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Study on HCH and DDT Pollution in Soil Based on Cubic Spline Interpolation

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Abstract

According to the experimental data of HCH and DDT which pesticided in soil in Guanting Reservoir during 2003 to 2009, using cubic spline interpolation method to add the missing years in 2005. On the basis of it, we are evaluationing and analysising the HCH and DDT pollution condition and current in the region in soil. The results show that in the past seven years in the soil the total of HCH and DDT concentration decreased. From the degradation speed, the HCH of the decline rate is relatively stable in seven years and there were no obvious differences, the degradation rate of HCH is relatively slow during 2005 to 2007, from the beginning of 2007 HCH was degradation rate. The average rate can reach 23.65%. Finally, according to the national standard of soil pollution on soil in HCH and DDT pollution levels were evaluated, it can be seen in soils in Guanting reservoir of DDT and HCH is in the provisions of the state standard between 2003 to 2009.

Keywords

Organic chlorine; Degradation rate; Cubic spline interpolation; Matlab.

1. INTRODUCTION

With the continuous development of science and social progress, people are becoming more and more high requirement for the quality of life, environmental pollution problems are also starting to taken seriously by people gradually, people pay more attention to drinking water and food health problems than before, now the guanting reservoir surrounding of organochlorine pesticides in the soil pollution problem has become the focus of public health and major environmental problems. Organochlorine pesticides are persistent organic pollutants widely existing in various environmental media such as air, water, soil and sediments. They are characterized by biological enrichment, biological amplification and high toxicity [1]. The pollution products of organochlorine pesticides mainly include HCH, DDT, etc. The longest time required for CHC to decompose 95% in soil is about 20 years, while it takes at least 30 years for DDT to decompose 95%[2]. In addition, the boiling point of organochlorine is extremely high[3].

In addition, the organochlorine pesticide is recognized all over the world the first control of pollutants, as well as persistent pollutant, it is difficult to natural degradation in the environment, with high toxicity, semi volatile, difficult to degradation and biological chemicals etc, can amplify through bioaccumulation [4], and can be enriched through various channels in the human body and animal and plant body, so that a health hazard [5]. In particular, the soil pollution around guanting reservoir is relatively serious, so it has a great impact on the vast masses of people who use guanting reservoir water. This article take the cubic spline interpolation to fit the missing data supplement, in order to analysis of some years change trend and fierce, and you can also study various factors influence on organochlorine degradation rate in the soil, according to the building of index system to evaluate dye organochlorine

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contamination in the soil conditions, provide important basis for the guanting reservoir pollution prevention.

2. INVESTIGATION ON THE CONTAMINATION OF HCH AND DDT IN GUANTING RESERVOIR SOIL

The guanting reservoir is located in zhangjiakou, hebei province and Beijing yanqing county boundaries, is one of the main water source of water supply in Beijing, is after the founding of new China, the first large scale of the construction of the reservoir was built after the war of liberation of the People's Republic of China is the first large reservoir, its location in hebei zhangjiakou and near Beijing yanqing county; The total reservoir is 4.16 billion cubic meters, and the reservoir basin is 43,400 square kilometers [9]. The reservoir has played an important role in power generation, irrigation and flood control for more than 40 years. Due to the upstream reservoir area ecological environment have been a lot of great degradation, a large number of sewage discharged into the reservoir, and the upstream areas of the construction of the engineering been intercepting water storage, reservoir as well as contribute to our biodiversity is declining, the environmental pollution problems are also growing, high degree of estuarine sedimentation, coastal erosion problems are slowly, at the same time, Beijing as the capital of the People's Republic of China, in order to protect the safety of the masses of Beijing residents drinking water, thus protect the ecological environment of the guanting reservoir should be aroused the concern of the society.

