Journal of Environmental Management 92 (2011) 724–732

Contents lists available at ScienceDirect

Journal of Environmental Management

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

Spatial and temporal distribution of polychlorinated biphenyl (PCB) concentrations in soils of an industrialized city in Turkey

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A R T I C L E   I N F O

Article history:
Received 31 May 2010
Received in revised form
10 September 2010
Accepted 6 October 2010
Available online 29 October 2010

Keywords:
Homologue groups
Total organic carbon
Indicator congeners
Dioxin-like congeners
Air-soil flux
Principal-component analysis

A B S T R A C T

Surface soil (0–5 cm) samples from 43 sampling sites covering the entire urban territory of Bursa, an industrialized city in Turkey, were collected in each season and analyzed for 83 polychlorinated biphenyls (PCBs). The mean concentration of total PCBs (Σ83 PCBs) among all sites over the four seasons was 2121.51 pg/g dry weight (dw), with a range of 207.61–5461.95 pg/g dw. Total PCB concentrations in the soil samples collected near an industrial region were the highest in all seasons.

In general, PCB patterns were dominated by low-chlorinated homologue groups (≤5 Cl groups at a 79% level). The predominant homologue group found in Bursa city soils was the penta-CBs (29.1%) followed by the tetra-CBs (25.5%) and tri-CBs (17.6%). A total of seven dioxin-like PCB congeners (CB-77, 81, 105, 114, 118, 123, and 126) were found in every sampling location and their mean total concentration for all locations and seasons was 259.27 pg/g dw, with a range of 7.02–1581.13 pg/g dw. A significant relationship ($r = 0.77$, $p < 0.01$) was found between the concentrations of dioxin-like PCBs and the seasonal average sum of PCB concentrations. A correlation between light congeners (<penta-CB) and total organic carbon (TOC) was not observed, whereas a significant correlation ($r = 0.36$, $p < 0.05$) for heavy congeners (≥penta-CB) and TOC was found.

The pollution potential was assessed based on the values found in soils in different regions in relation to current guideline values. Overall, it was found that PCB levels in the urban soils of Bursa were much lower than both the target values and the values found in most European soils and other regions.

1. Introduction

Polychlorinated biphenyls (PCBs) are among the most persistent and toxic of the group of chemicals classified as persistent organic pollutants (POPs). The manufacture, use, and importation of PCBs have been phased out since 1970s because of their teratogenic, immunogenic, or carcinogenic health effects and persistent nature (Breivik et al., 2002). The widespread production and use of these chemicals before their legal restriction led to the contamination of soils, presenting potential ecological and human health risks (Breivik et al., 2007). Even today, many years after the restrictions were enacted, urban/industrial areas continue to act as major sources of atmospheric PCBs in surrounding regions (Halsall et al., 1995; Bozlaker et al., 2008). PCBs have been widely used in electrical equipment like capacitors and transformers and as hydraulic fluids, flame-retardants, plasticizers, heat exchangers, or additives in pesticides (Breivik et al., 2007; EA, 2007). PCBs can travel long distances in the air and be deposited in areas far from where they were released. For example, PCBs have been found in remote areas such as Antarctica due to long-range transport in the atmosphere (Klanova et al., 2008). Although banned in most parts of the world, PCBs continue to be released from old equipment and waste sites (Breivik et al., 2002; Li et al., 2010).

Soil can be an important sink of PCBs due to its large retention capacity (Harrad et al., 1994; Cousins and Jones, 1998; Ockenden et al., 2003) and can also act as a contributor of pollutants to the atmosphere by volatilization (Gouin et al., 2002). Generally, urban soils show greater contamination levels than rural sites due to their proximity to pollution sources, and urban and industrial areas have been reported as significant sources of PCBs (EA, 2007; Wilcke et al., 2006; Ren et al., 2007). A better understanding of soil contamination is necessary to avoid the related ecological and human health risks.

PCBs have never been produced in Turkey, and PCB use was banned in 1995 according to the Regulation on Hazardous Chemicals of 1993 (RoHC, 1993; NIP, 2006; Dagli, 2005). However, PCB-

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doi:10.1016/j.jenvman.2010.10.019