

Ambient Concentrations of PCDDs, PCDFs and PCBs in New Zealand Soils

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Introduction

This study is one component of the Ministry for the Environment's Organochlorines Programme which will develop national environmental standards and guidelines for organochlorine contaminants in New Zealand. As part of this programme, a major environmental survey was undertaken to determine concentrations of PCDDs, PCDFs, PCBs, organochlorine pesticides and chlorophenols in specific environmental compartments. Details on the background to this environmental survey¹ and initial contaminant concentration data for aquatic environments² have been reported previously. This paper reports data on the levels of PCDDs, PCDFs and PCBs in New Zealand soils.

Materials and Methods

Soil samples were collected and analysed as previously reported¹. All 2,3,7,8-PCDD and PCDF congeners were measured congener specifically, along with homologue totals. The following PCB congeners were determined: PCB #77, 126, 169, 28, 31, 52, 101, 99, 123, 118, 114, 105, 153, 138, 167, 156, 157, 187, 183, 180, 170, 189, 202, 194, and 206.

Results and Discussion

A full report³ on this study, including the sampling and analytical methods, and complete contaminant concentration data is available from the Ministry for the Environment. A summary of the PCDD, PCDF and PCB data (dry weight basis) is given in Table 1.

Concentrations of PCDDs and PCDFs (including half the limit of detection (LOD) values for non detectable congeners) were typically in the range 0.17 - 1.99 ng I-TEQ kg⁻¹ (pristine soils), 0.17 - 0.90 ng I-TEQ kg⁻¹ (agricultural soils) and 0.52 - 6.67 ng I-TEQ kg⁻¹ (urban soils). One agricultural sample and one provincial centre sample were found with elevated concentrations of 2,3,7,8-TCDD, which could be associated with the manufacture and use of the phenoxy herbicide 2,4,5-T.

The pristine forest soils were found to contain relatively greater concentrations of the less highly chlorinated congeners, most notably the TCDFs, when compared to the pristine

grassland, agricultural and urban soils. The enhanced accumulation of the less highly chlorinated PCDDs and PCDFs in forest soils has also been observed in studies overseas^{4,5}.

Table 1 Concentrations of PCDD/Fs and PCBs in New Zealand soils.

Land Type	Sum PCDD/Fs ^a ng kg ⁻¹ DW		PCDD/F I-TEQ ^a ng kg ⁻¹ DW		Sum PCB congeners ^a µg kg ⁻¹ DW		PCB TEQ ^a ng kg ⁻¹ DW	
	Min	Max	Min	Max	Min	Max	Min	Max
Pristine forest	17.1	306	0.17	1.99	0.14	1.20	0.065	0.16
Pristine grassland	26.9	101	0.35	0.85	0.13	0.25	0.065	0.29
Hill country pasture	13.1	121	0.37	0.90 (9.14) ^b	0.12	0.18	0.065	0.12
Flat land pasture	15.8	372	0.17	0.74	0.12	0.37	0.065	0.13
Provincial centre	71.2	1200	0.72	3.73 (33.0) ^b	0.30	3.38	0.067	0.23
Metropolitan centre	50.6	2850	0.52	6.67	0.23	9.74	0.087	1.33

(a) Includes half LOD for non detected congeners; (b) Single outlier

In general, PCDD and PCDF concentrations in agricultural soils were extremely low, with a median contaminant level for hill country pasture of 0.58 ng I-TEQ kg⁻¹ (including half LOD) and a median level for flat land pasture of 0.54 ng I-TEQ kg⁻¹ (including half LOD). These results are consistent with the recent finding of low dietary exposures of the New Zealand population to PCDDs and PCDFs⁶.

PCDD and PCDF concentrations (including half LOD), for provincial centre soils were determined in the range 0.72 to 3.73 ng I-TEQ kg⁻¹ with one outlier of 33.0 ng I-TEQ kg⁻¹. The median TEQ level for provincial centre soils was 1.05 ng I-TEQ kg⁻¹. The provincial centres studied have residential populations ranging from 108,428 (Hamilton) to 10,191 (Greymouth), and would be typical of urban townships in New Zealand. PCDD and PCDF concentrations found in the two metropolitan centres were comparable to concentrations determined in provincial centres. For Auckland, concentrations were in the range 1.03 to 6.67 ng I-TEQ kg⁻¹ (median = 1.76 ng I-TEQ kg⁻¹), and for Christchurch in the range 0.52 to 1.84 ng I-TEQ kg⁻¹ (median = 0.79 ng I-TEQ kg⁻¹).

Irrespective of land type, for almost all samples, the more highly chlorinated PCDD congeners were the most abundant and most frequently detected of all the PCDDs and PCDFs. As a result, the major contributors to total I-TEQs were typically the 1,2,3,4,6,7,8-HpCDD and OCDD. Collectively, these two congeners contributed on average approximately 75 % or more of the total I-TEQ when calculated excluding LOD.

With few exceptions, no PCB congeners were measured in pristine or agricultural soils. A limited number of congeners were found in urban soils, giving PCB concentrations (including half LOD) for provincial centres in the range 0.067 - 0.23 ng TEQ kg⁻¹ and for

metropolitan centres in the range 0.087 - 1.33 ng TEQ kg⁻¹. The most frequently detected and abundant PCB congeners found in provincial and metropolitan centres soils were PCB #153 and #138. Collectively, these two congeners accounted for approximately 45 % of the sum of PCB congeners measured, and together with congeners #101, #118, #187, #180 and #170, accounted for approximately 85 % of the sum of PCB congeners measured.

It is useful to place this concentration data in an international perspective. Relevant comparative data includes results from studies undertaken in the Netherlands⁷, Germany⁸ and the UK⁹. In the Netherlands⁷, soils from 32 grassland sites gave PCDD and PCDF concentrations in the range 1.8 to 16.4 ng I-TEQ kg⁻¹. On the basis of this study, it was estimated that general background levels in Dutch soils varied from 2 to 10 ng I-TEQ kg⁻¹, with a maximum concentration of 20 ng I-TEQ kg⁻¹. An extensive soil database including 1,594 samples from rural, urban and industrial settings in Germany shows the difference between urban and rural soils⁸. The soil levels in rural settings (excluding forest soils) ranged from 1 to 5 ng I-TEQ kg⁻¹. In urban areas typical PCDD and PCDF concentrations in the soil ranged between 10 to 30 ng I-TEQ kg⁻¹, whereas in industrial areas the concentrations ranged up to 100 ng I-TEQ kg⁻¹. In the UK⁹, PCDD and PCDF concentrations in rural soils were determined in the range 0.78 to 17.5 ng I-TEQ kg⁻¹, with a mean of 5.17 ng I-TEQ kg⁻¹. The urban soils had PCDD and PCDF concentrations in the range 4.88 to 87.3 ng I-TEQ kg⁻¹, with a mean of 28.4 ng I-TEQ kg⁻¹.

The results from this soil survey show that loadings of PCDDs, PCDFs, and PCBs in New Zealand soils (Table 1) are markedly lower than concentrations reported for pristine, agricultural and urban soils in other developed countries.

References

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Figure 1 Sampling locations