2.1. Investigation of HCH Pollution in Guanting Reservoir Soil

2.1.1. Investigation on the total concentration of HCH in guanting reservoir soil

After investigation, reading relevant data and analysis, the average value of HCH in the surrounding soil of guanting reservoir from 2013 to 2019 (except 2015) is 0.00047mg/kg-0.00083mg/kg. Compared with other cities in China, the result is lower than the concentration of HCH in the soil of guangzhou, guangdong and northern zhejiang.

2.2. Investigation on DDT Pollution in Guanting Reservoir Soil

2.2.1. Investigation of the total concentration of DDT in soil

After investigation, reading relevant data and analysis, it was found that the average value of DDT in the surrounding soil of guanting reservoir from 2003 to 2009 (except 2005) was between 0.001532mg/kg-0.00487mg/kg, which was significantly lower than that in tianjin, guangzhou, Yangtze river delta and other areas in China.

3. THIS PAPER IS BASED ON CUBIC SPLINE INTERPOLATION

3.1. The Missing Data Is Solved by Cubic Spline Interpolation

According to relevant data, the average total annual concentrations of HCH and DDT in the surrounding soil of guanting reservoir from 2003 to 2009 were obtained through collation, but the average total concentration of HCH and DDT in 2005 was found to be missing after collation. Due to the cubic spline interpolation algorithm, the solution of the cubic spline polynomial is more complex, numerical also difficult to calculate, and on the Matlab with cubic spline interpolation method can simply draw the required data, and also be able to get a smooth curve, the data also can reduce error of minimum, and convenient to evaluate the requested data, so this article to 2005 missing data fitting, using Matlab to find the missing data, so we can compare convenient it is concluded that the demand of data, and can also get change trend. The data consulted are shown in table 1.

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Table 1. The average concentration of 2003-2009 HCH and DDT (except 2005)

year	pollutants	average concentration(mg/kg)
2003	∑HCH	0.00083
	∑DDT	0.01532
2004	∑HCH	0.00074
	∑DDT	0.01338
2006	∑HCH	0.0006
	∑DDT	0.01102
2007	∑HCH	0.00053
	∑DDT	0.00894
2008	∑HCH	0.00049
	∑DDT	0.00703
2009	∑HCH	0.00047
	∑DDT	0.00487

3.1.1. Find the Missing Data of HCH

Matlab is used for HCH cubic spline difference program as follows:

```
x=[2003 2004 2006 2007 2008 2009];
y=[0.00083 0.00074 0.0006 0.00053 0.00049 0.00047];
xi=2003:1:2009;
xH=2005;
yspline=interp1(x,y,xi);
yH=interp1(x,y,xH);
plot(x,y,'*',xH,yH,'o',xi,yspline,'-')
```

After running in Matlab,yH=0.00066, and the result of smooth curve was shown in figure 1. The real point represents the known data, and the empty point represents the desired data. As shown in the figure, the average concentration of HCH in 2005 was 0.00066mg/kg.

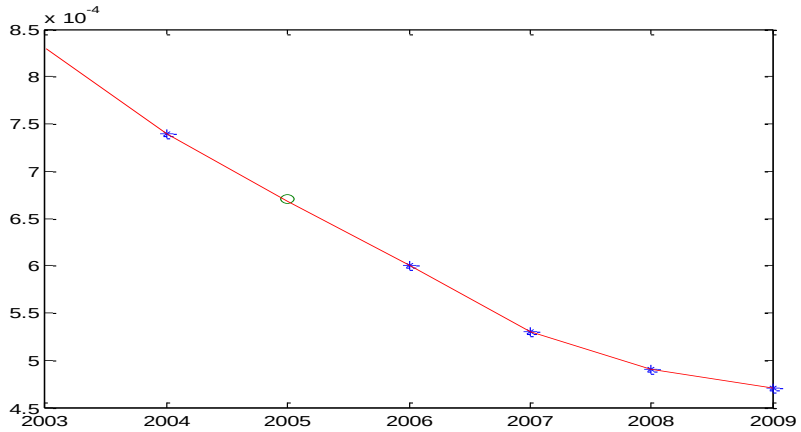

Fig 1. The average concentration of HCH in 2005

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3.1.2. Find DDT Missing Data

