



## Contamination of phthalate esters, organochlorine pesticides and polybrominated diphenyl ethers in agricultural soils from the Yangtze River Delta of China



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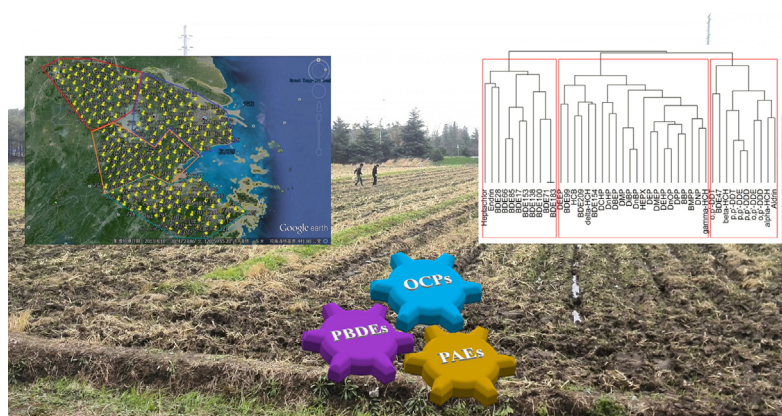
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### HIGHLIGHTS

- Several endocrine disruptor compounds were determined in Chinese agricultural soils.
- Different spatial distributions were observed among PAEs, OCPs and PBDEs.
- High levels of EDCs exist along borders between Shanghai and neighboring provinces.

### GRAPHICAL ABSTRACT



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### ABSTRACT

To reveal the pollution status associated with rapid urbanization and economic growth, extensive areas of agricultural soils (approximately 45,800 km<sup>2</sup>) in the Yangtze River Delta of China were investigated with respect to selected endocrine disruptor compounds (EDCs), including phthalate esters (PAEs), organochlorine pesticides (OCPs) and polybrominated diphenyl ethers (PBDEs). The residues of sum of 15 PAEs, sum of 15 OCPs and sum of 13 PBDEs were in the range of 167–9370 ng/g, 1.0–3520 ng/g, and <1.0–382 ng/g, respectively. The OCPs residuals originated from both historical usage and recent input. Agricultural plastic film was considered to be an important source of PAEs. Discharge from furniture industry was potential major source of PBDEs in this region. The selected pollutants showed quite different spatial distributions within the studied region. It is worth noting that much higher concentrations of the EDCs were found on the borders between Shanghai and the two neighboring provinces, where agriculture and industry developed rapidly in recent years. Contaminants from both agricultural and industrial activities made this area a pollution hotspot, which should arouse more stringent regulation to safeguard the environment and food security.

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1. Introduction

Soil is a major reservoir for a variety of pollutants (Zhang et al., 2011) and is a secondary emission source of contaminants to groundwater, surface water, and the air (Tao et al., 2008). In recent years, soils in China have been severely polluted by intensified farming activities, industrial operations and urban development (Cai et al., 2008). Multi-class environmental endocrine disruptor compounds (EDCs), such as phthalate esters (PAEs), organochlorine pesticides (OCPs) and polybrominated diphenyl ethers (PBDEs), may coexist in soils and accumulate in crops and human bodies through food chains, posing risks to ecosystem and human health (Hites, 2004; Lemaire et al., 2004; Net et al., 2015). Therefore, it is important to study the pollution of coexisting EDCs in soil.

PAEs have been prevalently used in the production of agricultural plastic film in China, which presents an important source of PAEs to farmland soils (Hu et al., 2003; Wang et al., 2013). Due to recent outbreaks of food safety issue in Taiwan and Mainland China, PAEs have aroused intensive public attention to their adverse effects on human health, especially reproductive physiology (Li and Ko, 2012). In addition, OCPs were produced and extensively used in agriculture in China during the 1950s–1980s (Li et al., 2001; Liu et al., 2015). Although the usage was terminated over thirty years ago, OCPs are still widely distributed in the environment and attract considerable scientific and regulatory interests due to their persistence, bioaccumulation and multiple

endocrine disrupting risks to eco-systems and human health (Concha-Grana et al., 2006; Hu et al., 2010; Niu et al., 2013). In recent years, as emerging pollutants, PBDEs are of considerable concerns for their increasing detection rates and elevated levels in the environment (Wang et al., 2011; Luo et al., 2014) and human bodies (Hites, 2004; Chen et al., 2014). Their toxicity has also been widely studied in a variety of animal models (Messer, 2010), and significant concerns of toxicity on human health such as hormonal deficits have been raised (Giordano et al., 2009).

