DICHLODIPHENYLTRICHLOETHANES (DDTS) RESIDUES IN TAM GIANG – CAU HAI AND LANG CO LAGOONS, VIETNAM

Nguyen Xuan Khoa [a], Nguyen Xuan Trung [b], Pham Hung Viet [b]

[a] *Hue college of Sciences, Hue city, Vietnam;*

[b] *Hanoi University of Science, Vietnam National University, Hanoi, Vietnam*

ABSTRACT

Analysis of DDTs in the water, sediment and organism samples taken from the lagoon system in Thua Thien Hue province, Vietnam (including Tam Giang - Cau Hai lagoon and Lang Co lagoon), one of the biggest lagoons in South-East Asia, was carried out. Correlation between DDTs concentrations in the water, sediment and organism samples was assessed. Also, relations between DDTs concentration and suspended solids, DDTs concentration and salinity in the lagoon water were considered.

Keywords: DDTs, lagoon, Tam Giang – Cau Hai.

INTRODUCTION

Tam Giang - Cau Hai lagoon with the area of 22,000 ha and 1,500 ha Lang Co lagoon in Thua Thien Hue province, Vietnam (see Figure 1) is one of the biggest lagoons in South-East Asia. The lagoons locate about 70 km length along the seaside and receive saline water from the sea through three mouths (Thuan An, Tu Hien and Lang Co) and fresh water from the rivers originating from the mountains at the south-west side of the province. The lagoon is attractive by its biodiversity and great aquatic resources. At present, about 300,000 residents (~30% population of the province) are living on aquaculture in the lagoon region (data from Thua Thien Hue Fishery Dept., 2003). This report is one of the studies relative to environmental issues at the lagoons that are being paid much attention to.

Sampling

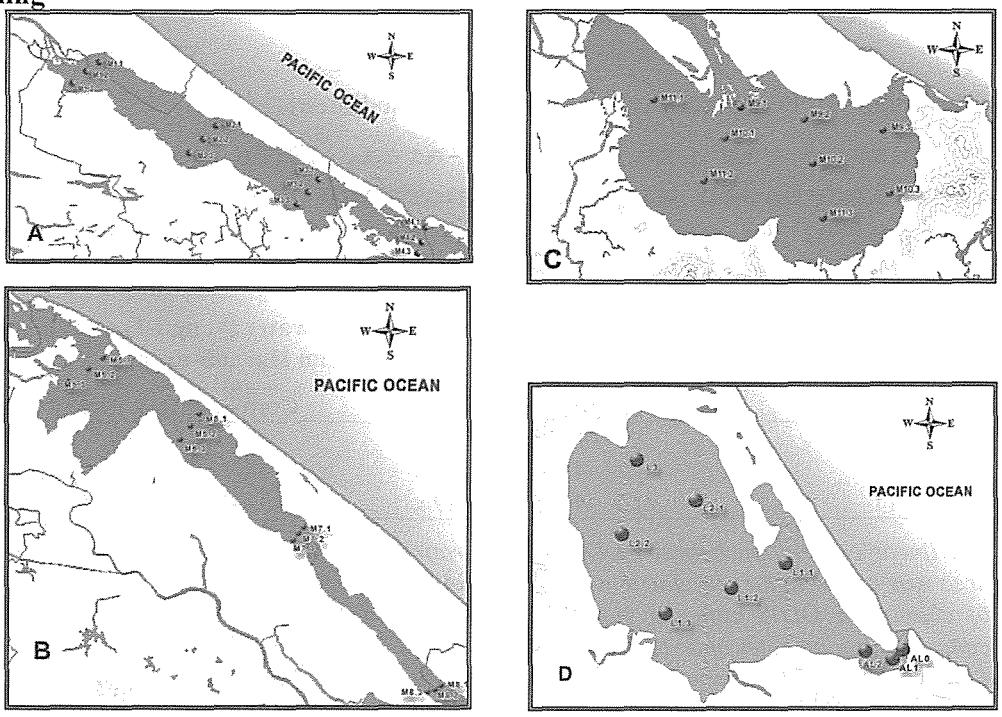

Figure 1. Sampling sites for analysis of DDTs in water, sediment, mussel and fish

A. Tam Giang sub-area; B. Thuy Tu sub-area; C. Cau Hai sub-area; D. Lang Co lagoon

Grab samples (water, sediment, mussel and fish) were taken at 1 - 3 points at each selected cross section (see Figure 1) from March 1998 to November 2001: 11 sections (M1 - M11) in Tam Giang - Cau Hai lagoon and 4 sections (AL - L3) in Lang Co lagoon. Sample storage and treatment were carried out according to requirements for DDTs analysis in water, sediment, mussel and fish (D3086-1985 ASTM, 1995; Standard Methods..., APHA, 1989).

