CORRELATING PCDD/FS AIR EMISSION INVENTORY TO AMBIENT AIR PCDD/FS AT A COUNTY SCALE

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Abstract

The Taoyuan County Dioxin Air Emission Inventory (TCDAEI) was established using locally data measured by accredited laboratories using standard methods. This study tried to realize the advantages of correlating DAE inventory to ambient air PCDD/Fs (AAD) levels at a county scale. A continuously decreasing trend of DAE was observed from year 2004 to 2007, reflecting the benefit of enforcing dioxin standards. The significant difference among DAE from different geographic area indicated the spatial characteristic of DAE. The AAD fluctuation in urban and rural area was minute. On contrast, significant difference between AAD from sampling sites in the industrial park was apparent, implying local DAE sources were highly responsible for seasonal fluctuation of AAD from industrial parks. The relationship of DAE to AAD using data from industrial park was not positively correlated. Nevertheless, regular measurements of AAD could reveal abnormal DAE and warranted timely remedy action.

Introduction

Taoyuan in Chinese means "peach blossom garden" and is located midway between the capital city of Taipei and the Hsinchu high-tech industrial center. With a land area of 1,220 square kilometers and about 2 million inhabitants, the population density is about 1600 inhabitants/Km^2. Driven by increasingly growing economic activity, the environmental burden has become an issue of public concern. A total of fifty-seven incinerators and stationary pollution sources are mandatory to comply with dioxin control and emission standards on waste incinerator, small- and medium-sized incinerator, steelmaking industry electric arc furnace, and stationary pollution source (Table 1) [1]. The Taoyuan County Government initiated a dioxin air emission reduction strategy in year 2003.

Table 1. Dioxin standards in Taiwan[1]

Regulated Entities	Applicable Conditions		Emission Standards (ng I-TEQ/Nm^3)	Compliance Time
Waste incinerator	10 ton/hr or 300 ton/day	Newly	0.1	1997/08/08
		Existing		2001/08/08
Small- and medium-sized waste incinerator	Larger than 4 ton/hr	Newly	0.1	2001/01/01
		Existing	0.1	2003/01/01
	smaller than 4 ton/hr	Newly	0.5	2001/01/01
		Existing		2004/01/01
Steelmaking Industry Electric Arc Furnace	All applicable	Newly	0.5	2002/01/01
		Existing	5.0	2004/01/01
			0.5	2007/01/01
Steel Industry Sintering plant	All applicable	Newly	0.5	2004/06/16
		Existing	2.0	2006/01/01
			1.0	2008/01/01
Steelmaking Industry Electric Arc Furnace Dust High Temperature Refining Facility	All applicable	Newly	0.4	2005/10/12
		Existing	9.0	2005/10/12
			1.0	2006/09/01
Stationary Pollution Source	All applicable	Newly	0.5	2006/01/02
		Existing	2.0	2007/01/01
			1.0	2008/01/01

Various activities were undertaken by Taoyuan County Government thereafter which included the development of Taoyuan County Dioxin Air Emission Inventory (TCDAEI). TCDAEI was designed to function like existing inventories[2,3] except at a county scale aiming at assessing DAE reduction improvement, tracking performance of enlisted dioxin emission source, and revealing temporal trend and spatial difference of DAE. The quality of DAE is high owing to the use of local dioxin data measured by accredited laboratories using standard methods. However, other factors, such as stack height, meteorology (wind direction and speed, temperature, etc.,), distance from emission source, atmospheric transfer and deposition…all affected the level of ambient air PCDD/Fs (AAD) released from DAE sources. The AAD was usually measured by the academic laboratory as Taiwan currently does not have any standard regarding AAD, which permits the sampling and analysis of ambient PCDD/Fs by any capable and creditable laboratory. The AAD might provide clue about the temporal and spatial variability of atmospheric PCDD/Fs at rural, urban, and industrial locations, aiming at: (1) to safeguard the AAD is below the tentative maximum allowable level of 0.6 pg I-TEQ/Nm^3; (2) to foresee potential new DAE and mal-functioned DAE sources; (3) to provide metric for assessing DAE improvement.

In order to realize the advantages of correlating DAE inventory to AAD levels at a county scale, we used measured data from Taoyuan County, Taiwan. We collected and analyzed the TCDAEI to understand its trend and spatial characteristics first, followed by collecting AAD data of Taoyuan County.

Materials and Methods

The annual DAE from a source was obtained by multiplying the emission factors (EF, g I-TEQ/T) with activity rate (A, T/yr). We used locally measured EF to estimate annual DAE (g I-TEQ/yr). The stack gas PCDD/Fs were measured using Taiwan EPA standard methods[4] NIEA 807.74C and NIEA 808.73B and carried out by Industrial Technology Research Institute, Taiwan. The AAD were collected during four campaigns from year 2008 to 2009. Eight sampling sites spread in Taoyuan County (Figure 1) were selected. Ambient air sampling was carried out using US EPA Compendium Method TO-9A. PCDDs/Fs analyses were carried out by NTHU team using US EPA Method 23. Detailed experimental details were reported previously.[5]

