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The environmental impact assessment of DDT in China

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ABSTRACT

The impact of permanent organic pollutants(POPs)on the health of human beings and the environment is drawing increasing attention of the international society. DDT was ranked as one of the first 12 controlled materials by the convention of POPs[1], but the knowledge on the impact of DDT on the ecology and environment is still not clear enough even now. This article makes an analysis of the harm of DDT on the ecology from the following aspects: its transformation and end-result in the environment, its function of biological magnification and its toxicity of environmental chemistry. Then is a relatively systematic discussion over the environmental impact of DDT and the products containing DDT in their production, transportation in their entire lifecycle. Based on this, an analysis and evaluation is carried out mainly on the impact of DDT on the environment of our country. The results show that the amount of residue of DDT in the soil of the main yielding regions is without exception high and that there is no apparent difference in terms of the amount of residue of DDT between different kinds of soils show that DDT has a prominent influence on the soils of the main yielding regions; The result of the environmental disaster monitoring showed that there were DDT and its catabolites DDD1 and DDE2 in the seawater and the marine deposits which are still the poisons with high hangover; the thickness of DDT and Cu in the bodies of the bred organism from the breeding zones in the sea water alongshore sometimes exceeded the standard; DDT and its catabolites have a very strong biologic feature of accumulation and amplification.

KEYWORDS

Environmental Impact Assessment;
DDT;
Lifecycle;
Marine environment.

PREFACE

The impact of the permanent organic pollutants (POPs) is increasingly drawing the attention of the international society. The Stockholm Convention Concerning the Permanent Organic Pollutions was passed in Stockholm, the capital of Sweden on May 22, 2001. It has been signed by 151 states and passed by 83 nations up to the present. It is the third international convention with the compulsory demand on reducing the emissions after Vienna Convention on Protecting the Ozonosphere of 1987 and Framework Convention on Climatic Change of 1992 and an important move in the international society's assuming the prior control over the toxic chemicals[2].

For protecting the environment and the health of the people, our government actively took a hand in the negotiation about Stockholm Convention Concerning the Permanent Organic Pollutions and the overall process of drawing the text of the convention[3], and signed the convention on May 23,2001, the day it was first open to be signed. On June 25, 2004, the convention was ratified by the Standing Committee of the National People's Congress in its tenth conference and was formally enforced in China on November 11, 2004. In 2005, State Commission for Development and Reforms, Board of Agriculture, Board of Health, Board of Construction, and other related ministries and commissions (11 in total) were authorized by State Department and they formed State Group for Carrying Out the Convention and Harmonizing the Work with State Environmental Protection Administration as the head, and the Leading Group and the Office for Carrying Out the Convention (OCOC for POPs as the shortened form) came into existence within State Environmental Protection Administration.

DDT was ranked as one of the first 12 controlled materials by the convention of POPs. The main uses of DDT produced by China are: 80 percent used as the intermediate to produce dicophane for which China has applied for release and can produce and use it till 2009, used to control the disease, emergent malaria and produce the anti-mosquito incense, and another about 5 percent used as the anti-fouling additive for shipping, which was not released by the secretariat of the convention[4].

China started producing DDT in 1950s, and mass-produced it from the middle of 1960s and to the early 1980s, with the historical accumulative total of more than 400,000 tons.11 corporations once produced DDT. Since 1983, China has kept the production of DDT under compulsory control. No unit or individual can produce and sell it with the exception of Tientsin Botian Limited Company (the former Tientsin Chemical Plant, TC for short thereinafter) which was appointed by our state for producing DDT for special purposes authorized by our state and the exception of Yangzhou Agricultural Agent Pesticide of Jiangsu which uses DDT as the intermediate to produce dicophane and which is not allowed in business[5].

DDT began to be used as the accessorial noxious material of antifouling paint in 1960s widely in the coats of all kinds of ships. The accumulative total of the DDT for antifouling paint had come up to 10,000 tons by 2002; after that our state joined the Stockholm Convention and put close restraint on the use of DDT in each of the related trades. The total amount of the DDT for antifouling paint was about 1000 tons from 2002 to 2005. The total amount of the DDT for antifouling paint had been about 11,000 tons by the end of 2005.