Matlab for DDT cubic spline difference program as follows:

```
x=[2003 2004 2006 2007 2008 2009];
y=[0.01532 0.01338 0.01102 0.00894 0.00703 0.00487];
xi=2003:1:2009;
xH=2005;
yspline=interp1(x,y,xi);
yH=interp1(x,y,xH);
plot(x,y,'*',xH,yH,'o',xi,yspline,'-')
```

After running in Matlab, yH=0.01219 was obtained, and the smooth curve result was shown in figure 2. The real point represents the known data, and the empty point represents the data obtained. The average concentration of HCH in 2005 was 0.01219mg/kg.

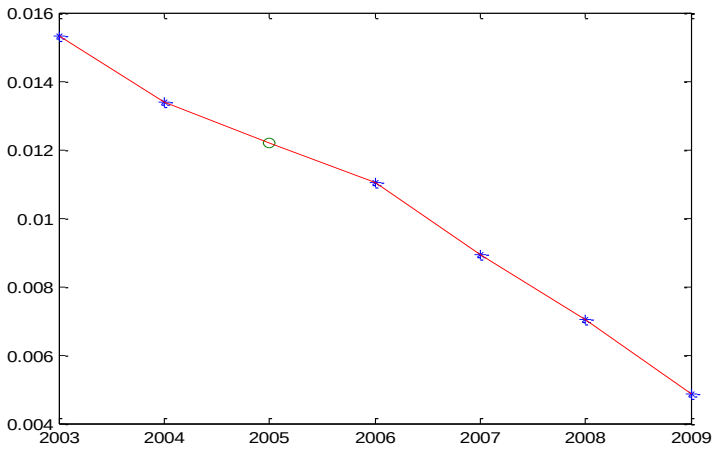

Fig 2. The average concentration of DDT in 2005

4. THE RESULTS OF EVALUATION

4.1. Building Index System

According to relevant data, the Chinese standard soil index system was sorted out, that is, gb1518-1995 was the national standard [17]. The construction of the standard soil index system was shown in table 2.

Table 2. The national soil environmental quality standard

	Level 1	Level 2	Level 3
CHC	0.05	0.5	1
DDT	0.05	0.5	1

4.2. The Trend 0f Organochlorine in Soil

2003-2009 average concentration of HCH as shown in figure 3, we can see from the picture of HCH is a downward trend year by year, the annual average concentration we can see from the figure in the seven years of HCH decline rate is stable, and the rate of decline is relatively slow,

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using the difference we can work out this seven years at an average rate of 9.35%, in the seven years HCH degrade the maximum rate of 10.84%, the minimum rate of 6.12%, from the perspective of the degradation rate of each year, no big difference.