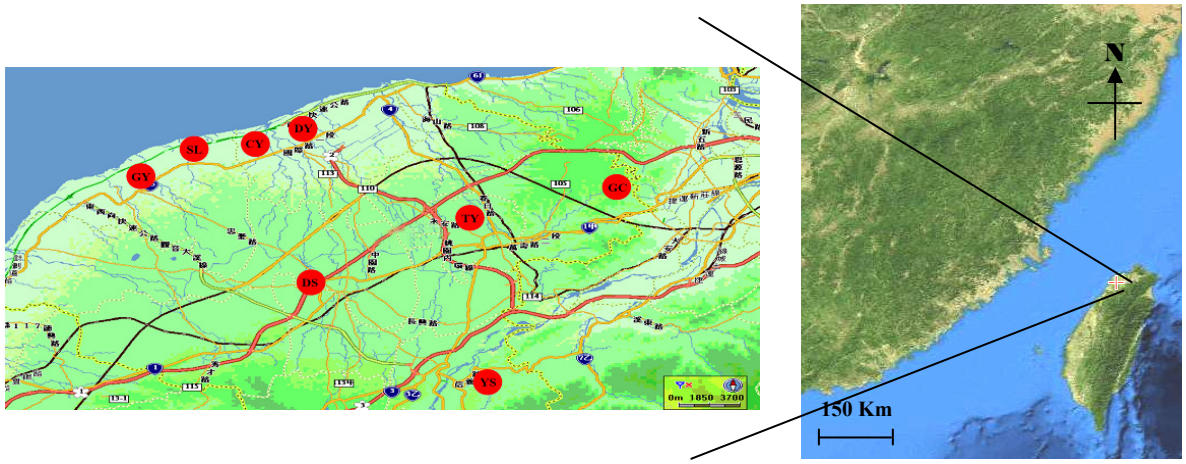

Figure 1. The ambient sampling sites in Taoyuan County, Taiwan

Results and Discussion

Table 2 summarizes the DAE of Taoyuan County from year 2004 to 2008. A continuously decreasing trend was observed from year 2004 to 2007. The abrupt increase in year 2008 was due to the onset enforcement of dioxin control and emission standards of stationary pollution sources on 2008/01/01. An additional 2.121 g I-TEQ/yr released from stationary pollution sources was taken into count. The temporal trend of decreasing DAE reflects the benefit of enforcing dioxin standards. The year 2008 DAE was further divided into four sectors, namely, DY industrial park, GY industrial park, CL industrial park, and other as 0.29, 0.29, 0.95, and 6.92 g I-TEQ/yr, respectively. The significant difference among DAE from different geographic area indicated the spatial characteristic of DAE.

Table 2. Summary of Taoyuan County DAE (g I-TEQ/yr)

Category	Year				
	2004	2005	2006	2007	2008
Large-sized SWI	0.055	0.055	0.056	0.056	0.059
Medium-sized SWI	0.094	0.066	0.044	0.086	0.090
Small-sized SWI	0.302	0.192	0.113	0.488	0.391
Electric arc furnaces	10.611	9.980	8.836	6.649	5.538
Boilers with auxiliary fuel	0.055	0.054	0.066	0.114	0.271
Stationary polluting sources	--	--	--		2.121
Taoyuan County DAE	11.117	10.347	9.116	7.393	8.470

Table 3 summarizes the AAD of Taoyuan County in year 2008. Sampling sites GY and SL located in GY industrial park; DY and CY located in DY industrial park; TY located in Taoyuan City; DS located near CL urban industrial park; GC located near heavy traffic road; YS located in rural mountain area. Elevated level (0.868 pg I-TEQ/Nm^3) was observed once at GY. Seasonal fluctuation of AAD was apparent, i.e. from industrial park CY, DY, CL. Significant difference between the two sampling sites in the same park, i.e., GY and SL; DY and CY, was also observed. On contrast, the AAD fluctuation in urban TY and rural YS results was minute, implying local DAE sources were highly responsible for seasonal fluctuation of AAD from industrial parks. The relationship of DAE to AAD using data from GY, DY, and CL industrial park was not positively correlated, indicating the representativeness of the sampling sites might be questionable. Another possible cause is the completeness of the enlisted DAE sources. Nevertheless, regular measurements of AAD could reveal abnormal DAE and warranted timely remedy action. The search for mal-functioned DAE source is another challenging task and is currently undergoing.

Table 3：Summary of Taoyuan County ambient air PCDDs/Fs (pg I-TEQ/Nm^3)

Sampling Date	Sampling Site							
	GY Industrial Park		DY Industrial Park		Urban		Road	Rural
	GY	SL	DY	CY	TY	DS	GC	YS
2008/5~6	0.047	0.089	0.106	0.333	0.042	0.021	0.013	0.011
2008/8~9	0.868	0.075	0.057	0.083	-	-	-	-
2008/11~12	0.279	0.065	0.032	0.367	0.034	0.174	0.067	0.023
2009/1~2	0.071	0.067	0.056	0.405	-	-	-	-
Average	0.316	0.074	0.063	0.297	0.038	0.098	0.040	0.017

Acknowledgements

The authors are thankful to the National Science Council of Taiwan and Environmental Protection Bureau of Taoyuan County Government for financial support.

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