ESTIMATES OF PCDD/DFs DISCHARGE FROM A PADDY FIELD

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Introduction

Studies on and policies of persistent organic pollutants (POPs) as PCDD/DFs have been conducted by mainly focusing on point sources[1,2,3]. One reason for these tendencies is that in order to attain the effect of pollution load reduction from non-point sources, it takes a long period of time to grasp present conditions and establish proper measures.

In Korea, discharge concentration levels of POPs including dioxin from non-point sources are not clearly defined. Especially, paddy fields, one of the non-point sources, may cause water-body contamination when they are utilized for food production with agricultural pesticides and fertilizers. So, studies on non-point sources of pollution on endocrine disruptors (EDs) including POPs from paddy fields are necessary.

Farmland in Korea continues to decrease in area, but at present, it occupies about 18.6% of the national territory and paddy fields amount to 11.4% of the given land[4]. Changes in agricultural environment resulting from industrialization means intensive use of farmland and pesticides, so their effects on water and earth pollution should not be neglected.

Land used in Korea for agriculture is mostly for paddies and dry fields. Studies on PCDD/DF loads discharged from paddy fields and flowing into the sea are almost totally absent.

This paper examines the discharge amount of PCDD/DFs at a limited drainage basin in an agricultural area and estimates the discharge loads from paddy fields, a non-point source.

Therefore, this paper aims at reporting findings on discharge loads of PCDD/DFs from paddy fields, a non-point source, and their characteristics in order to examine short and long-term control measures and create awareness of a necessity to control them.

Materials and Method

As the amount and characteristics of discharge of non-point pollutants differ greatly region to from region, the selection of a drainage basin as a subject is essential to calculate basic units of non-point pollutants. The examination of non-point sources that measure both the level of pollution and the discharge amount should be carried out by two primary methods: monitor on a unit by unit cumulative basis as well as at the lower end of a drainage basin.

This paper obtains its estimates by using these two methods eclectically on the pollution loads of PCDD/DFs before and after its drainage from paddy fields of 2,644.64 twice a year according to agricultural periods.

The actual measurement results of non-point pollution sources in paddy fields may vary depending on conditions such as the size of given paddy fields, water inflow, and water outflow.

Therefore, this study examines the Nak Dong river drainage basin including paddy fields and uses the concentration and amount of pollutants measured in the lower end of the basin and at each unit as its method.

Suspended solids (SS) are separated from samples by using Glass microfibre filters (GF/C 47mm∅, Whatman).

The separated liquid samples are absorbed with ENVI-18DSK, and SS and ENVI-18DSK are extracted into 200 mL of toluene with a Sohxlet device. The extracted liquid is purified by using multilayer a silica gel column and alumina column and the effluent is analyzed by HRGC/HRMS after becoming concentrated. Analytical methods were described in previous paper[5,6]. For 2,3,7,8-TEQ coefficient to estimate the discharge amount, WHO-TEF coefficient is used.

Results and discussion

Concentration Level of PCDD/DFs in Paddy Fields

This study shows that the concentration level of PCDD/DFs flowing into paddy fields is 0.017 - 0.355 pg WHO - TEQ/L (Without PCB), and that of PCDD/DFs flowing out from paddy fields is 0.016 - 0.512 pg WHO -TEQ/L (Without PCB). The analytic results are shown in Table 1.

Table 1. Concentration of PCDD/DFs in Paddy Fields

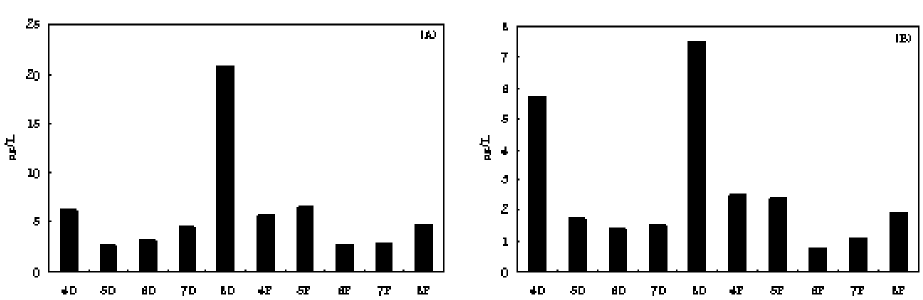
Field condition			In-flow	Out-flow	Used pesticide
Paddy field	2003	1st(seeding)	0.153	0.512	Cyhalofop-butyl, bentazone
		2nd(harvest)	0.162	0.016	Cartap hydrochloride
	2004	1st(seeding and pesticide)	0.355	0.020	Cyhalofop-butyl, bentazone
		2nd(application mid season)	0.017	0.068	Cartap hydrochloride

