TITLE OF RESEARCH PROJECT

Investigation on the Occurrence of PCBs and dioxin-like PCBs in Cisadane River of Banten Province, Indonesia

PROJECT MEMBERS

Name	Affiliation	Position	Contribution part
Fuzi Suciati	BRIN Indonesia	Principal Investigator	Research designing, sampling, analysis, report writing, paper manuscript preparation
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PROJECT PURPOSES

The purposes of this study are to determine PCBs and dioxin-like PCBs in water ecosystem of Cisadane River in order:

a) to understand the occurrence and distribution of PCBs and dioxin-like PCBs in the Cisadane River, and
b) to estimate the potential health risk of PCBs and dioxin-like PCB to human in relating with public utilization of Cisadane River.

This study will comprehensively provide information on large number of PCBs congeners parameters and serve to enrich the inventory of PCBs and dioxin-like PCBs on a global scale, elucidate whether public are at risk, and identify potential PCBs and dioxin-like PCBs sources in the country, which will provide important data for decision makers. Beside determination of PCBs and dioxin-like PCBs,

this study is also aimed at conducting survey in order to collect additional samples of environmental matrices in selective sensitive area(s) for further environmental contaminants of concern.

METHODS

Sampling and Sample

The study combined sampling survey and laboratory analysis. The collected samples were sediment and fish taken from the Cisadane River representing upstream, middle, and lower reaches of the river. In each of the watershed segment will be evaluated the presence of PCBs and dioxin-like PCBs. The determination of sampling sites referred to observation station location built by the Ministry of Environment and Forestry (MOEF) as shown in Figure 1. There are 14 water quality monitoring stations along the channel of Cisadane River. Samples of the upstream part were taken at the Empang Bogor Dam and the downstream part were taken at the Cisadane River Monitoring Post in Tangerang City. For the middle part samples were taken by purposive sampling based on the situation in the field.

