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Health risks for the population living in the vicinity of an Integrated Waste Management Facility: Screening environmental pollutants

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HIGHLIGHTS

- Health risks of an Integrated Waste Management Facility in Catalonia are assessed.
- PCDD/F exposure near this facility is up to 10-times higher than that near others.
- Environmental monitoring of incineration plants should be performed case-by-case.
- Since results are very preliminary, confirmatory studies should be conducted.

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ABSTRACT

We performed a screening investigation to assess the human health risks of the Integrated Waste Management Facility (IWMF: mechanical–biological treatment (MBT) plant plus municipal solid waste incinerator (MSWI); Ecoparc-3) of Barcelona (Spain). Air concentrations of pollutants potentially released by the MBT plant (VOCs and bioaerosols) and the MSWI (trace elements, PCDD/Fs and PCBs) were determined. Trace elements, PCDD/Fs and PCBs were also analyzed in soil samples. The concentrations of trace elements and bioaerosols were similar to those previously reported in other areas of similar characteristics, while formaldehyde was the predominant VOC. Interestingly, PCDD/F concentrations in soil and air were the highest ever reported near a MSWI in Catalonia, being maximum concentrations 10.8 ng WHO-TEQ/kg and 41.3 fg WHO-TEQ/m^3, respectively. In addition, there has not been any reduction in soils, even after the closure of a power plant located adjacently. Human health risks of PCDD/F exposure in the closest urban nucleus located downwind the MSWI are up to 10-times higher than those nearby other MSWIs in Catalonia. Although results must be considered as very preliminary, they are a serious warning for local authorities. We strongly recommend to conduct additional studies to confirm these findings and, if necessary, to implement measures to urgently mitigate the impact of the MSWI on the surrounding environment. We must also state the tremendous importance of an individual evaluation of MSWIs, rather than generalizing their environmental and health risks.

1. Introduction

In 2012, the annual amount of municipal solid waste (MSW) per capita generated in the EU-27 was 492 kg, following a slight decreasing trend (Eurostat, 2012). The disposal of such quantity of waste has become one of the most crucial environmental problems. A few years ago, landfills were predominantly used for MSW management, mainly because of the notably reduced operation costs. However, while materials and energy are not valorized in this practice, it is also associated with potential health risks (Rovira et al., 2012). Therefore, alternative methods have been being implemented. The European waste hierarchy developed in the EU Waste Framework Directive (2008/98/EC) reports a priority order of what constitutes the best overall environmental option in waste legislation and policy: prevention, preparing for re-use, recycling, recovery, and disposal (Mari et al., 2009).

Waste incineration, also known as waste-to-energy, has become a serious option in developed and emerging countries (Cheng and Hu, 2010; Reddy, 2014). It presents numerous advantages such as energy recovery and volume minimization (Antonopoulos et al., 2014; Ferré-Huguet et al., 2006; Nadal et al., 2013; Pirotta et al., 2013; Schuhmacher et al., 1997). In addition, their contribution as releasers of a wide variety of chemical pollutants, including polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) and heavy metals has notably decreased after the implementation of new legislative and technical regulation measures (Mari et al., 2010). However, public

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controversy is also present around municipal solid waste incinerators (MSWIs), which are commonly affected by the "Not In My Back Yard" (NIMBY) syndrome. Because of social and legislative pressures, complementary methods for managing the MSW have been introduced, being mechanical–biological treatment (MBT) one of the most extended (Garg, 2014). In Catalonia (Spain), MBT plants are called Ecoparcs. At the moment, there are 4 Ecoparcs within the metropolitan area of Barcelona (Catalonia, Spain), as well as other MBT plants outside (Mataró, Lloret de Mar, and Botarell). In 2006, Ecoparc-3 started to operate regularly. This MBT plant, located in Sant Adrià de Besòs, was built next to a MSWI operating since 1975. Overall, the MSWI and the MBT plant constitute the Integrated Waste Management Facility (IWMF) of Sant Adrià de Besòs, whose capacity is 192,000 tons/year for mechanical–biological treatment, and 350,000 tons/year for energy recovery. In the period 1998–2001, we performed a monitoring study aimed at determining the environmental impact of the MSWI after the assembly of a new gas cleaning system. We analyzed the levels of PCDD/Fs in samples of soil and vegetation collected nearby (Domingo et al., 2000, 2002a,b; Schuhmacher et al., 2000). In 2005, the facility was adapted to the environmental requirements of the European Directive 2000/76/EC, and the occurrence of PCDD/Fs, polychlorinated biphenyls (PCBs) and other persistent organic pollutants (POPs) in air around the facility was also determined by means of active and passive air sampling devices (Mari et al., 2008a,b). However, environmental data regarding the same chemicals, as well as other potentially generated by the MBT plants, both chemical and microbiological, are currently inexistent, even though Ecoparc-3 started to operate in 2006.