Analytical method

Suspended solids (SS) and salinity were measured at the field by potable instrument (TOA-WQC 22A).
Organochlorine and organophosphorus pesticides were analyzed by gas chromatography (D3086-1985 ASTM, 1995; Standard Methods..., APHA, 1989).

RESULTS AND DISCUSSION

Results of DDTs analysis are shown on Table 1.

Table 1. Average concentration of DDTs in water (ng.l-1), sediment and organism (ng.g-1, based on dry weight) in Tam Giang - Cau Hai lagoon and Lang Co lagoon, Vietnam (from March 1998 to November 2001)

Sampling site	Sample	Number of samples	DDTs concentration
Tam Giang - Thuy Tu sub-area	Water	108	19.30 ± 1.63
	Sediment	36	14.51 ± 3.80
	Rabbitfish	25	178.76 ± 51.97
Cau Hai sub-area	Water	81	46.97 ± 26.51
	Sediment	27	33.35 ± 8.58
	Local carp	25	285.6 ± 82.39
Lang Co lagoon	Water	27	23.48 ± 7.48
	Sediment	27	9.77 ± 26.47
	Blue mussel	65	776.4 ± 190.2

Relation between DDTs concentrations in water and sediment

In dry season, in Cau Hai sub-area, DDTs concentration in water increased with the increase in DDTs concentration in sediment (see regression equations obtained by Stagraphics Plus 3.0 package on Table 2).

Table 2. Linear correlation between DDTs concentrations in water (y, ng.l-1) and those in sediment (x, ng.g-1, based on dry weight) in Cau Hai sub-area

Sampling point	Regression equation	Correlation coefficient (R)
M9	y = -4.977 + 0,781 x	0.74
M10	y = -42.11 + 2,457 x	0.51
M11	y = -41.99 + 3.449 x	0.76

The linear correlation between DDTs concentrations in water and sediment in Cau Hai sub-area was not so tightened, due to not high correlation coefficient (see Table 2). However, trend of change in DDTs concentration in sediment might be predicted from change in DDTs concentration in water and vice versa.
Linear and non-linear correlations (y = 1/x and y = log x) between DDTs concentrations in water (y) and those in sediment (x) were not found (R around 0.3) for the samples taken from Tam Giang – Thuy Tu sub-area (i.e. outside Cau Hai sub-area).

Relation of DDTs concentrations in water, sediment and organism

From growth characteristics of every species, Vo Van Phu (1995) claimed that Rabbitfish (*Siganus guttatus*) is often living from the cross section M3 to the cross section M5, Local carp

(*Cyprinus centralus*) is often living in Cau Hai lagoon (M9, M10 and M11), while blue mussel is cultured at AL1, AL2 and Al3. Therefore, to find out the relation of DDTs concentrations in various sample types, only parameters relating to these areas were studied. In such areas, the DDTs residues of various sample types are shown in Table 3. Results shown in Table 3 indicates that:

- DDTs residue of water environment was hundreds times lower than that of sediment but still low in comparison with the DDTs concentrations of areas in the mouths of Red River (48.55 - 59.64 ng/L) and Duong river (3.7 - 56.1 ng/L) cited in [3]. However, DDTs concentrations of the Tam Giang - Cau Hai and Lang Co lagoon system were higher against that of some surface water samples (1.3 ng/L) cited by other authors in 1993 [2]. DDTs concentrations of sediment samples taken from lagoons of Thua Thien Hue were equivalent with other areas, such as Ha Long Bay (28 ng/g) (Viet P.H et al., 2000), the coastal zone of North Vietnam (10.41 ng/g) (Nhan D.D. et al., 1999), Saigon - Dong Nai river (19.37 ng/g) (Anh M.T. et al., 2000), but were much lower compared with that from canals of Ho Chi Minh city (1039 ng/g) or paddy fields (1300 ng/g) (Thao V.D., Kawano M. and Tatsokawa R., 1993).
- DDTs concentrations accumulated in Blue mussel were approximately 80 times higher than in sediment and more than 33000 times higher compared with in water. In addition, DDTs accumulation ratio in Blue mussel were far greater than in Local carp and Rabbitfish (4.5 and 3.5 times, respectively). This was an very important evidence to affirm that Blue mussel is a species which has an ability of DDTs elimination from water environment.

Table 3. DDTs accumulation ratios of various sample types

Sampling site	Average DDTs concentrations in various sample types ($\mu g.L^{-1}$ or $ng.g^{-1}$)			Accumulation ratio (organism/ sediment/water)
	Organism	Sediment	Water	
Tam Giang - Thuy Tu	178.8	14.51	0.019	9408/764/1
Cau Hai	285.6	33.35	0.047	6077/710/1
Lang Co sea mouth	776.4	9.77	0.023	33066/416/1

Relation between the DDTs concentrations of water and some specific water parameters in Tam Giang - Cau Hai and Lang Co lagoons

Relation between DDTs concentrations of lagoon water and suspended solids (SS)

The average SS values of water samples are shown in Table 4.

