crucial step toward the elimination of worldwide persistent organic pollutants (POPs) contamination. Moreover, the need of comparable emission inventories at city or region level is widely recognized to develop evidence-based policies accounting for the relation between emissions and institutional, socio-economic and demographic characteristics at small scale level.

Due to the low spatial and temporal resolution of the available measurements, highly variable air concentrations of several POPs have been observed in Latin American and Caribbean countries. This paper presents a high resolution spatially disaggregated atmospheric emission inventory for selected POPs in order to assess the environmental fate of some of these compounds in a finer resolution. As study case we estimated releases to air of POPs in a typical mid-size urban conglomeration in Argentina. Inventoried compounds were total polychlorinated biphenyls (PCBs), total polybrominated diphenyl ethers (PBDEs), total dichlorodiphenyltrichloroethane (DDT) on a sum basis, hexachlorobenzene (HCB) and dioxins and furans (PCDD/Fs), for which emissions were estimated in 0.92 kg/year, 1.65 kg/year, 4.2E−02 kg/year (total sum of congeners), 0.86 kg/year and 4.4E−02 kg/year respectively, values that are in accordance with the geographic and economic context. Although emitting sources are quite varied, there are very clear trends, particularly in relation to open burning of municipal solid waste and agrochemical use as major contributors. Overall, the inventory provides valuable data for the analysis of the heterogeneity of POP emissions and the necessary inputs for air quality modeling.

1. Introduction

Persistent organic pollutants (POPs) are chemicals that are recognized for their high stability, their susceptibility to high long-range atmospheric transport, their potential to bioaccumulate in the food chain, and their inherent toxicity to wildlife and human beings [46]. The setup of a country or region-based POP inventory is considered a crucial step toward the elimination of worldwide POPs contamination. Moreover, identification of the emission sources of POPs in the environment is essential to establish the quantitative factor in source–receptor relationships, and to reduce environmental burdens profitably [5]. Furthermore, reducing primary emissions would also lead to the reduction of secondary loadings of POPs, since these are supported by primary atmospheric emissions and would bring the benefit of reduction in local, regional, and global concentrations.

In this respect, the Toolkit for Identification and Quantification of Releases of Dioxins, Furans and Other Unintentional POPs has been used by some countries in Latin America to develop national release inventories as required by Article 5 (Measurements) and Article 15 (Reporting) of the Stockholm Convention [17], including an early PCDD/PCDF inventory compiled for releases in Argentina [32]. Although these official emission data present a general picture of emissions of individual POP substances in quantitative terms, no spatial distribution (i.e.: on a grid system) is reported.

While international effort has been put into developing harmonized inventories at global or regional scale [8,9,13,20,25], substantial differences have been observed by comparing different

* Corresponding author.
E-mail address: david.allende@frm.utn.edu.ar (D. Allende).
Peer review under responsibility of KeAi Communications Co., Ltd.

Production and Hosting by Elsevier on behalf of KeAi

http://dx.doi.org/10.1016/j.emcon.2015.12.001

inventory estimates with measurements at city or local levels in Latin America and Caribbean countries [4,7,21,41,42,50]. Moreover, model simulations applied to this region appear to perform poorly for specific rural or urban sites, since they rely on emission inventories that fail to properly represent the accurate spatial distribution of the sources [6,41].

In that sense, there is an evident need for highly reliable spatial disaggregated maps that improve the information on POPs emission at local scale and provide proper input data for environmental models; both essential to establish more accurate exposure assessments and to improve possible control measures.

The present study is a methodological approach applied to the development of a spatially-distributed, high-resolution emissions inventory for selected POPs based on anthropogenic sources. As a case study, we used local information to generate a comprehensive inventory in order to understand the extent of POPs emissions to air from major sources in a typical mid-size urban conglomeration in Argentina. Since there is an increasing concern in Latin America about sustainable development strategies, an immediate priority is to reduce atmospheric emissions mainly related to thermal processes, agriculture and urban activities. Hence, dibenzo-p-dioxins/furans (PCDD/Fs), total polychlorinated biphenyls (PCBs), total polybrominated diphenyl ethers (PBDEs), total dichlorodiphenyltrichloroethane (DDT) on a sum basis, and hexachlorobenzene (HCB) were inventoried to provide support to environmental fate assessment, highlighting the main differences between the inventories performed in other regions and the local particularities of the sources. The spatial allocation of emissions was made using source-based spatial surrogates from available basic data to avoid problems arising from different level of disaggregation, both in quantity and quality. Moreover, we quantified and assessed the magnitude and spatial extent of these primary POPs releases to the atmosphere by using a methodological procedure that can be applied to any region allowing the compilation of a consistent regional inventory.