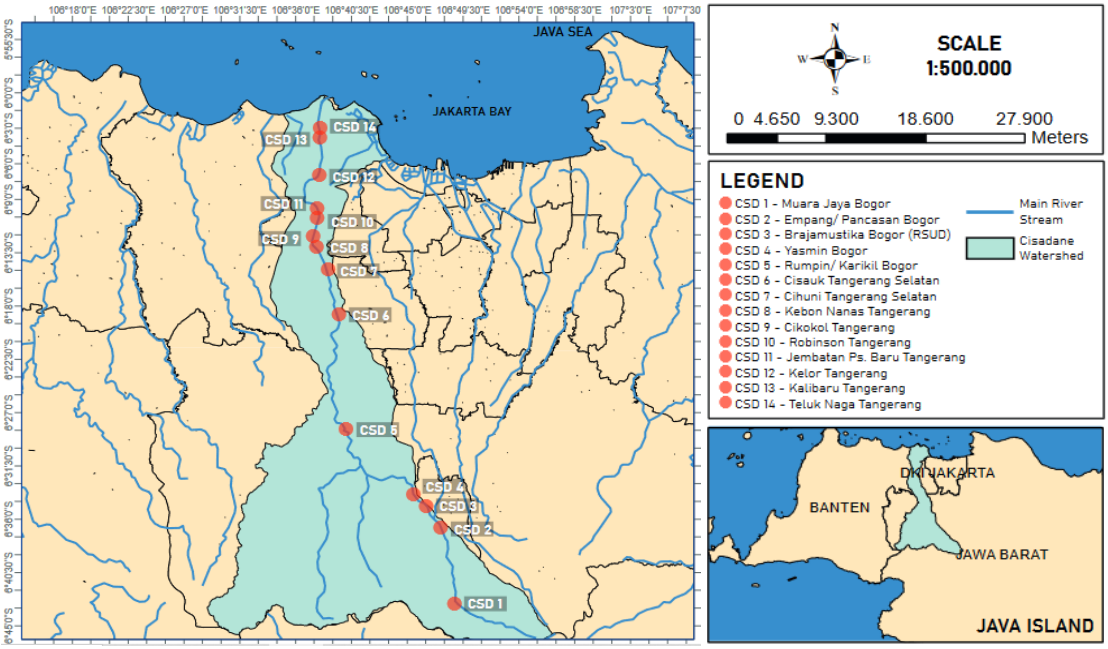

Figure 1. Map showing sampling area for PCBs and dl-PCBs

Target Chemicals and Analyses

The target environmental pollutants to be evaluated in Cisadane River ecosystem are total polychlorinated biphenyls (Table 1) with special attention of dioxin-like PCBs consisted of 13 congeners (Table 2). Up to the present no research on dioxin-like PCBs has been carried out for Cisadane River.

Table1 Total PCBs congeners

Chlorinated number	Congener
1	CB-1
	CB-3
2	CB-10, CB-4
	CB-8
	CB-15
3	CB-18, CB-19
	CB-22, CB-28, CB-33, CB-37
4	CB-54
	CB-44, CB-49, CB-52
	CB-70, CB-74
	CB-81
	CB-77
5	CB-104
	CB-95
	CB-87, CB-99, CB-101, CB-119
	CB-110, CB-123
	CB-118
	CB-114
	CB-105
	CB-126
6	CB-155
	CB-149, CB-151, CB-153, CB-168
	CB-138, CB-158
	CB-128, CB-167
	CB-156
	CB-157
	CB-169
7	CB-188
	CB-171, CB-177, CB-178, CB-180,
	CB-183, CB-187, CB-191
	CB-170
	CB-189
8	CB-194, CB-199, CB-202, CB-201
	CB-205
9	CB-206, CB-208
10	CB-209

Table 2 Special attention Dioxin-like PCBs

Type	Congener		TEF
	BZ number	IUPAC name	
Non-ortho	77	3,3',4,4'-TCB	0,0005
	126	3,3',4,4',5-PeCB	0,1
	169	3,3',4,4',5,5'-HxCB	0,01
Mono-ortho	105	2,3,3',4,4'-PeCB	0,0001
	114	2,3,4,4',5-PeCB	0,0005
	118	2,3',4,4' ,5-PeCB	0,0001
	123	2',3,4,4',5-PeCB	0,0001
	156	2,3,3',4,4',5-HxCB	0,0005
	157	2,3,3',4,4',5'-HxCB	0,0005
	167	2,3',4,4',5,5'-HxCB	0,00001
	189	2,3,3',4,4' ,5,5'-HpCB	0,0001
Di-ortho	170	2,2' ,3,3',4,4' ,5-HpCB	0,0001
	180	2,2',3,4,4',5,5'-HpCB	0,00001

The chemicals analysis was conducted at Center of Advanced Technology for the Environment (CATE), Graduate School of Agriculture, Ehime University, Japan under collaboration technical laboratory analysis by Mr. Dede Falahudin and supervised by Prof. Shin Takahashi. Samples would be extracted according to established Method.

RESULTS

Sampling

Sampling to obtain representative environmental samples in Cisadane River including sediment and fish were carried out using purposive sampling technique. Then 5 subsampling's were composited for each single location as shown in Figure 1. Sampling campaign were conducted during 9-29 May 2023. All the samples were stored in the Laboratory of Center of Advanced Technology for the Environment (CATE), Graduate School of Agriculture, Ehime University. Figure 2 shows the sampling activities in the Cisadane watershed. Table 3 shows samples and sampling locations conducted at Cisadane River.

Figure 2. Sampling activity

Table 3 Samples and sampling locations conducted at Cisadane River.

