DISTRIBUTION OF DDTs IN URBAN SOILS OF BEIJING, CHINA

Yang Lingyan, Xia Xinghui

School of Environment, Beijing Normal University / State Key Laboratory of Water Environment Simulation, Beijing, 100875, China

Abstract

Dichlorodiphenyltrichloroethanes (DDTs) in urban soil samples (0~20cm) from Beijing were determined using a Varian CP-3800 gas chromatograph equipped with a 63^{Ni} electron capture detector (GC-63^{Ni} ECD) system. The total DDTs concentrations in the soil samples varied from 0.03 to 1282.58 ng/g, with an average of 68.14±189.46 ng/g. DDTs concentration showed a decreasing trend from the centre to the suburb of the city, and it increased with the age of the urban area. The DDTs concentration in CL was much higher than the other five types of land use, which was due to the usage of DDTs to protect vegetation in CL.

1. Introduction

Urban soil usually contains much higher concentrations of trace pollutants than those of rural or background soils[1]. As pollutants in urban soils can be easily transferred into humans through ingestion, inhalation, or dermal routes, etc., they have a direct impact on the health of human beings, especially children and elderly people who are physiologically more vulnerable to environmental pollution[2,3]. Dichlorodiphenyltrichloroethanes (DDTs) have been identified as hormone disrupters which are capable of affecting the normal function of endocrine and reproductive systems of humans[4,5]. Due to the environmental persistence, DDTs can be easily accumulated in soil, eventually resulting in human exposure directly or indirectly. Until now, only few researches have been done on the DDTs in urban soils around the world[6,7,8]. Li et al. and Wang et al. have studied the distribution of DDTs in urban soil of Beijing, but they only regarded to two types of land use: the urban parks and the urban schools[9,10]. So far the DDTs distribution in urban soils with different types of land use in Beijing has not been systematically studied. With the rapid expansion and development of urbanization, the intensity of public activity in different types of land use is distinct; therefore, the research on DDTs levels in different types of land use as well as the possible sources and the impact factors for DDTs distribution in Beijing is necessary.

2. Materials and Methods

In this study, a total of 127 topsoil samples (0~20cm) were collected from urban area of Beijing during April to May in 2008. A total of 8 samples were collected in business area (BU), 9 samples were collected in classical garden (CL), 9 samples were collected in culture and educational area (CU), 12 samples were collected in large public green space (LA), 12 samples were collected in residential area (RE, 7 aged and 5 newly built), and In roadside area (RO), 77 samples were collected from both sides of 10 roads, which were expressed by sampling lines in Fig.1.

Soils were crushed to 100 meshes and extracted using an ASE by acetone and hexane (1:1, volume) under 100℃ and 1500 psi. The concentrations of DDT and its metabolites in the samples were analyzed by a Varian

CP-3800 gas chromatograph equipped with a ^{63}Ni electron capture detector (GC-^{63}Ni ECD) and a DB-5 fused silica capillary column (30 m×0.25 mm I.D., and 0.25 μm film thickness) with pentachloronitrobenzene as the internal standard. The MDLs of p,p'-DDE, p,p'-DDD, o,p'-DDT and p,p'-DDT were 0.01, 0.01, 0.01 and 0.02 ng/g-dry weight, respectively; the recoveries of p,p'-DDE, p,p'-DDD, o,p'-DDT and p,p'-DDT in spiked blanks and matrix spikes were 71.9-95.5%, 81.5-95.1%, 96.7-113.2% and 90.0-104.2%, respectively.