The Yangtze River Delta (YRD), located in eastern China, is one of the most populated and economically prosperous regions in the world. The core part of the YRD consists of Shanghai, northern Zhejiang and southern Jiangsu, with a population more than 110 million. The YRD region accounts for more than 15% of China's GDP (Wuxi Municipal Bureau of Statistics, 2013). Intensive farming has also been conducted due to the demand for agricultural products from urban areas (Huang et al., 2011; Li et al., 2001). Numerous chemical manufactures are located on the provincial boards. Because of the high usage in industrial and agricultural productions, OCPs, PAEs, and PBDEs may coexist in farmlands of the YRD at elevated concentrations.

There have been several surveys on soil contamination in China (Hu et al., 2003; Niu et al., 2013; Tao et al., 2008; Zou et al., 2007). However, these studies generally focused on a single class of targeted contaminants in a limited number of samples and/or relatively small sampling area. Few studies have characterized the regional-scale spatial

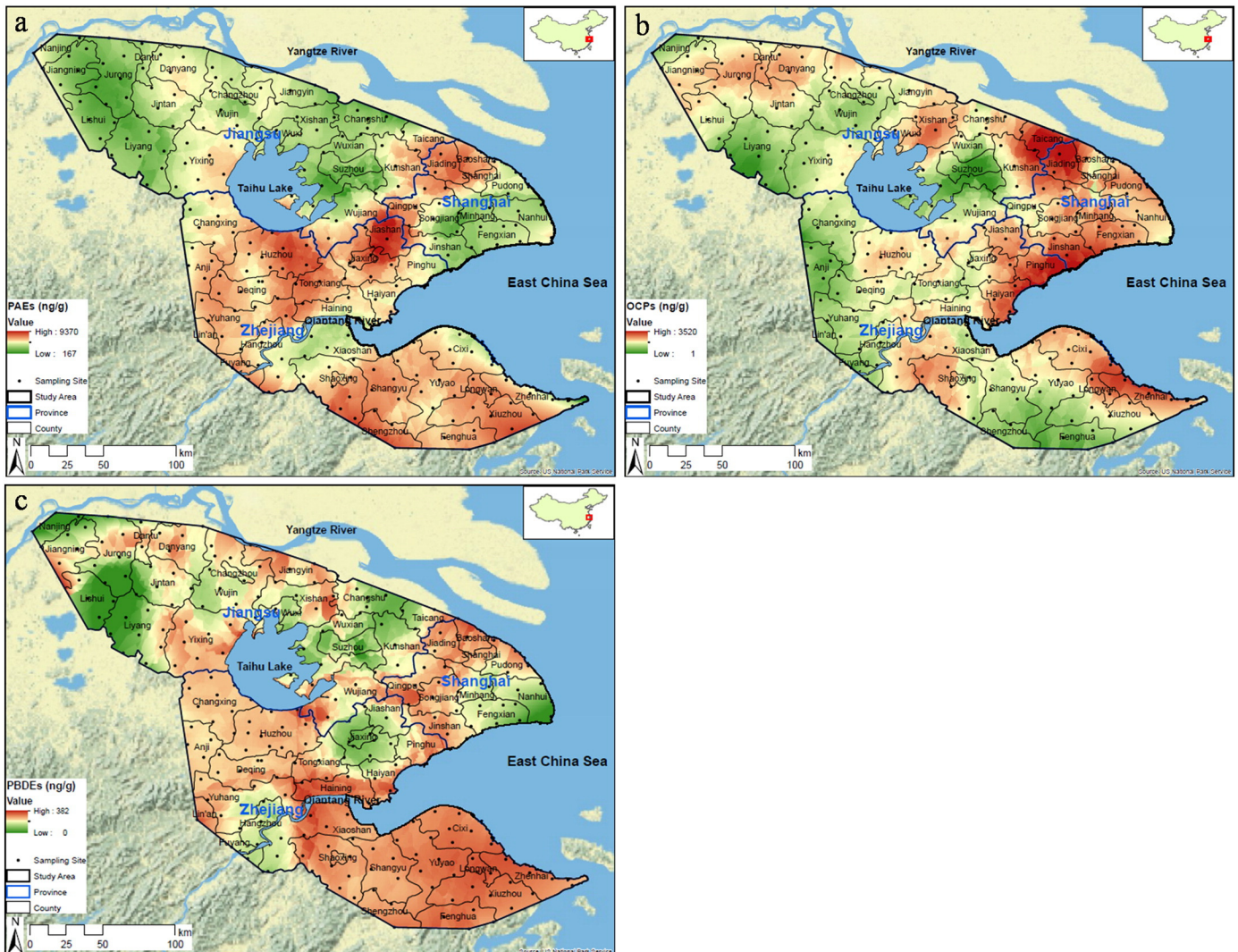


Fig. 1. Spatial distributions of (a) PAEs, (b) OCPs and (c) PBDEs in agricultural soils of YRD region.

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