

NATIONWIDE PCDD/Fs LEVELS IN AMBIENT AIR, VEGETATION AND SOIL IN THE VICINITY OF 19 MSWIS IN TAIWAN

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Introduction

The ROC Taiwan government has selected incineration as the major means of waste treatment considering the increasing lack of landfill sites. A national project to construct 21 large municipal solid waste incinerators (MSWIs) was implemented in 1991. Currently, there are 19 MSWIs in operation with a daily treatment capacity of 16,900 metric tons. Atmospheric emission of dioxins from MSWIs has always been heavily concerned by the public. In response to this issue, both the central and local governments have entrusted a series of projects to survey polychlorinated dibenzo-*p*-dioxins and dibenzofurans (PCDD/Fs) levels in ambient air, vegetation, and soil in the vicinity of large MSWIs. In this paper, we collected and analyzed the reported PCDD/Fs data from these survey projects. The aim is to present nationwide PCDD/Fs distribution in Taiwan environment, discuss the possible emission sources, and suggest future actions.

Methods and Materials

The PCDD/Fs levels in 366 ambient air samples, 250 vegetation samples and 286 surface soil samples from 222 sampling sites in the vicinity of 19 MSWIs were reported in this paper. The data were from various survey programs¹⁻⁹ with samples collected in two seasons during 1999 and 2002. Each MSWI was assigned a code with corresponding location shown in the right side of Fig. 1. The vegetation samples were predominantly banyan leaves. The reported data in the report were all subjected to committee review to assure the fulfillment of QA/QC requirements.

Results and Discussion

PCDD/Fs levels in ambient air, vegetation and soil in the vicinity of MSWIs were shown in Tables 1, 2 and 3, respectively. The mean and median value are 0.123, 0.084 pg-TEQ/Nm³ in ambient air, 3.365, 2.700 pg-TEQ/g d.m. in vegetation, and 3.608, 1.370 pg-TEQ/g d.m. in soil, respectively. The mean to median ratio is 1.5, 1.3 and 3.6, respectively, indicating that the data is normally distributed. We therefore use median value to represent the average environmental level.

The minimum and maximum value are 0.004, 1.680 pg-TEQ/Nm³ in ambient air. The highest five median values are from MSWIs J, E, M, G, and Q. Detailed study of the industrial activities around MSWI J indicated a nearby medical waste incinerator is responsible for the extraordinary high ambient PCDD/Fs. The source for high PCDD/Fs around MSWI E was not found yet. Consistent low stack emissions obtained from regulator monitoring program precludes MSWI E as the source. Open burning of household waste was proposed as the source for MSWI M which was under construction.

Figure 1 presents the nationwide distribution of PCDD/Fs levels in ambient air in the vicinity of 19 MSWIs (left portion) with corresponding location (right portion). The size of the circle is directly proportional to the median value of ambient PCDD/Fs TEQ around each MSWI. Almost all MSWIs located in the western Taiwan where 93% of the population resided, i.e., the north and the southwest

regions¹⁰. The monitored values around MSIW S could therefore be regarded as PCDD/Fs baseline level in Taiwan. They are 0.020 pg-TEQ/Nm³ in ambient air, 0.303 pg-TEQ/g d.m. in vegetation, and 1.300 pg-TEQ/g d.m. in soil.

The minimum and maximum value are 0.029, 33.70 pg-TEQ/g d.m. in vegetation. The highest five median value are from MSWIs N, E, A, C, and R. The minimum and maximum value are ND, 180.0 pg-TEQ/g d.m. in soil, respectively. The highest five median value are from MSWIs E, Q, G, C, and P. The extraordinary high PCDD/Fs levels in air, vegetation, and soil around MSWI E, warrants detailed investigation of the other emission source. MSWI Q possessed extraordinary high PCDD/Fs levels in air and soil also warrants future study. On the contrary, the extraordinary high PCDD/Fs level in air and soil around MSWI G, which was under construction then, indicates the presence of other emission sources. Therefore, the MSWI Q can not be solely responsible for the high ambient air levels. A remarkable PCDD/Fs difference in air was observed for MSWI D when the incinerator ceased operation for improvement. This might because MSWI D equipped with an electrostatic precipitator and wet-scrubber gas-cleaning system for dioxin abatement.

Table 1. PCDD/Fs level in ambient air in the vicinity of MSWIs in Taiwan. (pg-TEQ/Nm³)

