

## PCDDs/DFs Pollution in Vietnam Soils

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### INTRODUCTION

It is well known that the south of Vietnam was polluted by 2,3,7,8-TeCDD, a contaminant of 2,4,5-T herbicide used in Agent Orange, Purple, Pink and Green during the Second Indosina War. So far, PCDDs/DFs levels in human tissues (breast milk and human adipose tissue) in Vietnam were reported by some investigators.<sup>1-3</sup> However, to our knowledge no information is available regarding the environmental levels of PCDDs/DFs.<sup>4</sup> Therefore the present investigation was conducted to determine the existing levels of 2,3,7,8-TeCDD originated from defoliants in soils. An attempt was also made to elucidate the presence of new sources of PCDDs/DFs, if any, in soils besides herbicides.

### MATERIALS AND METHODS

All soil samples were collected during four past investigation projects (Jan 1989, Jun 1989, Jan 1990 and May 1991). To assess background concentration in soils, we had collected soils from Hanoi where the herbicides had not been sprayed. The details of soil sampling locations are shown in Fig.1. Samples included crop land soil, paddy field soil, sediment (river and pond) and wilderness soil.

#### Sampling location of Vietnam soils.

Tay Ninh	(54)	Hanoi	(5)
Tam Nong	(4)	Hue, Phu Loc	(6)
Doc Bin Kieu	(6)	Song Be	(11)
Ca Mau	(16)	Ho Chi Minh	(9)
(The number of sample)			

#### The detection rate of 2,3,7,8-TeCDD in analyzed sample.

Tay Ninh	14/54	Hanoi	0/5
Tam Non	0/4	Hue, Phu Loc	3/6
Doc Bin Kieu	0/6	Song Be	1/11
Ca Mau	0/16	Ho Chi Minh	2/9

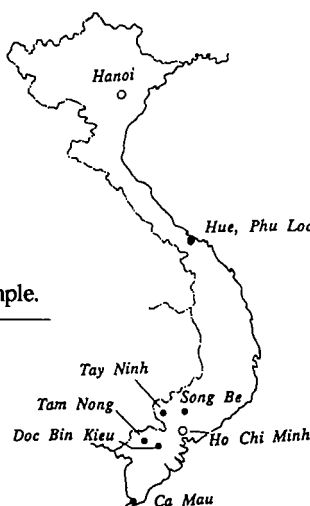
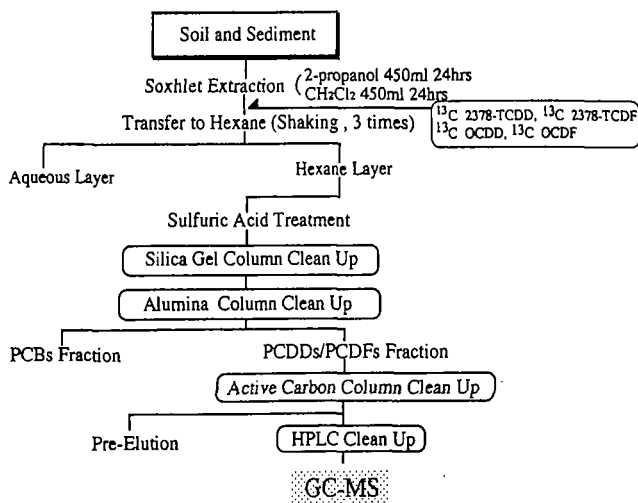


Fig.1 Sampling location in Vietnam

These samples were placed in chemically cleaned polyethylene bags and brought to Japan. They were air-dried in room temperature and passed through a 32 mesh sieve.

