# Survey on pollution level of PCDDs and PCDFs in River Sediments from Northern Part of Taiwan, Republic of China

**Osamu Aozasa, Teruyuki Nakao, Souichi Ohta and Hideaki Miyata**
Faculty of Pharmaceutical Science, Setunan University 45-1, Nagaotoge-cho, Hirakata, Osaka 573-01, Japan
**Hueng-Tser Tsai**
Department of Environment Engineering and Health, China-Nan College of Pharmacy and Science, Tainan, Taiwan, Republic of China
**Jinn-Rong Lu**
Global-Entech Co., LTD., 2nd Floor, 5, Lane 235, Pao Chiao Road, Hsin Tine Taipei, Taiwan, Republic of China
**Yu-Tzu. Huang**
Department of Agriculture Chemistry, Taiwan University Chung-Li, Taipei, Taiwan, Republic of China

## Introduction

We already surveyed that sediments in the estuary area of representative 12 rivers in the whole Taiwan, Republic of China, which were polluted by polychlorinated dibenzo-p-dioxins (PCDDs), polychlorinated dibenzofurans (PCDFs) and non-ortho chlorine substituted coplanar PCBs (Co-PCBs)[1]. Among the sediment in 12 rivers analyzed, high pollution was observed in the sediments of Tanshui River of northern part of Taiwan, Laochieh Rivulet of northern part of Taiwan and Putzu Rivulet of southern part of Taiwan. In the above three rivers with high pollution, a further survey of the pollution degree in upper basin of Tanshui River as the largest river is therefore needed.
In this study, 17 surface sediment samples from over the downstream to the upstream area of Tansui River and its related three rivers of Daikan River, Hsintein River and Keelung River were analyzed for PCDDs and PCDFs in order to find the contamination sources.

## Experimental methods

### 1) Sampling

Surface sediment samples were collected from over the downstream to upstream area of Tansui River and its related three rivers in northern part of Taiwan in August, 1996. The sampling points of sediment were illustrated in Fig. 1. Samples were taken within a depth of less than 20 cm from Daikan River (N=4), Hsintein River (N=4), Keelung River (N=6) and Tanshui River (N=3).

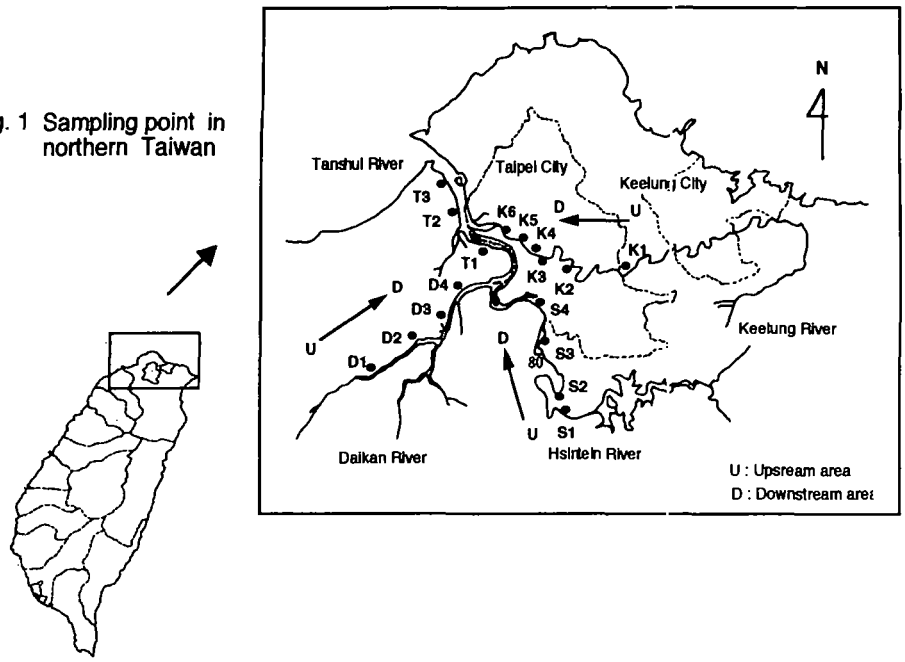


Fig. 1 Sampling point in northern Taiwan

## 2) Analytical procedure

The sediment specimens were thinned in a thickness of 1 cm, left for 1 day at 40℃ for complete dryness, and then pulverized into small pieces. Each powdered sample (50g) was extracted with 250 ml of toluene for 5 hrs. under reflex. The toluene extract was filtered through a filter with 1 $\mu$m pore size in order to remove sediment particles. After addition of keeper solvent (n-decane, 0.3 ml), the extract was concentrated to a volume of less than 0.3 ml and adjusted to a volume of 10 ml with n-hexane. After spiking of internal standards (five $^{13}C_{12}$-PCDDs and $^{13}C_{12}$-PCDFs, each 500 pg), the extract was purified according to our previous method composing essentially of multi-layer silica gel column chromatography and alumina column (10 g, Merck neutral, activate I) chromatography, followed by determination of PCDDs and PCDFs at a resolution of 8000 using a Hewlett Packard 5890J gas chromatograph-JEOL SX-102 mass spectrometer under similar conditions described elsewhere[2].