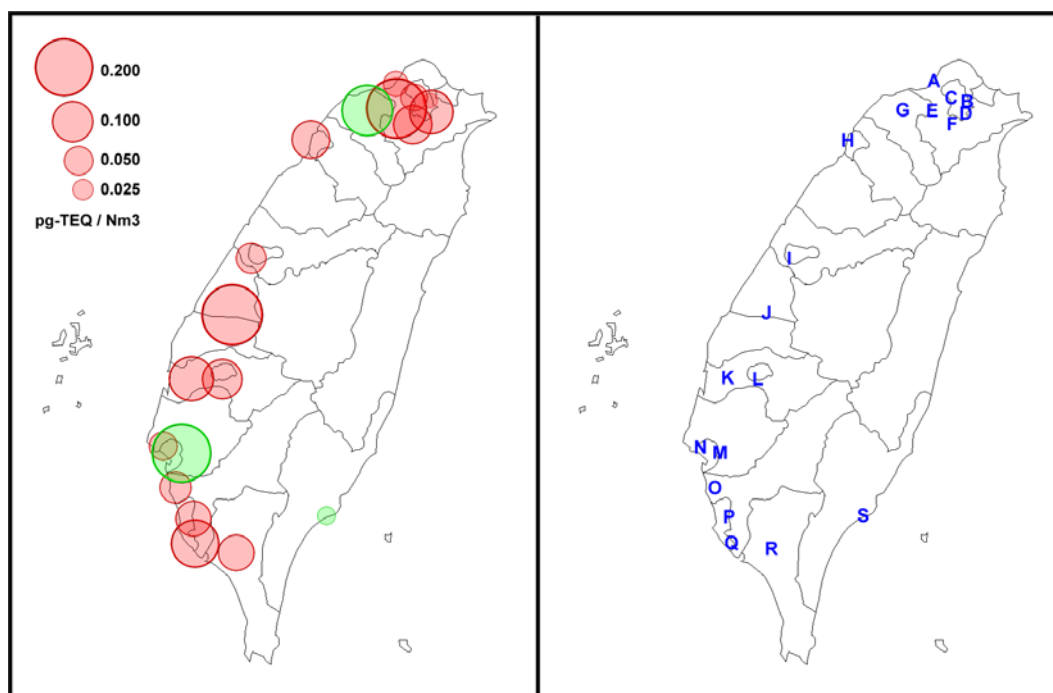
Code	n	Mean	Median	Minimum	Maximum
A	16	0.045	0.039	0.009	0.137
B	16	0.018	0.013	0.004	0.045
C	16	0.058	0.044	0.008	0.143
D	28	0.293	0.114	0.036	1.680
^a D	9	0.021	0.021	0.009	0.044
E	20	0.220	0.217	0.057	0.500
F	12	0.095	0.090	0.020	0.200
[*] G	12	0.188	0.157	0.049	0.404
H	17	0.103	0.088	0.050	0.272
I	26	0.204	0.056	0.022	1.190
J	16	0.196	0.220	0.024	0.339
K	16	0.113	0.120	0.017	0.246
L	14	0.168	0.095	0.008	0.723
[*] M	48	0.266	0.209	0.018	1.450
N	16	0.050	0.048	0.023	0.087
O	16	0.057	0.059	0.011	0.179
P	14	0.069	0.077	0.020	0.140
Q	14	0.184	0.136	0.028	0.433
R	16	0.082	0.079	0.015	0.181
[*] S	24	0.031	0.020	0.008	0.103
All	366	0.123	0.084	0.004	1.680

^a: collected during the ceased operation period

^{*}: collected before the construction

Acknowledgements

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Figure 1. Nationwide distribution of PCDD/Fs level in ambient air in the vicinity of 19 MSWIs (left) and corresponding location in Taiwan (right).

Table 2. PCDD/Fs level in vegetation in the vicinity of MSWIs in Taiwan. (pg-TEQ/g d.m.)

Code	n	Mean	Median	Minimum	Maximum
A	14	9.680	5.910	1.080	29.90
B	14	3.050	2.700	0.964	9.730
C	14	6.110	4.210	0.702	33.70
D	14	1.790	0.842	0.261	9.760
E	16	8.810	6.350	1.730	21.00
F	14	1.390	0.931	0.223	6.440
*G	14	3.150	2.800	0.331	8.730
I	14	3.790	2.920	1.250	8.240
J	14	2.520	0.988	0.427	9.440
K	14	1.710	1.290	0.355	5.110
L	14	2.320	1.750	0.560	6.130
N	14	6.520	6.530	1.560	9.890
O	14	3.610	3.430	2.020	5.970
P	14	1.850	1.420	0.502	5.190
Q	14	1.500	1.710	0.338	3.490
R	14	3.550	3.630	1.880	5.200
*S	24	0.453	0.303	0.029	1.860
II	250	3.635	2.700	0.029	33.70

* collected before the construction

Table 3. PCDD/Fs level in soil in the vicinity of MSWIs in Taiwan. (pg-TEQ/g d.m.)

Code	n	Mean	Median	Minimum	Maximum
A	14	2.470	2.000	0.633	9.430
B	15	3.330	1.680	0.327	24.60
C	14	1.930	2.050	0.835	2.900
D	14	0.651	0.442	0.143	1.680
E	16	4.350	5.000	0.401	10.90
F	14	9.120	0.046	ND	67.90
*G	14	4.110	2.280	0.150	19.80
H	10	1.910	1.460	0.524	5.020
I	14	1.790	1.370	0.455	5.030
J	14	1.060	0.755	0.317	3.660
K	14	7.600	0.985	0.513	55.90
L	14	13.50	0.640	0.266	180.0
*M	24	1.940	1.450	0.370	5.870
N	15	1.400	0.958	0.512	6.500
O	14	2.060	1.290	0.797	4.870
P	14	3.840	2.030	0.659	17.90
Q	14	4.380	3.580	0.921	13.00
R	14	1.680	1.110	0.466	6.060
*S	24	1.430	1.300	0.154	3.450
II	286	3.608	1.370	ND	180.0

* collected before the construction

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