In dry season, the SS values were rather stable. Suspended solids of samples taken from all over the lagoon system of Thua Thien Hue varied from 1 to 18 mg/L. With respect to the linear correlation between DDTs concentrations (ng/L) and SS values of samples, regression equations and correlation coefficients were deduced and shown in Table 5.

The intercepts and correlation coefficients indicated that when the SS values were high then the DDTs concentrations found in samples were also high. However, this linear correlation was not a very close one (correlation coefficients of most cross sections ranged from 0.42 to 0.72). Therefore, it can be seen that suspended particles might contain DDTs and served as one of DDTs contaminating sources of water.

Table 4. Average SS and salinity values of all cross sections in dry season

Cross section	Para-meter	Average salinity ($g.l^{-1}$) and SS ($mg.l^{-1}$) in dry season													
		3 - 98	5 - 98	7 - 98	9 - 98	3 - 99	5 - 99	8 - 99	5 - 00	7 - 00	9 - 00	3 - 01	5 - 01	07 - 01	09 - 01
M1	Sal.	1.98	0.7	4.17	7.50	0.03	0.02	4.40	0.03	0.60	0.05	0.04	0.03	5.72	1.00
	SS	13	12	14	12	14	15	18	9	16	5	16	3	4	6
M2	Sal.	7.16	8.8	13.07	13.30	2.75	1.03	11.18	7.00	8.14	1.28	0.35	27.50	14.48	9.82
	SS	9	6	13	14	10	15	16	12	14	15	11	4	11	16
M3	Sal.	20.4	19.4	21.1	20.7	10.6	5.7	17.7	18.7	20.1	4.3	5.6	16.4	25.0	19.2

	SS	8	10	11	9	6	9	10	6	7	9	4	5	5	4
M4	Sal.	26.1	27.4	21.17	20.13	16.57	5.63	21.64	25.78	22.07	4.84	9.88	22.40	26.35	24.10
	SS	5	8	9	7	6	9	11	4	6	6	2	5	4	7
M5	Sal.	23.4	20.8	19.65	21.89	14.82	6.93	21.98	21.10	22.83	10.79	17.53	8.14	24.93	20.76
	SS	7	9	8	8	7	9	12	7	8	7	5	6	8	9
M6	Sal.	20.2	18.5	15.65	21.20	16.04	9.40	16.85	19.56	20.87	13.36	17.09	11.93	20.68	18.61
	SS	5	4	4	8	11	9	12	4	5	5	4	7	8	6
M7	Sal.	12.9	10.3	10.40	18.47	13.48	7.37	12.48	20.15	18.36	14.65	13.50	12.18	15.95	16.65
	SS	7	6	4	7	9	8	8	4	7	5	5	5	6	8
M8	Sal.	9.6	8.0	7.29	14.68	7.30	4.90	8.61	17.69	15.04	14.26	12.73	9.55	13.52	14.39
	SS	5	4	4	5	6	7	8	3	4	8	3	5	6	4
M9	Sal.	9.8	17.2	16.63	12.47	2.90	3.53	8.08	19.00	20.10	14.57	16.54	11.34	21.22	16.67
	SS	5	7	6	10	5	8	4	2	7	6	4	7	4	3
M10	Sal.	9.2	12.0	15.43	14.18	1.93	2.89	9.08	15.58	20.53	11.29	13.95	8.55	19.45	15.54
	SS	3	7	6	11	4	12	9	2	3	6	2	3	2	3
M11	Sal.	4.9	8.4	10.86	15.34	0.64	2.96	8.61	13.39	19.40	10.13	10.36	7.04	17.41	14.20
	SS	6	8	9	7	3	9	5	2	6	4	3	1	4	2
AL	Sal.	27.5	28.3	29.70	29.12	27.77	27.12	28.33	27.10	28.73	26.98	31.02	25.80	28.14	24.81
	SS	2	5	3	2	5	4	7	3	3	5	2	2	4	4
L1	Sal.	26.9	28.8	29.92	29.34	25.27	25.50	27.55	25.35	26.25	23.18	27.95	22.31	27.60	24.07
	SS	9	6	6	5	6	4	7	4	4	5	2	3	3	4
L2+3	Sal.	28.5	29.3	29.72	29.43	25.65	25.81	28.48	24.40	27.17	23.40	28.77	21.04	27.83	24.30
	SS	5	4	6	10	3	7	5	4	2	4	1	2	5	8

Table 5. Regression equations of DDTs concentrations (y – ng/L) vs. SS (x – mg/L) in water