## Results and discussion

Fig. 2 showed total actual concentrations of PCDDs and PCDFs in river sediments from 17 locations. The total concentration of both compounds was in a wide range of 13.7 to 2960 pg/g dry weight (d.w.). The high level (558 to 2960 pg/g d.w.) was found in the samples from Keelung River (K1 to K6) and Tanshui River (T1 to T3). Especially, samples of K1 and K6 gave a remarkably high contamination level of 2960 and 1820 pg/g d.w., respectively. Tanshui River flows in Taipei City, and Keelung River also flows

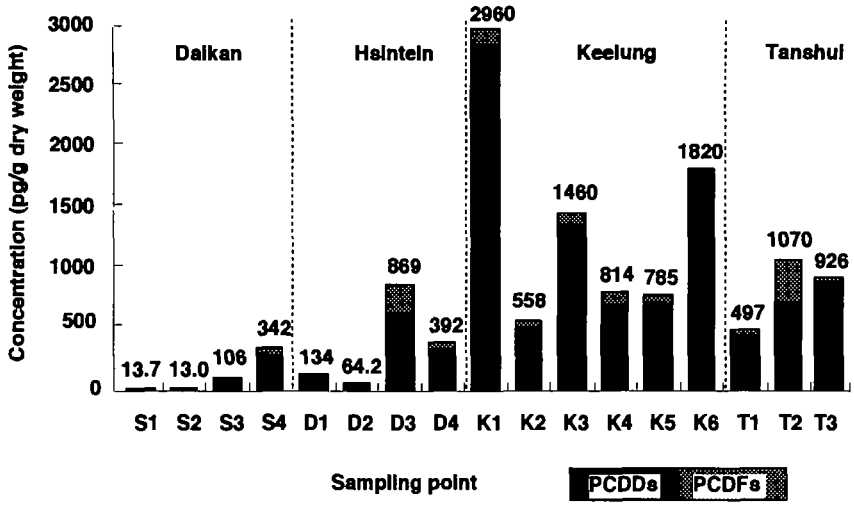


**Fig. 2 Total concentrations (pg/g dry weight) of PCDDs and PCDFs in sediments from river in northern Taiwan**

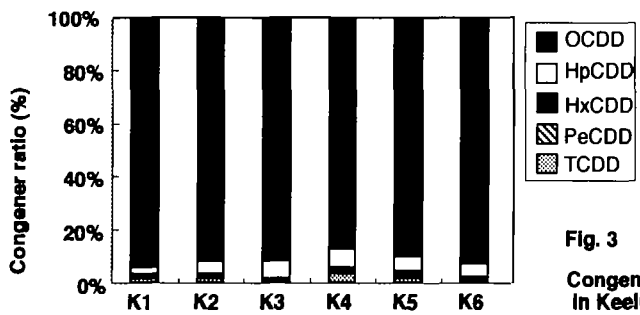


**Fig. 3**
**Congener ratios of PCDDs in Keelung River**

through Taipei and Keelung Cities with a high population density. Therefore, the adverse effects for health condition of residents living in this high polluted area were concerned. On the other hand, in Daikan River and Hsintein River, the concentrations at the lower basin sites (D3, D4 and S4) were higher than those at the upper basins (D1, D2 and S1 to S3). The reason why sampling points of D3, D4 and S4 was highly polluted, was attributed to close Taipei City as high pollution area. From these results, almost sediments (K1 to K6, T1 to T3, D3, D4 and S4) from urban area such as Taipei City and its surrounding area showed relatively a high level (342 to 2960 pg/g). This finding suggests that the contamination sources exist largely in whole urban area. In general, the MSW incineration facility or industrial factory are well known to be as one of the main sources of PCDDs and PCDFs. However, the number of two facilities is extremely limited in commercialized Taipei City with a high traffic volume. While, a bulk of leaded gasoline has been used as fuel for automobiles. In thus case, a substantially