No	ID	Location Name	Latitudinal	Date	Samples
1	CSD 1	Muara Jaya, Bogor (Upstream)	6°43'17.3"S 106°48'57.8"E	09/05/2023	Sediment, Fish
2	CSD 2	Pancasan, Bogor (Upstream)	6°36'19.8"S 106°47'32.8"E	09/05/2023	Sediment, Fish
3	CSD3	Brajamustika, Bogor (Upstream)	6°34'59.5"S 106°46'33.5"E	09/05/2023	Sediment
4	CSD 4	Yasmin, Bogor (Upstream)	6°34'01.3"S 106°45'38.5"E	09/05/2023	Sediment, Fish
5	CSD 5	Rumpin, Bogor (Upstream)	6°28'24.9"S 106°40'04.3"E	29/05/2023	Sediment
6	CSD 6	Kranggan, South Tangerang (Middle)	6°20'46.7"S 106°38'57.4"E	26/05/2023	Sediment
7	CSD 7	Cisauk, South Tangerang (Middle)	6°18'40.5"S 106°39'27.19"E	29/05/2023	Sediment
8	CSD 8	Cihuni, South Tangerang (Middle)	6°15'32.8"S 106°38'52.1"E	29/05/2023	Sediment
9	CSD 9	Kebon Nanas, Tangerang (Middle)	6°13'01.8"S 106°37'43.3"E	23/05/2023	Sediment, Fish
10	CSD 10	Cikokol, Tangerang (Middle)	6°12'05.3"S 106°37'26.0"E	23/05/2023	Sediment, Fish
11	CSD 11	Robinson, Tangerang (Middle)	6°10'32.6"S 106°37'45.5"E	23/05/2023	Sediment
12	CSD 12	Ps. Baru, Tangerang (Middle)	6°09'38.9"S 106°37'46.1"E	16/05/2023	Sediment, Fish
13	CSD 13	Kelor, Tangerang (Downstream)	6°06'57.8"S 106°37'55.1"E	16/05/2023	Sediment, Fish
14	CSD 14	K. Baru, Tangerang (Downstream)	6°03'42.7"S 106°38'00.0"E	16/05/2023	Sediment, Fish
15	CSD 15	Tl. Naga, Tangerang (Downstream)	6°03'10.7"S 106°38'03.9"E	16/05/2023	Sediment, Fish

Result of Laboratory Analysis

Up to the present the majority analysed samples for PCBs were sediments. For the fish samples are still on preparation for laboratory analysis. Results of the laboratory analysis on PCBs in sediment samples collected from Cisadane River are shown in the Table 4. PCBs were detected in all the sediment samples analyzed with total PCBs concentration ranged from 0.046-0.41 ng/g dry wt. Relatively higher concentration of PCBs were found in the middle than in the upper part of Cisadane River in particular for locations across to South Tangerang and Tangerang City where high anthropogenic activities are known. The levels of PCBs detected in the present study were relatively similar in the range of those sediments collected from several rivers in Surabaya City, Indonesia, i.e. 0.29 – 6.1 ng/g dry wt. (Ilyas et al., 2011). However, the levels were still lower than those of reported sediments from some Asian countries such as Tonghui River, Beijing (3.3 ng/g dry wt.; Zhang et al., 2004), and Sai Gon-Dong Nai River, Vietnam (6.8 ng/g dry wt., Minh et al., 2007).

As for PCBs profile, the proportion of PCBs homolog as presented in Figure 3 shows demonstrated variation among sampling locations. For instance, hexa-CBs were detected in all sampling locations, whereas other homolog of PCBs

were detected at some locations. Large variation of PCBs homolog were detected at downstream of the river (mono- to octa-CBs) compared to the upstream (mono- to hexa-CBS). Generally, the downstream sediments were composed of lower PCBs homolog particularly tri-CBs as the dominant type, whereas the upstream part of the river by higher PCBs homolog, particularly hexa-CBs. Considering that sediment acts as a repository of environmental contaminants and PCB profiles in sediment generally resemble to origin sources, then the variation of PCBs homolog within the river segment may indicate variation in use of technical formulation of PCBs in the study area. Further analysis of the remaining samples (n=5) would make clear the spatial variation of PCBs in the sediment of Cisadane River. Following the findings further analysis of PCBs in the collected biota would be important for bioaccumulation nature of these compounds as well as further assessment to human risk.

