WATER RESEARCH 40 (2006) 183–194

Available at www.sciencedirect.com

SCIENCE DIRECT®

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

Organochlorinated pesticide multiresidues in surface sediments from Beijing Guanting reservoir

*Nandong Xue, Daren Zhang, Xiaobai Xu**

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, State Key Laboratory of Environmental Chemistry and Ecotoxicology, 18 Shuangqing Road, Beijing 100085, China

ARTICLE INFO

Article history:
Received 24 January 2005
Received in revised form
16 May 2005
Accepted 3 July 2005
Available online 20 December 2005

Keywords:
Guanting reservoir
Surface sediment
Organochlorine pesticides (OCPs)

ABSTRACT

For the analysis of organochlorine pesticides (OCPs) in sediments and water, a multiresidue analysis method based on gas chromatography with electron capture detection (GC/ECD) was developed. Solid-phase extraction (SPE) using Oasis® HLB cartridges was also applied in sample extraction. Mean recoveries were satisfactory with 72–103% and 71–103% for water and sediment, respectively. Twenty-one OCPs were analyzed in water and surface sediment samples from Beijing Guanting reservoir. Total concentrations of 21 OCPs were 16.7–791 ng/l (mean 234 ng/l), 275–1600 ng/l (mean 644 ng/l), 5250–33,400 ng/kg (mean 13,000 ng/kg) in surface water, pore water and sediment (dry weight), respectively. *P*, *p'*-DDE, δ-HCH, aldrin, γ-HCH and β-HCH are the most abundant compounds in water while *p*, *p'*-DDE, *o*, *p'*-DDT, β-HCH, δ-HCH, *p*, *p'*-DDT and aldrin accounted for about 85% of total 21 OCPs in sediment in Beijing Guanting reservoir. Concentrations of OCPs were high both in water and sediment samples in Beijing Guanting reservoir for municipal water supply. The data provides information on the levels and sources of OCPs in Guanting reservoir. The study indicated that measures should be taken to decrease OCPs residues in order to improve the quality of municipal water supply in Beijing.

1. Introduction

Guanting Reservoir located northwest of Beijing (approximately 90 km northwest) was built in 1952, with a storage capacity of 410 million m^3 and is one of two main water resources (92.98% of the total reservoir storage capacity in Beijing) for agriculture, industry and potable uses of Beijing. Since Guanting reservoir has suffered from extensive pollution over the last years (particularly in 1980s) due to runoff from non-point sources, direct dumping of wastes, unmanaged fishing, unrestricted shipping, mineral exploitation, and pollutants carried by rivers (Wang et al., 2003; Zhang et al., 2004). Water from this reservoir was not used as potable water since 1997.

Pesticides are important class of pollutants in Guanting reservoir. Not only can the pesticides be bio-concentrated through biogeochemical processes, but also often scavenged from the water through sorption onto suspended material, and then they get deposited to become a part of the bottom substrate. The sediment component of aquatic ecosystems can deposit pesticides. Consequently, bottom sediments often become storage of pesticides in the environment (Khan, 1977; Chau and Afgan, 1982). Different pesticides pose varying degrees and types of risk to water quality. Some pesticides (such as parathion and other organophosphate compounds) are highly soluble in water and relatively short-lived in the environment and may cause short-term problems when present at high concentrations. Some organochlorine

*Corresponding author. Tel.: +86 10 62919177; fax: +86 10 62923563.
E-mail address: xuxb@public.bta.net.cn (X. Xu).
0043-1354/$ - see front matter
doi:10.1016/j.watres.2005.07.044

pesticides (OCPs) such as DDTs, hexachlorocyclohexanes (HCHs), chlordanes (CHLs), hexachlorobenzene (HCB), aldrin, dieldrin, endrin, endrin aldehyde, heptachlor, heptachlor epoxide (HEPO), endosulfan I, endosulfan II, and endosulfan sulfate are only slightly soluble in water and highly resistant to degradation by biological, photochemical or chemical means, and their residues may persist in soil, aquatic sediment, and biomagnify in the food web (Tanabe et al., 1997). Over the past 30 years, the occurrence of OCPs in the environment is of great concern due to their persistent (Doong et al., 2002a) and long-range transportable nature (Fillmann et al., 2002) as well as toxic biological effects (Tanabe et al., 1994; Wania and Mackay, 1996). Studies have suggested that OCPs may affect the normal function of the endocrine system of humans and wildlife (Colborn and Smolen, 1996; Xue et al., 2005). Thus, OCPs in aqueous environment have attracted extensively interests from environmental scientists and public.