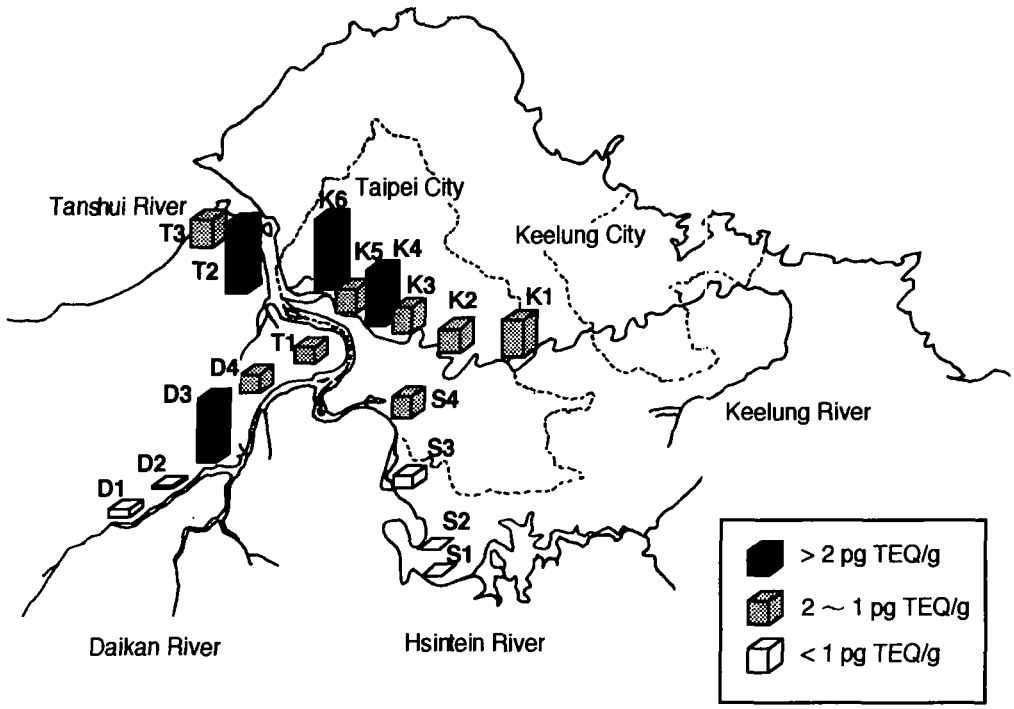


**Fig. 4 Total TEQ concentrations (pg TEQ/g dry weight) of PCDDs and PCDFs in sediments**

large amount of PCDD and PCDF was already confirmed to emit with the exhaust gas[3]. Taking the above findings into consideration, the high contamination in urban area is surmised to be mainly derived from PCDDs and PCDFs in the exhaust gas emitted from motor cars. The estimation is also supported by the result of atmospheric pollution survey using Banyan tree leaf as an indicator in whole of Taiwan[4]. Thus it was observed that the ratios of PCDDs and PCDFs for the total amount of PCDDs and PCDFs in banyan tree leaf at the district with low industrial activity such as Taipei City and its surrounding, were remarkably differ from that at industrial areas. In almost leaf samples at Taipei City and its surrounding, the high ratio of PCDDs for the total amount were observed in a range of 55 to 88%, whereas that of industrial area was below 45%. Therefore, it was suggested that high ratio was also seen in sediment samples (65 to 98%).

From the above observation result, the component ratio of PCDDs for the total amounts of PCDDs and PCDFs could be a useful parameter for the identification of contamination source. As shown in Fig. 3, the congener ratios in sediments from Keelung River with a high contamination level were compared. All samples of K1 to K6 showed the major to be OCDD with the component ratio of 87 to 94%. Interestingly, the charasteristic pattern was seen not only in Keelung River samples, but in almost sediments samples. This

indicated that they had been polluted from a common contaminant source. To clarify the contamination source, a detailed analysis of PCDDs and PCDFs in exhaust gas from motor cars in Taiwan therefore needed.

The total TEQ of PCDDs and PCDFs in sediment are summarized in Fig. 4. The level in northern Taiwan ranged from 0.03 to 4.7 pg TEQ/g. The high value was mainly observed in the sediments of Keelung River and Tanshui River. While, on the upper Daikan River and Hshintein River, the values reduced to less than 1 pg TEQ/g d.w. As well as the actual concentration, the total TEQ of PCDDs and PCDFs was also relatively high at urban area. The pollution levels of PCDDs and PCDFs in the surface sediments from 12 rivers in Japan were reported by Japanese Environmental Agency in 1995[5]. The TEQ of PCDDs and PCDFs was in a wide range of <0.02 to 24 pg TEQ/g. Taking these findings into consideration, the contamination in Taiwan was relatively lower than that in heavily contaminated Japan. However, urban area such as Taipei City in Taiwan polluted with higher level, as compared to areas with a low pollution in Japan.

**Acknowledgments**

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