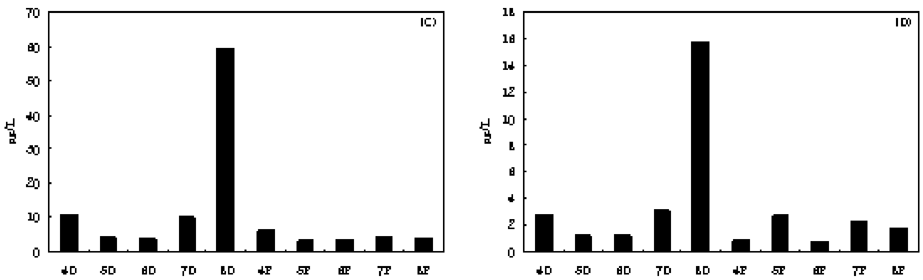
Unit : pg WHO-TEQ/L (Without PCB)

Based on the findings of this study, the homologue pattern of PCDD/DFs flowing in and out from paddy fields in 2003 and 2004 respectively are shown in Figure 1. The homologue pattern of PCDD/DFs in paddy fields is considered similar, and the concentration flowing out from paddy fields is lower than that flowing into the fields.

This means that a considerable amount of PCDD/DFs remains in the soil of paddy fields.

In homologue profile characteristics of inflow and outflow in paddy fields, the rate taken by OCDD is high. These results indicate that the use of herbicides in paddy fields is one of the causes. Besides, because of its physical and chemical features, OCDD, of all the PCDD/DFs, is the lowest in its reduction rate and highest in the residual amount





(A):In-flow(2003), (B):Out-flow(2003), (C):In-flow(2004), (D):Out-flow(2004)

Figure 1. Homologues concentration of PCDD/DFs in Paddy Fields.

Load Amount of Total Discharge from Paddy Fields

Load amount of annual pollutant discharge from the given paddy fields calculated by formulae in Figure 1 is shown in Table 2.

In this study, the load amount of pollutant generation calculated in agrarian fields is likely to be changed by biological physical and chemical functions when the flow arrives into the stream through water channels, but this factor is not taken into consideration.

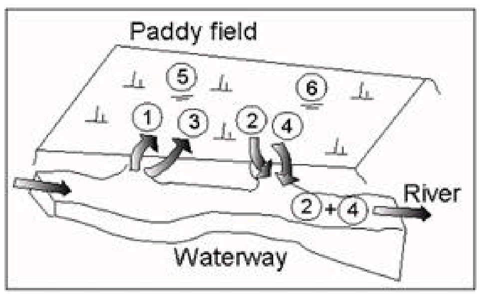


Figure 1. Flow figure PCDD/DFs in Paddy Fields.

Table 2. Load Amount of Total Discharge from Paddy Fields

Field condition		In-flux	Out-flux	Used pesticide
2003	1st(seeding)	20.20	67.58	Cyhalofop-butyl, bentazone
	2nd(harvest)	6.395	0.6336	Cartap hydrochloride
	Total	26.59	68.22	-
2004	1st(seeding and pesticide)	46.86	0.832	Cyhalofop-butyl, bentazone
	2nd(application mid season)	0.6732	2.693	Cartap hydrochloride
	Total	47.53	3.525	-

Unit : $\times 10^3$ pg WHO-TEQ/year (Without PCB)

Through the calculation process, load concentration of PCDD/DFs flowing out through channels into streams is estimated at 68.22ng WHO-TEQ (Without PCB) and 3.525ng WHO-TEQ (Without PCB) in the year 2003 and 2004 respectively. So, the discharge load amount of PCDD/DFs in 2,644.64 of paddy fields is calculated annually as 25.80 pg WHO-TEQ/ (Without PCB) and 1.333 pg WHO-TEQ/ (Without PCB) respectively.

Accordingly, given the area of paddy fields throughout the Korean territory is 11,384.08 [4], the discharge load amount of PCDD/DFs generated in paddy fields is estimated at 293,648 WHO-TEQ/year (Without PCB) and 15,173 WHO-TEQ/year (Without PCB) respectively.

PCDD/DFs in paddy fields are found to be one of the many sources flowing into the sea as the use of agricultural pesticides causes them to remain in the soil, and the outflow at harvest time to dry paddy fields causes them to flow into the oceanic water-body.

PCDD/DFs concentration in paddy field soil after the autumn harvest is lower compared to that in summer when agricultural pesticides are used frequently.

Acknowledgements

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