The purpose of the present preliminary study was to screen the concentrations of PCDD/Fs, dioxin-like PCBs (dl-PCBs), non-dioxin-like PCBs (ndl-PCBs), and elements in samples of air and soil collected in the vicinity of the IWMF of Sant Adrià de Besòs. Airborne levels of volatile organic compounds (VOCs) and bioaerosols (total bacteria and fungi) were also determined. Analytical data were used to assess human exposure to each one of the chemical pollutants, as well as to characterize the associated health risks for the adult population living in the neighborhood.

2. Materials and methods

2.1. Sampling

In May and June of 2014, samples of ambient air were collected in the vicinity of the IWMF of Sant Adrià de Besòs (Barcelona, Catalonia, Spain). The concentrations of a number of environmental pollutants potentially released by the MSWI and the MBT plant were determined. Two parallel samplings were conducted, depending on the analyzed contaminants. Four sampling points around the MSWI were selected to measure the levels of PCDD/Fs, PCBs and elements (Fig. 1). Because data were also used for health risk assessment, air sampling equipment was deployed in schools and sport centers, therefore highlighting children exposure to chemical pollutants. Prior to sampling, the AERMOD dispersion modeling software was executed to determine the main direction and spatial range of the air pollutants emitted by both facilities. Predominant wind directions were especially taken into account. Since

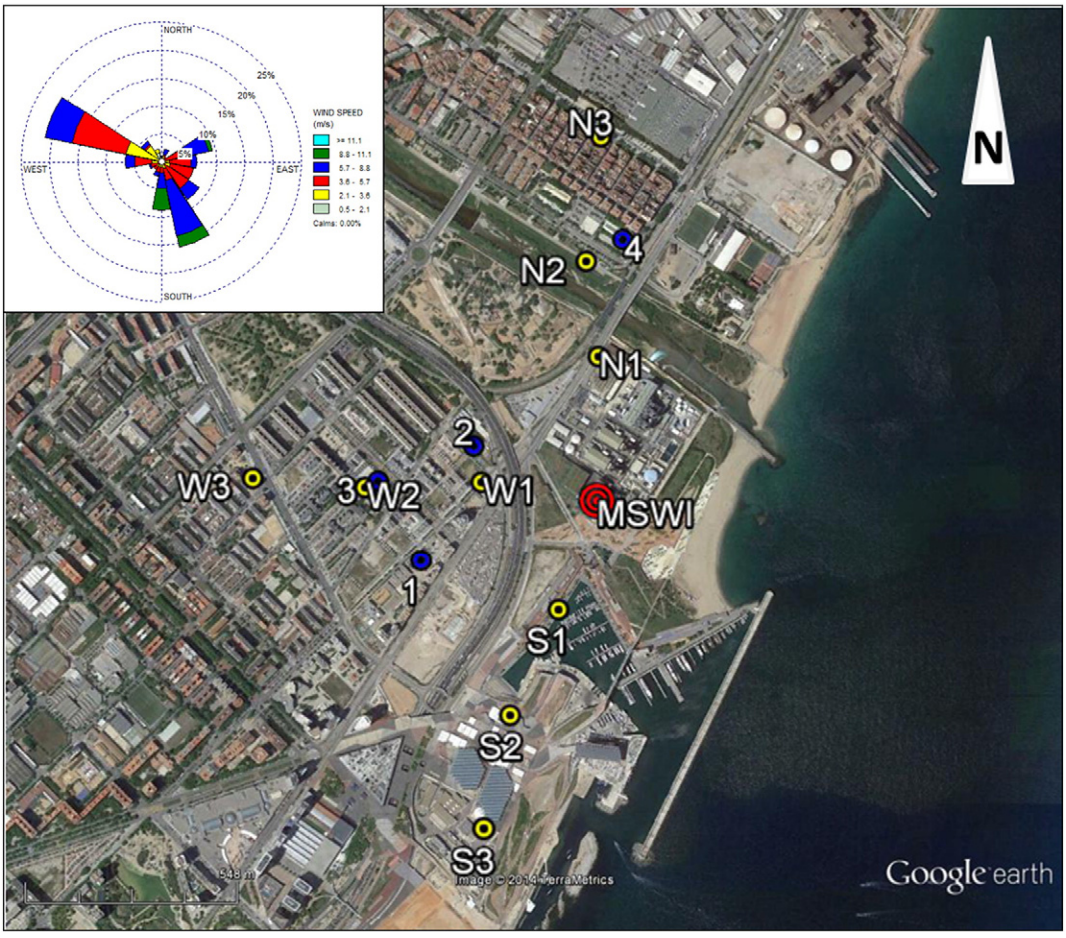

Fig. 1. Area of study and wind rose. Sampling points of PCDD/Fs, PCBs and metals (1, 2, 3, and 4) are marked in blue, while those of VOCs (N1, N2, S1, S2, W1, and W2) and bioaerosols (N1, N2, N3, S1, S2, S3, W1, W2, and W3) are marked in yellow. In red, MSWI.