THE ECOLOGICAL HARM OF DDT AND THE IMPACT OF ITS LIFECYCLE ON ENVIRONMENT

The ecological harm of DDT

The transformation and the end-result of DDT

(1) Basic nature

DDT:1,1-dual (4-chlorphenyl)-2,2,2-trichloroethane, colorless crystal solid, low water-solubility (-lgC=7.8,higher water-solubility in alkalescent sea water), high fat-solubility (the lgKow = 6.36).

DDT displays good physical, chemical and biological stability, and is a cumulative and lasting insecticide with high hangover. Its half life period in the soil is 10 to 15 years[6]. There are a variety of ways of transformation such as photolysis and biologic metabolism for DDT in the environment. It can be degraded into DDD through a series of complicated biochemical and environment-chemical reactions in the anaerobic condition, and into DDE in the aerobic condition. It has a low toxicity over the insects and higher animals, but it lowers the quality of sea water, pollutes the marine environment, affects the quality and quantity of the aquatic products and so greatly endangers the marine ecosystem and remains in the environment for a long term.

(2) The migration of DDT over the globe

DDT can be disseminated all over the globe by the atmosphere or transportation. The arctic has become its place to stay in. The Rang if Ertarandus is a herbivorous animal in its real sense which mainly feeds on the moss. The study discovers that the content of DDT is 0.16ng/ g (wet weight) in its muscle and 0.49ng/ g in its liver[7]. This result demonstrates that the regions far from the pollutant source are also faced with the harm of DDT as a result of the atmospheric transmission. The seal mainly feeds on fish, so the DDT in its body is mainly the accumulation by the food chain in water. Bang and the others made an analysis of the samples of blood of the seals from the northwest region of Svalbard which also showed the existence of DDT in the ecosystem of the arctic pole. The result indicates that DDT can be diffused to each corner of the earth along with the circulation of the atmosphere, and the recurrent migration of the fish and so on though the sampling point is far from the place where DDT was used[8,9]. DDT migrates basically through the following media.

1) Water body — sediments

DDT's nature of thinness in water and abundance in fat decides its lower content in water and most of it is absorbed by the suspended particulate matter such as minerals, biological detritus and colloidal materials and enters into the sediments in water with the physicochemical function of gravity settling and so on or becomes abundant in the organism for its absorption. The sediments in water are one of the main end-results of DDT. Its content in the sediments is even hundreds of times thicker than that in the water.

2) Soil — water body

The water-soluble OMs may greatly accelerate the migration of DDT into the soil and then pollutes the ground water. Soil erosion may also lead to the entrance of DDT into surface water and the sediments. Some study found that the content of DDT in the sediments of the Pearl River Delta rose in the 1990s[10].

3) Soil-atmosphere

The volatilization of the DDT as a hangover is a continuous source of the air pollution. Harner and some others foretold that the agriculture soil of Alabama of USA gave off 200-600 kg of p, p' - DDE with the model of soil ~ atmosphere exchange[11]. The thickness of DDT in the agriculture soil of Alabama, Louisiana, and Texas all surpasses the criterion as limited quantity(0.1 ng/g), and the DDT, toxaphene and dieldrin in the atmosphere are positively correlated with their thickness in the soil environment. The studies between 1996 to 1998 by Pennsylvania and Ohio showed that the soil is the primary pollution source of the air nearby.

The effect of biological magnification of DDT

The content of DDT is rising step by step when moving along the food chains in the ecosystem. One study of USA indicated that the magnification factor of DDT comes up to 10×10^6 times from the sea water to the adipose tissue of the marine organism: when the thickness of DDT in the sea water is 3ug/m3, that of the zooplankton is 0.04mg/kg, fingerling 0.5mg/kg, big fish 2.0mg/kg and that of the fish hawks which prey upon the fish is 25mg/kg the concentration coefficient of which is astonishing. Therefore, even the content in the environment is not high, the impact of DDT on the environment can't be neglected[12].

