Organochlorine pesticide residues in surface water from Sichuan Basin to Aba Prefecture profile, east of the Tibetan Plateau

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Abstract Organochlorine pesticides (OCPs) found in rivers from the Sichuan Basin to Aba Prefecture profile were analyzed to assess possible health risks to adults and children who use the river as a source of drinking water. OCP concentrations in surface water ranged between 22.29–274.28 ng L⁻¹. Compared with other published data around the world, OCP levels in this study were moderate. Among all OCPs, hexachlorobenzene (HCB) and hexachlorocyclohexanes (HCHs) were the predominant compounds. Higher concentrations of OCPs were attributed close to the agricultural fields of the Sichuan Basin, current OCPs inputs, and long-range atmospheric transport from abroad. Various spatial patterns of OCPs in the profile might be affected by the usage and physicochemical properties of the pesticides, in addition to the adjacent geographical environment. The health risk assessment indicated that most OCPs had little impact on human health according to the acceptable risk level for carcinogens (10⁻⁶) recommended by the US EPA. However, carcinogenic effects caused by heptachlor, Aldrin, HCB, and α-HCH might occur in drinking water. The risk of negative impacts caused by OCPs is much higher for children than for adults.

Keywords organochlorine pesticides (OCPs), surface water, spatial distribution, health risk assessment, Tibetan Plateau

1 Introduction

Organochlorine pesticides (OCPs), i.e., hexachlorocyclohexanes (HCHs), dichlorodiphenyltrichloroethanes (DDTs), drins (Aldrin, Dieldrin and Endrin), chlordane, heptachlor (HEPT), hexachlorobenzene (HCB), endosulfan, mirex, and toxaphene pose significant threats to both ecosystem and human health (Darko et al., 2008). In China, Aldrin, Dieldrin, HEPT, DDTs, and toxaphene were banned in 1983, while chlordane was banned in 1999 (Wong et al., 2005). Endosulfan is still on the list of allowable insecticides on crops in China (Zhang et al., 2012). Drins were never industrially produced or used as agricultural pesticides in China (Lammel et al., 2007; Zhang et al., 2012). However, recent studies have indicated that dicrofol (Qiu et al., 2005; Chen et al., 2008), lindane (Xing et al., 2010; Cai et al., 2012) and chlordane (Li et al., 2008; Zhang et al., 2012) are still used in China. On the other hand, many contaminants came from historical OCP residues (Xing et al., 2009; Wang et al., 2012; Yang et al., 2013).

The Tibetan Plateau has triggered a strong interest among the geoscience community due to its unique geographical location, unique climatic environment, in addition to relatively scarce industrial and agricultural activities. Various environmental media have been investigated for OCPs in this region, such as soil (Zheng et al., 2009; Tao et al., 2011; Wang et al., 2012), air (Gong et al., 2010; Liu et al., 2010; Wang et al., 2010a; Xiao et al., 2010), vegetation (Wang et al., 2007; Yang et al., 2008), and ice core (Wang et al., 2008; Wang et al., 2010b). It is hypothesized that cold-trapping effect for OCPs may be profound in the Tibetan Plateau because of dramatic
altitudinal gradients and its immediate vicinity to possible source regions, such as India and China. Comparatively, data is limited on OCPs found in water samples in the Tibetan Plateau. Yang et al. (2007; 2010; 2013) investigated fish samples taken from several rivers across the plateau and found various OCPs, such as DDTs, HCHs and HCB. Therefore, it is important to explore the occurrence of OCPs in water in view of the significant role of rivers in the Tibetan Plateau.

Studies on OCPs have been carried out from Sichuan Basin to Wenchuan County (Liu et al., 2010), the Balangshan region (Chen et al., 2008), and in the Jiuzhaigou Natural Scenic Area (Xing et al., 2010), all of which are high-altitude regions just east of the Tibetan Plateau. The results confirmed that many contaminants were attributed to the long-range atmospheric transport, which was most likely from Sichuan Basin. Aba Tibetan and Qiang Autonomous Prefecture (Aba Prefecture), located northwest of Sichuan province, is an important intergrade between the Tibetan Plateau and Sichuan Basin. Aba Prefecture is also the main route for monsoon winds to the Tibetan Plateau. These traits make Aba Prefecture a perfect place to gain a better understanding of OCP transport processes from low-altitude regions to remote high-altitude regions (Wania and Westgate, 2008; Xing et al., 2010). Aba Prefecture is traversed by more than 530 rivers, including the Yellow River which flows through 126 kilometers. The main branches of the Minjiang River, Jialing River, and Fujiang River in Sichuan province originated from Aba Prefecture. Therefore, this study chose the profile from Mianzhu City to Aba Prefecture (the Aba profile) to determine OCPs in surface water. The goals were to investigate the pollution characteristics of OCPs in rivers along the Aba profile, and to assess resultant health risks for individuals caused by the OCP contamination of drinking water. A map of the sampling sites is shown in Fig. 1, and statistics of each sampling site are presented in Table 1.

Fig. 1  Sampling sites along the Aba profile, Sichuan Province, China.