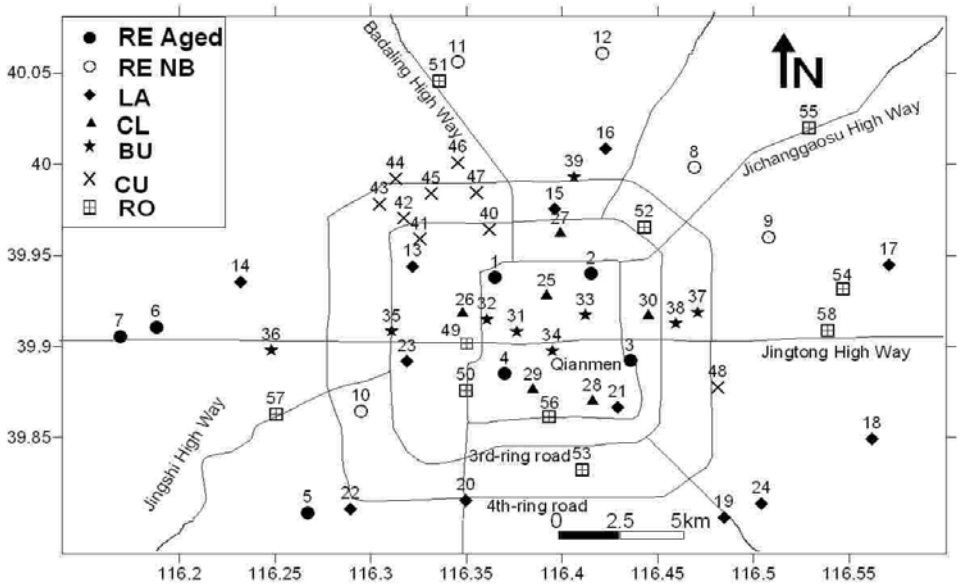

Figure 1 Description of sampling sites.

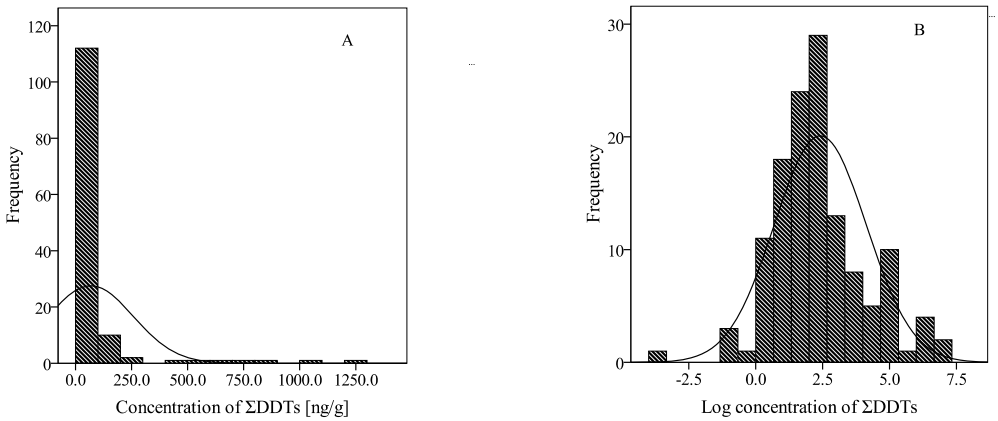

Figure 2 Frequency analysis of DDTs (a) and log DDTs (b) data of the total 127 samples.

3. Results and Discussion

3.1. Concentrations of DDTs in urban soils of Beijing

Frequency analysis of DDTs in 127 samples (Fig. 2A) indicated extreme values existed and DDTs generally followed a log-normal distribution in Beijing's urban soil (Fig. 2B). The total DDTs concentrations (sum of p,p'-DDE, p,p'-DDD, o,p'-DDT and p,p'-DDT) in the soils varied from 0.03 to 1282.58 ng/g, with an average of 68.14±189.46 ng/g. p,p'-DDE and p,p'-DDT were the principal contaminants of DDTs, with a mean concentration of 29.19±80.99 ng/g and 22.07±67.52 ng/g, respectively. The percentage of individual compounds in soils followed the sequence: p,p'-DDE > p,p'-DDT > o,p'-DDT > p,p'-DDD. p,p'-DDE was the main metabolite of p,p'-DDT , accounting for 42.8% of the total DDTs. As DDT would be dechlorinated to DDE in aerobic conditions and DDE is more persistent than the parent compound DDT[11], the higher concentration of DDE was found in urban soils of Beijing.

3.2. Comparision of DDTs levels in six types of land use

DDTs concentrations in soils with different types of land use followed the sequence: CL>LA>CU>BU>RE>RO. The mean concentration of DDTs in CL was obviously greater than the other 5 types of land use (Fig.3). It was 5 times higher than those in LA and CU, and more than 10 times higher than those in RE, BU and RO. The highest concentration of DDTs detected in CL may be due to the use of DDTs in these areas to protect vegetation[9]. For LA and CU, lawn and shrub are largely cultivated and protected routinely by administrators using pesticide which contains DDTs, so higher DDTs levels in LA and CU were also observed. As little vegetation is cultivated in BU, RE and RO, and most of these places may be lack of special vegetation management, DDTs concentration in BU, RE and RO was much lower than in CL, LA and CU.