The toxicity of environmental chemistry of DDT

The experimentation on animals proves that 3×10^{-6} of DDT is going to restrain some major enzymes in the cardiac muscle, and 5×10^{-6} is going to result in the death of the liver cells or disorganization. DDT has great toxicity over fish. The degree of balance of the hard roes of the salmons which suffer from DDT are damaged and the time of natural spawning is postponed. The present accumulation of DDT in the global environment has caused severe harm to the ecosystem[13].

DDT enters into the food chains, and much of it is ultimately accumulated in the animals. For example, its enrichment in the birds such as the peregrine falcon, the bald eagle and the osprey leads to the dysfunction in reproduction, the attenuation of the egg shell which is easy to be damaged and can't be hatched. In particular, the degree of the attenuation of egg shell is in linear relationship with the logarithm of the amount of residue of DDE in the eggs of the birds. The eggs of the birds which are zoophagous or piscivorous break up before they are hatched, which may cause the depopulation of the species group.

The metabolite of DDT can combine with human endoplasmic reticulum to lead to genetic transcription and to take on the relationship of dose-effect and induce the expression of cancer genes in some cells of breast cancer. As a result, the relationship between it and the breast cancer can't be neglected. The study, made by Zhang Hong working in surgical oncology in No.1 Hospital of Jilin University, about the accumulation of DDT in human body, also made it clear that the thickness of DDT in the fatty tissues of galactophore has a strong correlation with the breast cancer (especially the breast cancers with dependency on hormone)[14].

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The environmental impact of the lifecycle of DDT

The environmental impact of DDT in its production, storage and transportation

DDT is a sort of hazardous chemical with its history of more than 60 years. After its raw materials, that is to say, chlorobenzene, chloral and concentrated sulfuric acid, experience condensation reaction, distillation and crystallization, it is made, packed, stored and then transported to the dealers or the customers. At the same time, the waste acid as a result of the reactions of DDT and the diversified reaction products is cleared up in elevated temperature and sent to the phosphorus fertilizer plant to deal with. The chlorobenzene and the chloral are all toxic substances of environmental chemistry. In its process of production DDT severely pollutes the surrounding environment. For example, the content of DDT in the soil 4km^2 around Tientsin Chemical Plant exceeds the third class criterion for the ambient soil and is not suitable for farm and woods or for the natural growth of the plants.

The environmental impact of DDT in the production of its final products

The DDT antifouling paint is made by warming up and mixing the basic materials of the paint, the dye, the menstrum, and other biocides (for example, the powder of Cu_2O) and DDT, and then barrelled and transported to the outside. In the production of DDT the waste gas contains the organic solvent and trace amount of DDT which are disposed of by filtrating the gas and then discharged[5]. Generally speaking, this doesn't cause environmental pollution. However, it may be scattered as a result of leakage in the process of production or in the abnormal marketing process.

Some globelets of antifouling paint containing DDT may be splashed into the water or the soil when the fishing boat is in the process of hull painting in the boatyard or is being coated by the fishermen themselves[15]. Besides, trace amount of DDT may volatilize into the air in the processes of mixing the lacquers at the working site, lacquering and torrefaction of the paint films.

The environmental impact of the products containing DDT

In using the dicophane and the products for controlling the malaria in emergency which contain DDT, the DDT may migrate into the bodies of the propagation and the micro-organism and then into the human bodies through food chains and becomes enriched there.

DDT volatilizes into the air from the burning mosquito incense which contains DDT, pollutes the surrounding air, enters into the human body with the respiration and harms the health of man.

The ships coated with antifouling paint slowly give off DDT when sailing on the sea, then the DDT migrate into the marine micro-organism and the bodies of other propagation. Besides, the paint layer containing DDT shells off due to the mechanical bumps or the quality of construction and deposits in the seabed or is swallowed by the marine organism.

As DDT is a sort of permanent organic poison, though its quantity in a certain environmental unit may vary greatly, it is going to exist in the unit for a long term and migrate into a larger sphere at the same time.