Cross section	Regression equation (y = a + b*x)	Correlation coefficient
M1	y1 = 14.26 + 1.289*x1	R= 0.547
M2	y2 = 26.94 + 0.939*x2	R= 0.429
M3	y3 = 6.62 + 1.799*x3	R= 0.901
M4	y4 = 8.92 + 1.832*x4	R= 0.788
M5	y5 = 10.22 + 1.472*x5	R= 0.641
M6	y6 = 13.32 + 0.702*x6	R= 0.502
M7	y7 = 10.89 + 1.331*x7	R= 0.637
M8	y8 = 13.91 + 1.004*x8	R= 0.546
M9	y9 = 12.34 + 0.925*x9	R= 0.604
M10	Y10 = 49.53 + 3.267*x10	R= 0.715
M11	Y11 = 43.51 + 3.983*x11	R= 0.721
AL	Y12 = 16.57 + 2.078*x12	R= 0.461
L1	Y13 = 8.33 + 3.784*x13	R= 0.807
L2+3	Y14 = 18.21 + 2.197*x14	R= 0.511

Relation between DDTs concentrations of lagoon water and salinity

The average salinity (mg/L) of water samples are presented in Table 4.

Differently from the case of the correlation between DDTs concentrations and SS, the obtained results indicated that all the correlation coefficients of linear or nonlinear regression curves had the values less than 0.35. Hence, it could be said that there weren't any correlation between salinity values and water DDTs concentrations.

CONCLUSION

1) In Tam Giang - Cau Hai and Lang Co lagoon system, although DDTs concentrations of studied samples varied depending on sampling sites, however this variation were not so high. Average values of DDTs concentrations in various sample types are shown as follow:

- Water: 19.3 – 47.0 ng/L
- Sediment: 14.51 – 33.35 ng/g (based on dried weight)

- Fish: 178.76 – 285.6 ng/g (based on dried weight)
- Blue mussel: 776.4 ± 190.2 ng/g (based on dried weight)

2) During study period, in Cau Hai lagoon, there were linear correlation between DDTs concentrations of water and sediment samples with correlation coefficients ranging from 0.51 to 0.76.

3) In Tam Giang - Cau Hai and Lang Co lagoon system, water DDTs concentrations had a relation with the SS values. With respect to the linear correlation, the correlation coefficients varied from 0.429 to 0.901.

References

1. Mai Tuan Anh, Nguyen Ngoc Vinh, Nguyen Thanh Hung, Lam Minh Triet (12/2000), *Preliminary assessment of organochlorine and organophosphorous pesticides pollution level in Saigon - Dong Nai river basin*, Proceedings Workshop on Management, Use and Assessment of Environmental Pollution of Pesticides, Hanoi, pp. 8-16.
2. Byron A. Bodo (1996), *Aquatic Ecosystem Contamination and Riverine Flux of Persistent Organochlorine Pollutants (POPs) to Coastal Seas in the Asia-Pacific Region*, Ontarino (11/1996) (Canada).
3. Dang Quang Hung, Wolfram Thiemann (2002), *Contamination by selected chlorinated pesticides in surface waters in Hanoi, Vietnam*, Chemosphere 47, pp. 357–367.
4. Dang Duc Nhan, Nguyen Manh Am, Carvalho F.P., Villeneuve J.-P., Cattini C., (1999), *Organochlorine pesticides and PCBs along the coast of north Vietnam*, The Science of the Total Environment 237/238, pp. 363-371.
5. Vo Van Phu (1995), *Fish fauna and biological characteristics of 10 economic fish species in Thua Thien Hue lagoon system*, Biology Ph.D. thesis, Hanoi University, Hanoi.
6. Department of Aquaculture (11/2003), *Fundamental investigation data of coastal and lagoon areas of Thua Thien Hue province* (Program of General planing of aquaculture developing in the coastal and lagoon areas of Thua Thien Hue province from 2001 to 2010), Hue.
7. Standard Test Method for Organochlorine Pesticides in Water, D3086-1985 ASTM. 1995 (172-187)
8. Standard Methods for the Examination of Water and Wastewater, Seventieth Edition, APHA, USA, 1989 (6-158 – 6-162).
9. Vu Duc Thao, Masahide Kawano & Ryo Tatsokawa (1993), *Persistent organochlorine residues in soils from tropical and sub-tropical Asian countries,* Environmental Pollution 81, pp 61-71.
10. Pham Hung Viet, Pham Manh Hoai, Nguyen Hung Minh, Nguyen Thuy Ngoc and Phan Tien Hung (12/2000), *Preliminary Study on Soil and Sedimentation Contamination by Organochlorine Pesticides and PCBs in some selected Areas of Northern Vietnam,* Proceedings Workshop on Management, Use and Assessment of Environmental Pollution of Pesticides, Hanoi, pp. 1-7.