For soil samples in CL, the high concentration of DDTs was mainly due to the historical use of DDTs in these areas. As shown in Fig.4, for the classical gardens established after 1950s, when DDTs began to produce in China[12], the concentrations of DDTs have a rapid increasing trend with the age of classical gardens. For the classical gardens established before 1950s, the DDTs concentrations were little difference. This suggests that the DDTs concentration in CL was affected by both the usage history of DDTs and the age of the classical gardens.

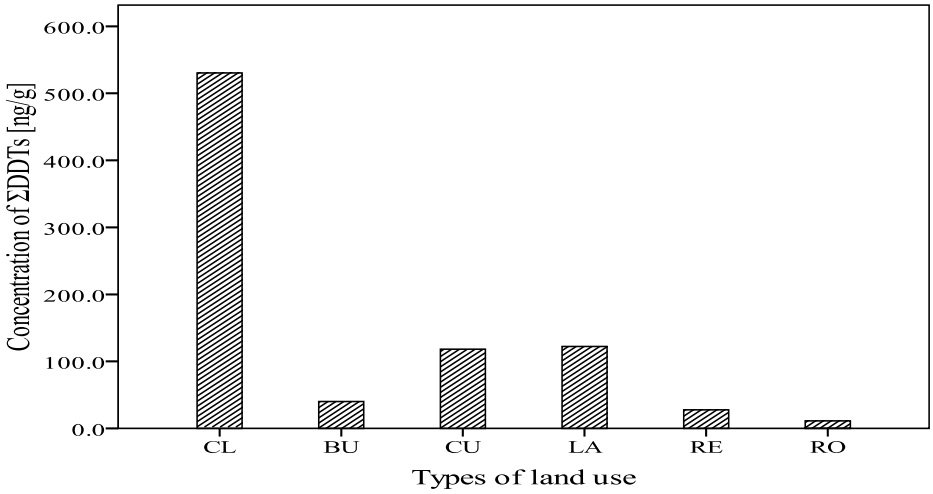

Fig.3 Concentrations of DDTs in different types of land use

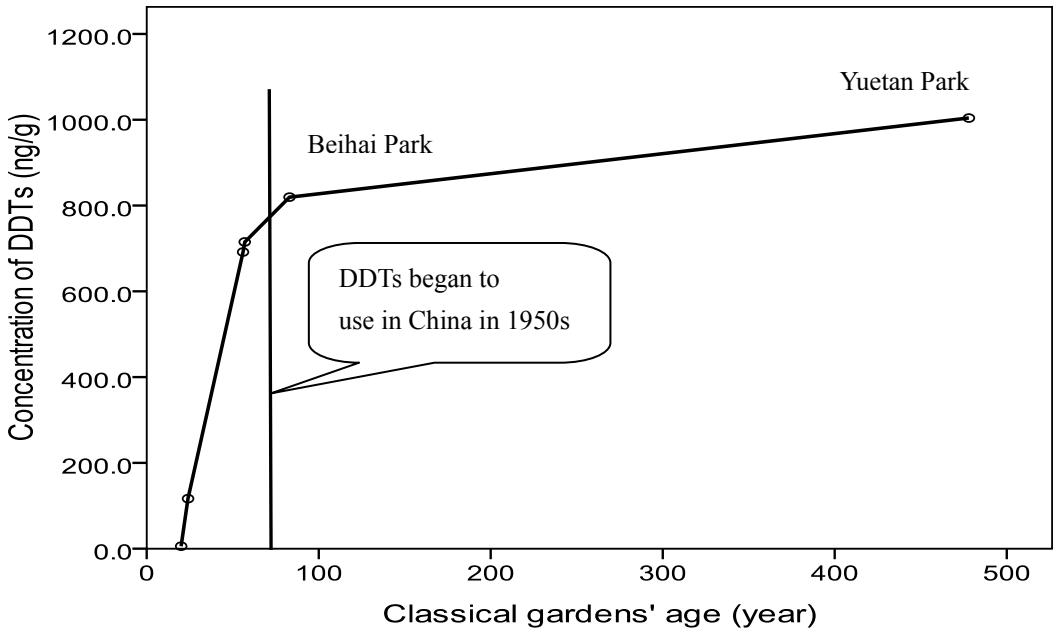

Fig.4 Correlation between DDTs concentration and the age of classic garden

3.3. Spatial distribution of DDTs in urban soils of Beijing

As shown in Fig.5, high DDTs concentrations were mainly in CL, such as Yuetan Park, Ritan Park, Beihai Park and Temple of Heaven Park, which located in the center of the city. The center of the city is an old urban area with the longest history in Beijing, the present layout of which was formed from the Ming Dynasty, over 500 years ago. DDTs also had a relatively high concentration in the northern part of the city, where some universities are located and most