THE ANALYSIS AND ASSESSMENT OF THE ENVIRONMENTAL IMPACT OF DDT IN CHINA

The environmental quality standards of China regarding DDT

DDT has its actual or potential influence on the environment and the organism. China has made a detailed regulation on the quality standards in terms of various media and environmental conditions. See TABLE 1.

The impact of DDT on China

The impact of DDT on the soil environment of the main yielding regions

The results of the collection and analysis of he samples from the surface soil of 188 sites of Tientsin by Gong Zhong-ming in 2001 showed that p,p'-DDT and p,p'-DDE were the principal pollutants in earth whose average amount of residue is respectively 27.5 ng/g and 18.8ng/g. The difference between different types of soil is unapparent. The amount of residue is without exception high where DDT is used in a great quantity from 1970 to 1980. After 20 years prohibition of the use of DDT, its amount of residue is still higher in general. On one hand, this is related to the stability of DDT; on the other hand, it is for our discussion whether DDT has been used on occasion[15].

TABLE 1 : The environmental quality standards of Chinese regarding DDT

category	media	Environmental conditions	category of the standard	number value	name of the standard
DDT	air	plant	The maximum allowable concentration of the hazardous substances in the plant	0.3mg/ m3	TJ36—79
	water	drink for life	the water quality standard for drink for life	1.0mg/L	GB5749—85
		the water body for fishery industry	water quality standard for fishery	0.001mg/L	GB11607—89
		seawater	sea water quality standard(for organoch- lorine pesticide)	category I: 0.00005mg/L category II、III、IV : 0.0001mg/L	GB3097-1997
		surface water	The water quality standard for surface water	The standard of the given item of the organic substance in the water areas of category I,II and III	GHZB1-1999
		fresh water	The maximum llowable concentration of the pesticide in the fresh water for protecting the hydrobiontes	0.002ug/L	1974
		seawater	the quality standard for the oceanic sediments	category I：0.02mg/kg category II：0.05 mg/kg category III：0.1 mg/kg	GB18668-2002
			the quality standard fir oceanic mussels	category I：0.01mg/kg category II：0.1 mg/kg category III：0.5 mg/kg	GB18421—2001
	soil	food	the standard for food sanitation	sugar：0.2mg/kg vegetable：0.1mg/kg fruit and fish: 1.0mg/kg	GB2763-81
		surroundings	the quality standard for soil environment	Grade I：0.05mg/L Grade II：0.5mg/L Grade III：1.0mg/L	GB1568-1995

The impact of DDT on the marine environment

(1) The impact of DDT on the marine sediments

The marine sediments serve as the environment for many marine halocarbons to exist and grow in. As most of the bottom dwellers have the function of gathering the pollutants, the quality of the sediments directly affects the quality of the bottom dwellers and the people's health[16].

The monitoring of the DDT in the marine sediments was carried out alongshore, in the adjacent sea, and in the open sea of our country in 2001. The monitoring results showed that the content of DDT in the surrounding waters near the entrance of Yangtse River and in the sea area alongshore of North Sea city exceeded the quality standard for category I sedimentsÿ0.02mg/kg), and the maximum value of the content of DDT in the sediments in Qinzhou Gulf exceeded the quality standard for category II sediments(0.05mg/kg). See TABLE 2.

TABLE 2 : Contents of DDT in the surface layer sediments in dalian and liaodong gulfs

District	p,p DDT	p'p DDD	p'p DD Eng/L
Dalian Gulf	0.81	0.92	0.58
Liaodong Gulf	0.58	2.48	0.83

In 2004, some sediments in the sea area suffered from the pollution of DDT. The pollution of DDT was more severe in the sediments of the sea areas of Liaodong Gulf, Dalian Gulf, and Tsingtao in shore. The sea area of the entrance of Yangtse River was polluted by DDT. The sediments in the sea area of Fujian acoast

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were heavily polluted and the content of DDT (0.1mg/kg) from one third of the stations exceeded the quality standard category III for the marine sediments. The sediments in some parts of the entrances and the docks and harbours alongshore of Hainan were heavily polluted. However, the DDT depositing in the bottom mud would be released into the marine environment when the bottom mud was raised again by desilting and typhoon. Therefore, the comprehensive and potential ecological risk was high.

