# Distribution of polychlorinated biphenyl (PCBs) in sediment from aquatic environment, Thailand

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**Abstract**

To assess the status and understand the historical trends of polychlorinated biphenyls (PCBs) in Thailand, we collected forty surface sediments and two sediment cores samples from the Chao Phraya River and the Gulf of Thailand during 2004 to 2006. All samples were calculated for dry weight basis. The total PCBs concentrations were calculated from 44 isomers and congeners. $^{137}Cs$ was measured to date the sediment cores. The analyses suggested that core GT15 had an appropriate sediment accumulation rate (~1 cm/year) and covered the past 60 years. The results showed the decreasing trend of PCBs concentration in sediment from canals to the river mouth of the Chao Phraya River and to the upper Gulf of Thailand, which ranging from 112 to 933 pg/g, 70 to 217 pg/g, and 128 to 194 pg/g, respectively. The result of PCBs from the sediment cores (GT14 and GT15) ranged from 80-180 pg/g and 200-2200 pg/g, respectively. The dramatic decrease in PCB concentrations around 30 cm (GT15), corresponding to the late 1970s, clearly demonstrates the effectiveness of the governmental regulation of the use of PCBs in Thailand in 1975.

**keywords** : distribution, sediment, sediment core, river, PCBs, Thailand

## Introduction

Polychlorinate biphenyls (PCBs) are a family of organic chemicals consisting of two benzene rings linked by a carbon-carbon bond. Chlorine atoms are substituted on

any or all the ten remaining available sites. PCBs had been widely used in industry as heat transfer fluids, dielectric fluid, and flame-retardants, etc. The lipophilic nature and persistence of PCBs also contributes to their high bioaccumulation potential and their biomagnification in higher tropic levels of the food chain. The substances resist photolytic, chemical and biological degradation. The use of PCBs in Thailand started in 1955 on the official governmental record and it was banned in 1975. However, accidental leakage of PCBs from stored transformers and condensers was detected after 1975 in Thailand [Watanabe et al., 1996]. In these contexts, understanding the recent trend of PCB levels in sediment is important for evaluating the effectiveness of the regulation of PCB usage.

**Materials and methods**

The Gulf of Thailand is located on the western side of the South China Sea, and is bordered by Thailand, Vietnam, Cambodia, and Malaysia. The monitoring program started from 2004 - 2006. Surface sediment samples were collected from canals and the Chao Praya River and the upper Gulf of Thailand, Twenty-four surface samples and two sediment cores (GT14 and GT15) were collected as showed in figure 1. $^{137}Cs$ and geochronometric were measured to date the sediment cores.

Sediment samples (~ 3 g) were precisely weighed and extracted by pressurized solvent extraction (ASE 200; Dionex) with dichloromethane (DCM)/acetone (3:1, v/v). The extracts were passed through a 5% $H_2O$-deactivated silica gel column to remove polar components, following activated copper treatment to remove elemental sulfur, and fractionated through a fully activated silica gel column. The first hexane fraction contained alkanes and hopanes, and the second fraction contained the alkylbenzenes (LABs and TABs) and PCBs (Ruchaya et al., 2007).

The total PCB concentration (i.e., ∑PCB) was calculated from the sum of 44 major isomers and congeners (IUPAC nos. 8/5, 18, 17, 16/32, 31/28, 20/33, 51, 45, 52, 49, 47, 44, 59/42, 41/64, 40, 74, 70, 66, 60/56, 90/101, 97, 87/115, 110/77, 151, 149, 118, 146, 132/153, 105, 141, 137, 138/160, 187, 183, 128, 174, 177, 171, 180, 179/190, 201, 203, 195, 194 and 206). PCBs standard was mixed of commercial kanechlor (300:400:500:600 ; 1:1:1:1). ∑PCB was identified by gas chromatography-electron capture detector (HP 5890 series II plus) and injector temperature was 250 °C. The fuse

silica capillary column was HP-1 (50 m length × 0.32 mm i.d, 0.25 μm film thickness of stationary phase) the oven temperature program was 70°C for 1 min to 150°C at the rate of 10°C/min, held 1 min and increased by 3°C $min^{-1}$ to 180°C and the last step increased by 10°C/min to 250°C, and held for 20 min.