of them were built in 1950s. As mentioned in Section 3.2, the vegetation management in universities may contribute to the accumulation of DDTs in urban soils around. In addition, concentration of DDTs in other parts of the city was low except the center and the north. In general, as shown in Fig.5, the DDTs concentration in Beijing showed a decreasing trend from the center of the city to the suburb, and this may be due to the development process of Beijing. The urban area of Beijing was formerly within the confines of the 2nd Ring Road, and this condition didn't change until the middle of the 20th century. With 30 years rapid development since the economic reforms in 1978, the urban area of Beijing has expanded to the recently constructed 5th Ring Road. DDTs concentration in urban soils of Beijing varied greatly with the history of the urban area; the longer history the urban area was, the higher the DDTs concentration was. Moreover, decreasing trend of DDTs concentration in each type of land use was discovered from the area inside the 2nd Ring Road to the area of the 5th Ring Road.

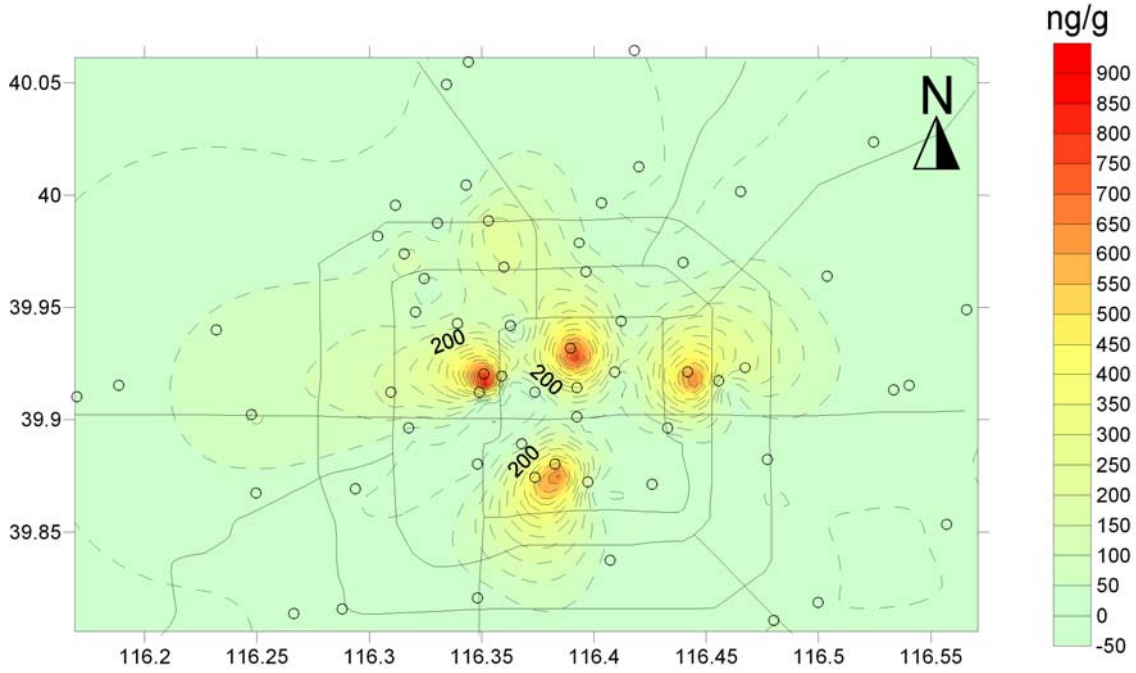

Fig.5 Distribution of DDTs in Beijing urban soils ("o" means the sampling sites)

Acknowledgements

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