2. Materials and methods

2.1. Study area

Great Mendoza is the most important urban area in the region of Cuyo and the fourth in population of Argentina (1.7 million inhabitants in 2010). The conurbation is located in the west-central part of the country, in a region of foothills and high plains, on the eastern side of the Andes, between 32° and 37° 35′S, and 66° 30′ and 70° 35′W.

The constructed area of about 16,700 km^2 extends in an irregular manner to the northeast, east and south, since the Andes Range prevents the city from growing to the west.

The surrounding area is a productive river oasis and one important wine region, accounting for nearly two-thirds of the country's entire wine production. Other important crops (mainly for the Argentine market) are apples, pears, tomatoes, onions, plums, olives, cherries, peaches and quince.

Great Mendoza is located in a semiarid region, with low relative humidity (<50%), and very low precipitation rates (230 mm yr^{-1}), with rain mainly occurring during Austral summer months. The closeness of the Andes Mountains has a strong influence on local meteorology and air quality, characterized by a day–night variation due to a typical valley-mountain circulation [40].

For the inventory purpose, the study area was divided into 8100 grid cells with 1 × 1 km^2 spatial resolution, covering the 11 different departments (Fig. 1).

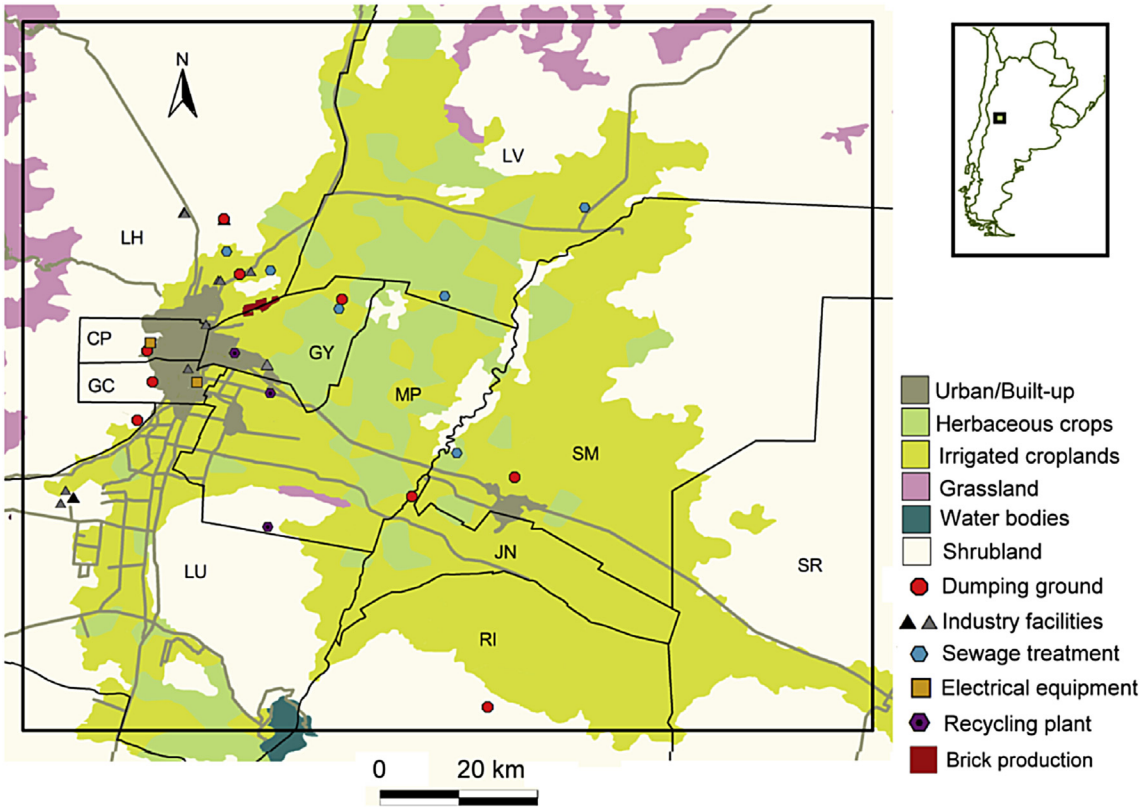

Fig. 1. Great Mendoza land use features and location of main POPs sources. Black solid lines represent interdepartmental boundaries: Capital (CP), Godoy Cruz (GC), Guaymallén (GY), Maipú (MP), Junín (JN), San Martín (SM), Rivadavia (RI), part of Luján de Cuyo (LU), Lavalle (LV), Las Heras (LH) and Santa Rosa (SR).