**Results and discussions**

The results showed the decreasing trend of PCBs concentration from canals, the river mouth of the Chao Phraya River and the estuary of the Chao Phraya River to the upper Gulf of Thailand, which ranging from 120 to 933 pg/g, 70 to 217 pg/g, 25 to 56 and 128 to 194 pg/g, respectively. Total PCBs concentrations in surface sediments samples shows higher concentration for tetra- to octa-chlorined ones, indicating a likely nearby source, which would correspond to Bangkok located on the left bank of the Chao Phraya River. The similarity of PCBs compositions showed closely to our previous study, which was dominanted by Kanechlor PCBs pattern (Watanabe et al.,1996). Comparison of PCBs residues among the four main rivers, which flow to the upper Gulf of Thailand, indicated that the Chao Phraya River was the main contributor of PCBs to the upper Gulf of Thailand.

The analyses suggested that core GT15 had an appropriate sediment accumulation rate (~1 cm/year) and covered the past 60 years. Core GT14 had a faster rate of sediment accumulation (~3 cm/year) and covered only the past 30 years. GT15 showed a smooth downward decrease from ~90% at the surface to ~60% at 60 cm, indicating no drastic vertical turbulence in the core. The result of PCBs from the sediment cores (GT14 and GT15) ranged from 80-180 pg/g and 200-2200 pg/g, respectively (Ruchaya el al., 2007). The major congeners (tetra- to octa-chlorinated) were detected in sediment samples from the Chao Phraya River and inshore sediments the same as sediments from our pervious studies (Watanabe et al., 2006). The subsurface maximum PCB concentrations demonstrated effective regulation of the use of PCBs in Thailand since 1975. However, PCBs were still detected in surface sediment layers (100-1000 pg/g), suggesting some leakage from storage places or resuspension and remobilization of PCBs accumulated in sediments in canals in Bangkok and lower reaches of the Chao Phraya River. Identification of the sources of PCBs is an important future task.

**Reference**

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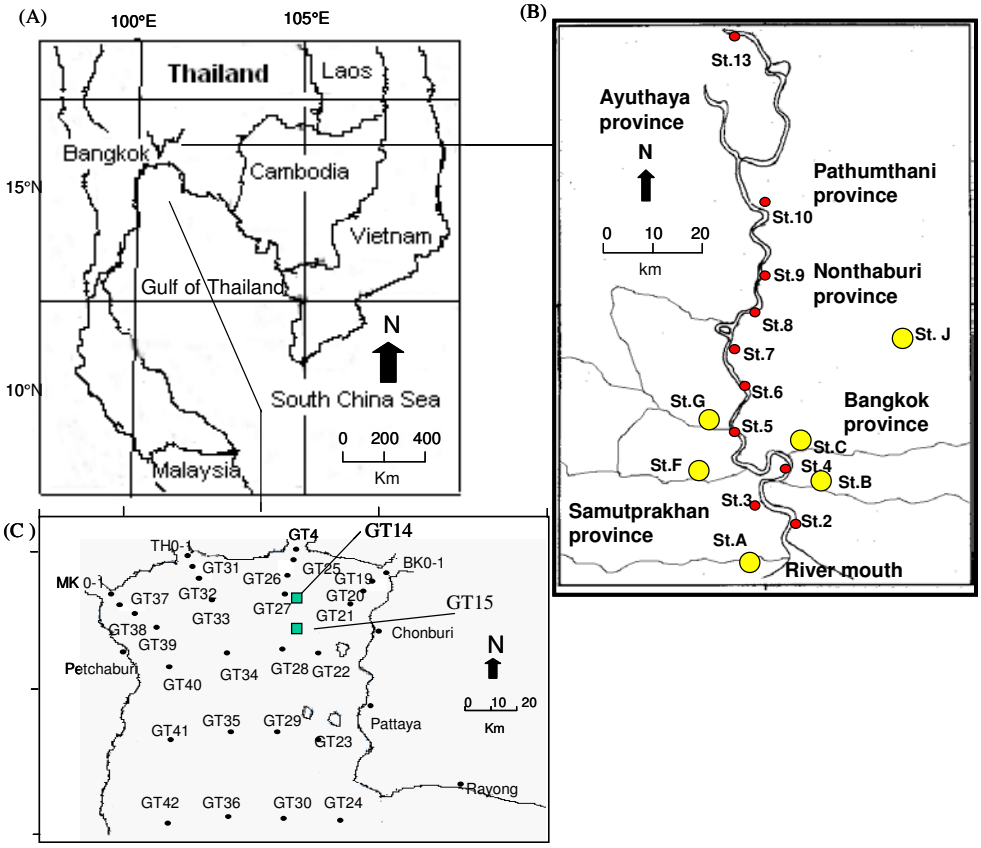


