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Concentrations, distribution, sources and risk assessment of organohalogenated contaminants in soils from Kenya, Eastern Africa

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ABSTRACT

The organohalogenated contaminants (OCs) including 12 organochlorine pesticides (OCPs), 7 indicator polychlorinated biphenyls (PCBs) and 7 polybrominated diphenyl ethers (PBDEs) were determined in soils collected from Kenya, Eastern Africa. The total OCPs fell in the range of n.d–49.74 μ g kg⁻¹ dry weight (dw), which was dominated by DDTs and endosulfan. Identification of pollution sources indicated new input of DDTs for malaria control in Kenya. The total PCBs ranged from n.d. to 55.49 μ g kg⁻¹ dw, dominated by penta- and hexa-PCBs, probably associated with the leakage of obsolete transformer oil. The soils were less contaminated by PBDEs, ranging from 0.19 to 35.64 μ g kg⁻¹ dw. The predominant PBDE congeners were penta-, tri- or tetra-BDEs, varying among different sampling sites. Risk assessment indicated potential human health risks posed by OCs in soils from Kenya, with PCBs as the most contributing pollutants. The local authorities are recommended to make best efforts on management of OC pollution, particularly from DDTs and PCBs to meet the requirement of Stockholm Convention.

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1. Introduction

Organohalogenated contaminants (OCs) such as organochlorine pesticides (OCPs), polychlorinated biphenyls (PCBs) and polybrominated diphenyl ethers (PBDEs), also known as persistent organic pollutants (POPs) regulated by the Stockholm Convention (UNEP, 2009), are a group of hydrophobic compounds which were highly toxic, environmental persistent and long distance transportable (Gouin et al., 2004; Wania and MacKay, 1996). OCPs such as DDT and HCH were once extensively used in agriculture worldwide. Despite the ban of production and application of OCPs since the 1970s in many countries, OCPs residues have been reported in water, air and soils around the world (Ge et al., 2013; Rios et al., 2010; Whitehead et al., 2015; Yang et al., 2014). PCBs had been used as transformer dielectric fluids, flame retardants, plasticizers and pesticide additives since the 1930s, and have also been identified in various environmental compartments and human tissues

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(Everaert et al., 2015; Koh et al., 2015; Wang et al., 2011). PBDEs have been widely used as flame retardants, and detected ubiquitously in the environment (Guan et al., 2007; Jiang et al., 2010). PBDEs were considered as emerging POPs under Annex A of the Stockholm Convention.

Kenya is located within the eastern side of the vast continent of Africa. Kenya became a contracting party to Stockholm Convention in 2004. Kenya had a population of approximately 32 million in 2003, about 70% of which lived in rural areas. Greater than two thirds of the land in Kenya is either desert or semi-desert, with only approximately 18% of the land suitable for agricultural use (Kenya NIP, 2007). Besides, unpredictable climate changes such as floods and droughts occurred frequently. Large efforts have therefore been made to enhance the food security, and the agricultural chemicals including obsolete OCPs have been consequently overused and even misused to control pests and boost agricultural productivity (UNEP, 2015). Although DDTs were banned for agricultural use in 1986 in Kenya, the other OCPs were not banned until 2004 (Kenya NIP, 2007). Some OCPs are still in use for public health purposes (Kenya NIP, 2007). PCBs can be released into the environment due to improper disposal of the waste equipment (Kenya NIP, 2014). Similarly, PBDEs contamination can be caused by poor





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