Table 4. Results of PCBs analysis of Cisadane River sediment

Sampling location	PCBs level (ng/g dry wt)
CSD 1	0.046
CSD 2	0.045
CSD 3	0.072
CSD 4	0.049
CSD 5	0.250
CSD 6	0.410
CSD 7	0.290
CSD 8	–
CSD 9	0.290
CSD 10	0.360
CSD 11	4.36
CSD 12	1.49
CSD 13	2.77
CSD 14	6.40

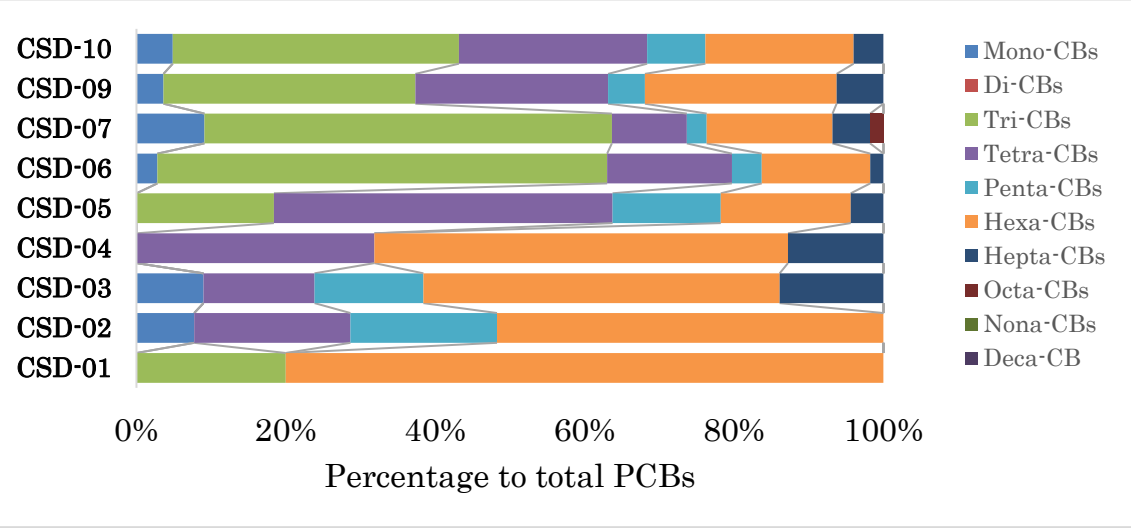

Figure 3. PCBs homolog proportion found in each sampling point

In order to provide an ecotoxicological aspect of sediment contamination, then concentrations of detected PCBs were compared to available sediment quality guidelines (SQGs) for fresh water ecosystems such as probable effect level (PEL) which represents the concentration above which adverse effects on aquatic biota are likely to occur, and interim sediment quality guideline standards (ISQGS). The two guidelines are proposed by the Canadian Council of Ministers of Environment (CCME, 2002). Findings of the current analysis of Cisadane River sediments demonstrated that none of collected samples exceeded the Canadian sediment quality guidelines, PEL value (277 ng/g dry wt.) for the protection of aquatic biota and ISQGS (34.1 ng/g dry wt.).

FUTURE CHALLENGES

There is variation of PCBs concentrations as well as homolog profiles in the sediment of Cisadane River, which may suggest variation in amount of sources input as well as type of technical commercial of utilized PCBs. Further analysis of PCBs in the remaining samples (n=5) would make clear the spatial variation of PCBs in the sediment of Cisadane River. Furthermore, analysis of PCBs in the collected biota would be important for bioaccumulation nature of this compound as well as further assessment of human health risk. Considering that there are many substances that are listed as POPs in the Stockholm Convention then further analysis on POPs contaminants is of concern. For example, there has been concern for PFAS that listed as POPs under Stockholm Convention, which also Indonesia priority of concern. Through LaMer Call for Proposal for FY 2024, by utilizing of water samples collected during 2023 from the Cisadane River, characterizing of PFAS in this ecosystem is proposed.

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