Each of soil sample(50g) was analyzed by following the procedures standardized in our laboratory.(Fig.2) Samples were extracted by 2-propanol and dichloromethane using a soxhlet apparatus followed by clean up with silicagel and basic alumina glass column chromatography. A final activated carbon and HPLC clean up were performed for all samples.<sup>9)</sup>

Determinations of PCDDs/DFs were made using a Hewlett Packard GC model HP 5890A and MSD model HP5970 (HRGC/LRMS). Capillary columns used were SP2331(30m) and ULTRA 1 (25m). The GC/MS system was used in the selected ion monitoring mode. The recovery of internal standard (<sup>13</sup>C-labelled 2,3,7,8-TeCDD/DF and -OCDD/DF) for all samples generally ranged between 50-90%.



**Fig.2 Analytical Procedure of PCDDs/DFs in Soil**

## RESULTS AND DISCUSSION

2,3,7,8-TeCDD was detected in some soils in Vietnam and the levels were generally very low. Only in a few locations the concentrations were detectable, contrary to our expectation. The levels of 2,3,7,8-TeCDD detected in 14 of 54 samples from Tay Ninh Province were ranged 1.2 - 38.5 pg/g dry weight basis (mean value:14.0 pg/g). The values determined in other locations were as follows: 4 of 6 from Hue Phu Loc(4.4 - 17.0, mean value:8.6 pg/g), 1 of 11 from Song Be Prov. (6.0 pg/g), 2 of 9 from Ho Chi Minh city (3.0 and 59 pg/g). These results (Table 1) show that most of the sprayed volume have been leached and ultimately drained toward sea and to the soil subsurface during the rainy season<sup>1)</sup>

Our soil profile data showed that 2,3,7,8-TeCDD existed in surface layer up to 10cm depth and could not be detected at lower than 10 cm of depth. Sprayed herbicide volume was considered 7.2 million kl and 10% area of the south of Vietnam was considered to be polluted by 170 kg of 2,3,7,8-TeCDD. The estimated amount per unit area, assuming a uniform distribution, is 163 mg/ha.<sup>6)</sup> If we would adopt that the sprayed area is 30000 km<sup>2</sup>,<sup>7)</sup> the estimated 2,3,7,8-TeCDD concentration in soil of 10cm depth at the early of sprayng is 25 pg/g considering that specific gravity of soil is 2.224.<sup>8)</sup> (Table 2)

**Table 2 An estimated level of 2,3,7,8-TeCDD in soils sprayed herbicides**

Sprayed Volume : 170 kg/10 years\*  
 Sprayed Area : 10,400\* ~ 30,100 km<sup>2</sup> \*\*

An estimator of 2,3,7,8-TeCDD residue ⇒ 25 pg/g

\* by A.H. Westing (1984)

\*\* by Le Cao Dai, et al (1986)

**Table 1 Levels ( pg/g dry weight ) of PCDDs/DFs in soils from Vietnam**

	Hanoi (5)	Hue Phu Loc(6)	Ho Chi Minh(9)	Tay Ninh (54)	Song Be (11)	Tam Nong (4)	Dog Bin Kieu (6)	Ca Mau (16)
2,3,7,8- 1,3,6,8- 1,3,7,9- ΣTeCDD	-	4.37 - 16.8 (4)	2.98 ,59.2 (2)	1.2 - 38.5 (14) 0.3 - 49.6 (13)	6.0(1) 0.6(1)	-	-	-
ΣPeCDD	-	-	4.74 - 9.96 (2)	6.1 - 40.3 (10)	1.0(1)	-	-	-
ΣHxCDD	-	-	36.2 - 98.4 (6)	14 - 416 (12)	4.7, 9.5(2)	-	10 - 18 (6)	33 - 85 (11)
ΣHpCDD	40.4 (1)	11.1 - 105 (3)	67.9 - 402 (8)	3.5 - 2900 (40)	2.7 - 185 (10)	-	26 - 53 (6)	43 - 154 (15)
OCDD	66.3 - 578 (5)	72.8 - 1318 (6)	317 - 1865 (9)	17 - 16000 (49)	11 - 880 (11)	69(1)	180 - 380 (6)	210 - 900 (16)
ΣPCDD	66.3 - 619 (5)	77.2 - 1428 (6)	469 - 2268 (9)	11 - 16970 (49)	13.7 - 1065 (11)	69 (1)	227 - 451 (6)	253 - 1139 (16)
ΣTeCDF	-	-	9.21 - 43.7 (5)	1.6 - 509 (19)	4.9 (1)	-	-	-
ΣPeCDF	-	-	-	29, 165 (2)	-	-	-	-
ΣHxCDF	-	-	37.1 (1)	11.4 - 662 (6)	-	-	-	-
ΣHpCDF	-	-	71.7 (1)	14 - 830 (5)	-	-	-	-
OCDF	NA	NA	NA	3.6 - 560 (5)	-	-	-	-
ΣPCDF			9.21 - 152 (5)	1.6 - 2190 (24)	4.9 (1)			