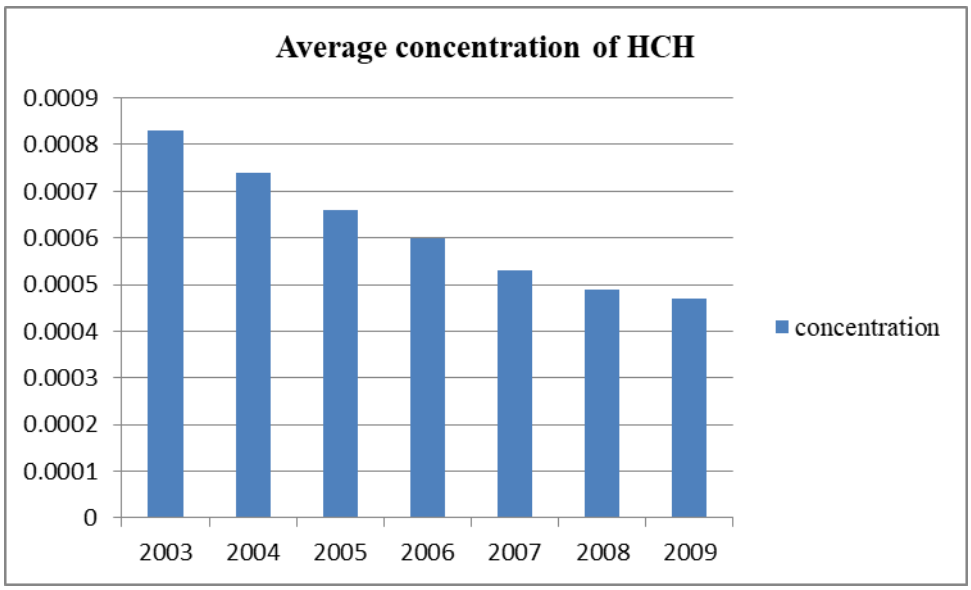

Fig 3. The average concentration of 2003-2009 in HCH

2003-2009, the average concentration of DDT as shown in figure 4, we can see from the picture as the concentrations of DDT and HCH is a downward trend year by year, but different from HCH degradation rate we can see from the picture of DDT degradation rate between 2005-2007 slowly, starting in 2007 DDT degradation rate significantly faster, with the difference we can get the seven years of DDT degradation rate is 17.09% on average, between 2003-2005, only 10.52% at an average rate of slower degradation, During the four years from 2005 to 2009, the degradation rate of DDT in soil was significantly increased, with an average rate of 23.65%.

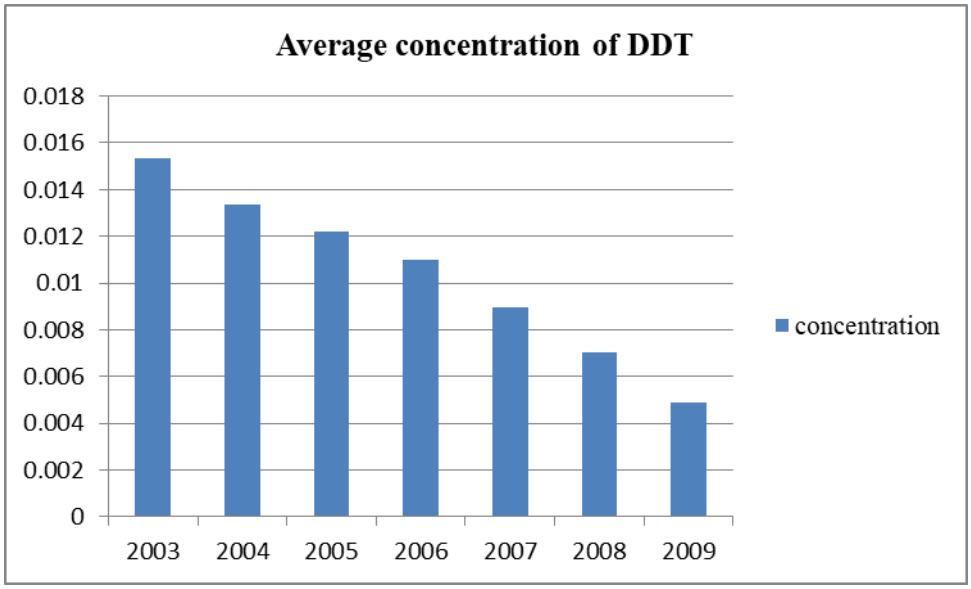

Fig 4. The average concentration of 2003-2009 in DDT

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4.3. Analysis of Degradation Factors 0f Organochlorine

There are many factors affecting the degradation of HCH and DDT, including air, soil and external factors of guanting reservoir. According to the investigation, the degradation rates of HCH and DDT are different in different soils. Soil in China is generally divided into sandy soil, clay soil, light loam, medium loam, heavy loam and sandy loam, etc., all of which have different degradation rates of HCH and DDT in organochlorine pollutants. According to the survey of relevant data [9] (see table 3); It can be seen from the figure that the degradation rates of HCH and DDT in medium soil are the same, and they are both the fastest. The degradation rate of HCH is the slowest in sandy soil, while the degradation rate of DDT is the slowest in light soil, which indicates that soil is beneficial to the degradation of HCH and DDT in organochlorine pollutants. HCH and DDT can also be degraded in other soils, but the degradation rate is slow.