Figure 1 Sampling locations of sediment samples

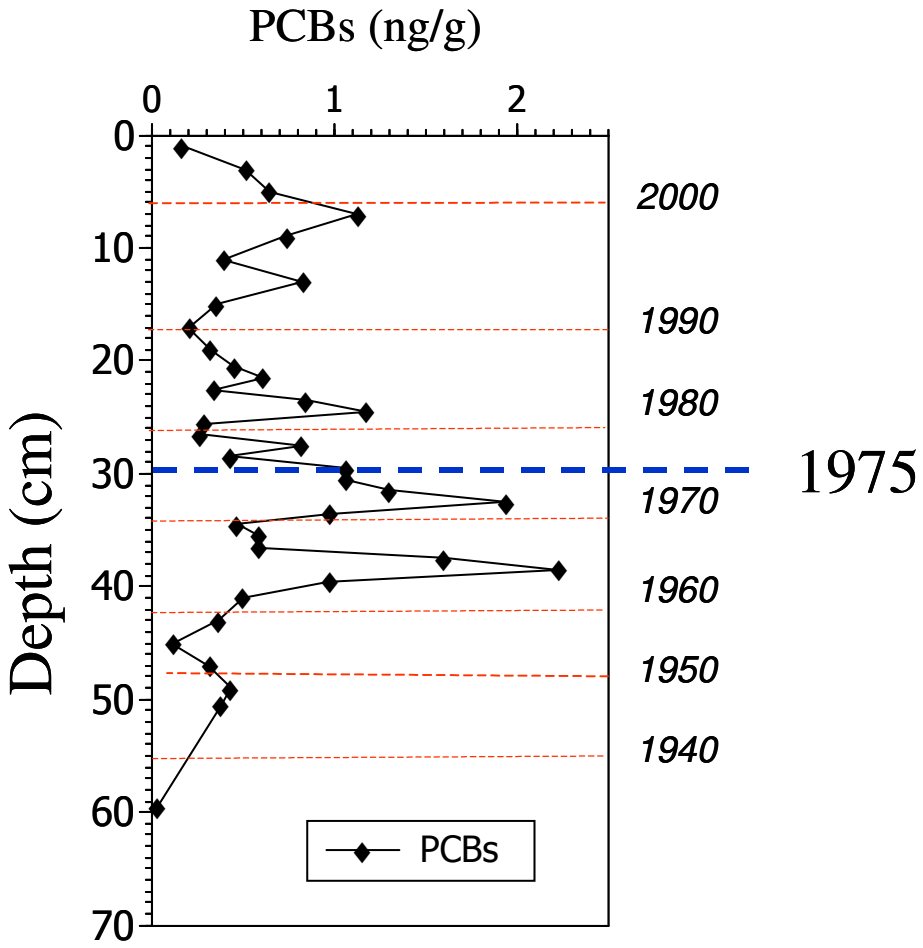


**Figure 2 Vertical profiles of PCBs in sediment core (GT15)**