-:less than the detection limit (1~50pg/g)

NA:Not Analysis

Number in parenthesis shows detected sample

It is presumed that the place detected nearly to 25 pg/g was undergone no runoff soil.

Other PCDDs except 2,3,7,8-TeCDD and PCDFs had been detected. It was known that herbicides 2,4,5-T contained 2,3,7,8-TeCDD and herbicide 2,4-D did 1,3,6,8- and 1,3,7,9-TeCDD. For this reason, we confirmed that the defoliant was sprayed in Tay Ninh where other TeCDD except 2,3,7,8-TeCDD had been detected. In everywhere, HpCDD and OCDD levels were very high in comparison to other PCDDs. Those congeners could not to be related to defoliant. Because we could detect those congener in soils from Hanoi. S.Hashimoto et al (1990) reported that HpCDD and OCDD were born spontaneously as a result of analyzing core sample of sediment. The core sample at 875 cm of depth in sediment was generated 8000 years ago.<sup>9</sup> In this reason, We have suggestion that HpCDD and OCDD in soils from Vietnam are also born spontaneously.

High concentration of PCDFs could be detected in some soil samples from Tay Ninh prov. We could detect considerable PCB residues in the same soil sample.<sup>9</sup> This location was used as base ground by U.S. Air Force. The composition of PCDFs congeners in this location was much similar to those of Arochlor-1254 and Arochlor-1260 in comparison with the composition of PCDDs/DFs congeners in PCBs which was reported by T.Wakimoto et al.<sup>10</sup>

Other sources must be consider for PCDFs pollution. We recognized that considerable PCDFs contamination existed in 2,4-D which had been used in Tay Ninh prov. Not only PCDFs contamination, PCDDs contamination could be also approved. (Fig.3)

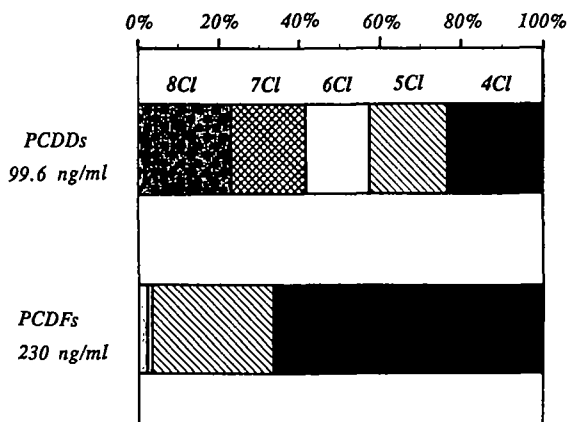


Fig.3 Compositions of PCDDs/DFs congeners in 2,4-D using in Tay Ninh Prov.

## CONCLUSIONS

1. In places where there is no runoff soils, most of 2,3,7,8-TeCDD residues originated from defoliant were still present.
2. Even though the area had been sprayed heavily by defoliant, current levels of 2,3,7,8-TeCDD in Vietnam soils are not so much different from soils in non-sprayed area.
3. At present and in future, we must monitor PCDDs/DFs pollution by pesticides (e.g. 2,4-D using now) and PCBs.

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