Table 3. The degradation rate of DDT and HCH in different soil

	Sandy soil	Light loam	In the loam	Sandy loam	loam
HCH	11.58	13.8	38.5	12.44	24.93
DDT	9.29	4.79	71.14	23.8	9.85

4.4. Grade Evaluation of HCH and DDT

Our evaluation criteria for HCH and DDT in the soil of Beijing guanting reservoir were evaluated according to the national standards for soil pollution, and the evaluation criteria have been constructed in 2 (see table 2). Due to the guanting reservoir with a total area of 280 square kilometers, is one of the most important reservoirs in our country, and national level of soil pollution standards apply to our country the important nature reserve, as stipulated in the Chinese people to provide domestic water to water source, orchards and other provisions of reserves, so the guanting reservoir soil pollution should be according to the provisions of the state level standard to evaluate. From the data obtained (see table 1), it can be seen that DDT and HCH in the surrounding soil of guanting reservoir from 2003 to 2009 were both within the first-level standards stipulated by the state through years of treatment by relevant departments and governments, that is, their total average concentration was less than 0.05mg/kg. In 2009, the concentration of HCH and DDT did not exceed the standard, and the qualified rate rose to 100%. In the other six years, the concentration of HCH did not exceed the standard.

5. CONCLUSION

(1). In temperate regions, the amount of organic chlorine in mature spruce forest soil deposited by a mild chloride is greater than that of inorganic chlorine [19], so organic chlorine is the main pollutant affecting the environment. Moreover, by using bleach to study organochlorine pollutants in soil under laboratory conditions, it can also be proved that the presence of organochlorine pollutants in soil plays a leading role [20]. The main cause of organochlorine pollution is the pollution caused by its products being difficult to degrade in soil.

(2). In the paddy field and reservoir organochlorine pollutants concentration higher than that of forest soil concentrations of organochlorine [21], so the guanting reservoir surrounding soil organochlorine pollutants concentration is higher than that in forest soil, the guanting reservoir organochlorine pollutants in the soil surrounding the seven years, mainly includes two kinds of HCH and DDT, their degradation rate is on the decline as a whole. However, at the beginning of the study period, the total average concentration of DDT was greater than the total average

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concentration of HCH, which indicated that the pollution degree of DDT on soil was greater than that of HCH, and the maximum overdose of HCH did not exceed the standard, while the maximum overdose of DDT exceeded the prescribed range. After a long time of degradation, DDT still maintains a high concentration, because p and p-dde are the most difficult to degrade in DDT, so the main factors affecting DDT are p and p-dde. The concentration of HCH is relatively stable, in which the stability of beta-hch is the most difficult to degrade.

(3). Organochlorine pollutants HCH and DDT in soil degradation rate of speed has a lot of external influence, different soil on the degradation of HCH and DDT in soil has a certain influence, through the above research, this article in the soil is the most suitable for the degradation of organochlorine pollutants, on the other of organochlorine pollutants can also get the degradation in soil, but the degradation rate slower, take a longer time.

(4). Different plants growing around the soil have no effect on the degradation rate of organochlorine pollutants.

(5). After years of treatment of guanting reservoir by relevant departments of the national government, the total average concentration of organic chlorine pollutants HCH and DDT in the surrounding soil of guanting reservoir from 2003 to 2009 all reached the prescribed national first-level standard, and none exceeded the standard.

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