(2) The condition of the polluted mussels in the sea

The mussels have a great capacity for gathering the pollutants in the surrounding living environment; the content of the pollutants in their body can reflect the quality of the living environment. The results from monitoring the quality of the mussels showed that there was still some DDT as hangover in very few bodies of the mussels from a few monitoring places in the sea areas alongshore[17]. In 2004,China started the monitoring program for mussels. The monitoring result of 2005 showed that the amount of residue in the bodies of the mussels from some places exceeded the standard, which showed that some sea areas were polluted by DDT.

CONCLUSION

That the amount of residue of DDT in the soil of the main yielding regions is without exception high and that there is no apparent difference in terms of the amount of residue of DDT between different kinds of soil show that DDT has a prominent influence on the soils of the main yielding regions.

The result of the environmental disaster monitoring showed that there were DDT and its catabolites DDD_1 and DDE_2 in the seawater and the marine deposits which are still the poisons with high hangover. The thickness of DDT in the sediments of some sea areas from Dalian Gulf to Qinzhou Gulf exceeded the standard category I or category II and the Cu of sediments in just a few sea areas exceeded the standard. The sediments are the habitat for the benthic organism. The quality of the sediments directly affects the quality of the mussels such as the clam, the foursquare clam, common mussel, and the monk-cap-like oyster and directly affects human health. In 2004, that the amount of residue of DDT in the bodies of the mussels from the sea area alongshore was found exceeding the standard. Besides, the thickness of DDT and Cu in the bodies of the bred organism from the breeding zones in the sea water alongshore sometimes exceeded the standard.

REFERENCES

[1] S.Saxena, M.Siddiqui; Toxicology, **17**, 326 **(1980)**.
[2] K.Kannan, S.Tanabe, R.Tatsukawa; Environ.Sci. Technol., **29**, 2673 **(1995)**.
[3] L.Zheng, M.B.Xian, G.Zhang; Guangzhou huanjingkexue, **14**, 5 **(1999)**.
[4] Z.M.Gong, X.J.Wang, B.G.Li; China. acta scientic circum stantic, **23**, 447 **(2003)**.
[5] H.R.Buser, M.D.Muller; Environ.Sci.Technol, **29**, 664 **(1995)**.
[6] Q.AN, Y.H.Dong, H.Wang; Soils, **37**, 147 **(2005)**.
[7] K.L.Willett, E.M.Ulrich, R.A.Hites; Environ.Sci. Technol., **32**, 2197 **(1998)**.
[8] W.E.Cotham Jr., T.F.Bidelman, Chemosphere, **22**, 165 **(1991)**.
[9] H.Huhnerfuss, J.Fller, W.Konig; Environ.Sci. Technol., **26**, 2127 **(1992)**.
[10] H.B.Zhang, Y.M.Luo, Y.Teng; Soils, **38**, 547 **(2006)**.
[11] J.G.Feng, X.Tao, A.S.Zhang, Chinese Agricultural Science Bulletin14. 29(1998).
[12] M.A.Patlak; Sci.Technol., **30**, 540 **(1996)**.
[13] J.E.Cavanagh, K.A.Burns, G.J.Brunskilll; Marine Pollut.Bull., **39**, 367 **(1999)**.
[14] H.Zhang, Y.L.Lu, X.Y. Xin et al.; Acta Ecological Sinica, **25**, 937 **(2005)**.
[15] Z.M. Gong, Y.H. Dong, Q. An et al.; Environmental Science, **22**,110 **(2001)**.
[16] T.Macek, M.Mackova, J.Kas; Biotechnol. Advances, **18**, 23 **(2000)**.
[17] J.Kaare, S.J.Carsten, T.Vigdis; Biol.Fertil.Soils, **33**, 443 **(2001)**.