Despite the ban and restriction on the usage of some OCPs in developed countries during the 1970s and 1980s, some developing countries are still using them for agricultural and public purposes because of the low cost and versatility in controlling various insects (Iwata et al., 1994; Tanabe et al., 1994; Monirith et al., 2003). In fact OCPs, in some cases, are still used or they are present as persistent residues of previous uses. Some surveys of OCPs contamination have been reported in coastal and estuarine sediments collected from Asian countries such as Vietnam, Turkey, Korea and China (Nhan et al., 1999; Bakan and Ariman, 2004; Khim et al., 1999; Doong et al., 2002a,b; Hong et al., 1999; Zhang et al., 2004) indicating the presence of significant source of OCPs in this region. Several studies have reported the presence of elevated levels of OCPs, such as DDTs and HCHs, in seawater and sediments in China (e.g. Zhou et al., 2001). However, most studies examined OCPs levels in waters, sediments from the marine environment, and little information is available on OCPs contamination in freshwater samples.

The tributaries of Guanting reservoir flow through agricultural area where agrochemicals are used intensively to improve crop yields. OCPs were used heavily in these areas from the late 1940s through 1983, when they were phased out, and ultimately, some of them, banned. Although some studies have assessed the environmental quality of Guanting reservoir, data on OCP residues in surface sediments are very scarce and focus mainly on HCHs and DDTs (e.g. Wang et al., 2003). Previous studies suggested that the sediment in the reservoir was the main pollution sources of OCPs (Wang et al., 2003). Hence, comprehensive studies on organochlorine residues in sediments are need to understand the status of contamination in the Guanting reservoir.

This study focuses on the composition, distribution and characterization of 21 OCPs in surface water, pore water and surface sediments from Beijing Guanting reservoir and focuses on assess in the status of OCPs contamination in the reservoir. The data would be useful to local government to remediate the contaminated water body in order to utilize the potential municipal water supply.

2. Materials and methods

2.1. *Study area and sampling locations*

The locations of the sampling sites are shown in Fig. 1. The sites were chosen based on hotspots of pollution around Guanting reservoir such as industrial region, domestic wastewater discharge areas or entrances of rivers. Throughout the survey a global positioning system (GPS) was used to locate the sampling locations. The top sediment samples (a mixture of sediment from the upper 10 cm) were collected by a grab sampler (Wildlife supply company, SAGINAW, Michigan, USA) in more than seven sampling sites. Samples were homogenized on site in clean glass containers. All samples were immediately sealed and stored at −4 °C in pre-cleaned glass jars until analysis. Samples were collected in September and November 2003, June and August 2004.

Surface water samples were collected in the same sites. Samples were taken using pre-cleaned glass bottles held in a

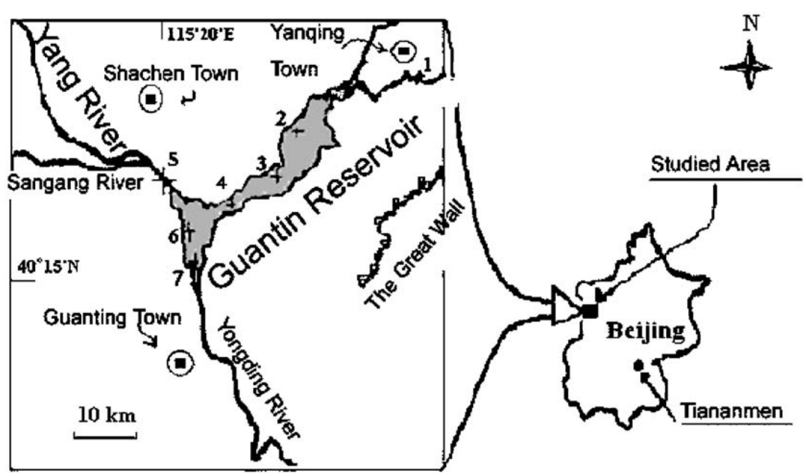

Fig. 1 – Sampling sites in Guanting reservoir and its geographical location (1–7 denote seven sampling sites in Beijing Guanting reservoir).