Title：

Characterization of Pharmaceutical and Personal Care Products (PPCPs) in Wastewater Treatment Plants in Indonesia.

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Purpose：

To determine pharmaceutical and personal care products PPCPs in wastewaters treatment plants particularly from sewage (domestic) waste water treatment plants and hospital where the treatment water enter to main river basin in Jakarta and West Java, Indonesia such as Citarum River Basin, Ciliwung River Basin and Cisadane River Basin, in order to understand the occurrence and distribution of PPCPs in WWTPs. This study will comprehensively provide information on large number of PPCPs parameters and serve to enrich the inventory of pharmaceutical pollution on a global scale and identify potential PPCPs sources in the country, which will provide important data for decision makers.

Methods:

Sampling and Sample

The study was combined of sampling survey to acquire the samples and chemicals analysis at laboratory. Samples are influent and effluent from domestic, hospital, and landfill waste water treatment plants (WWTPs). The WWTPs was selected to those which have effluent to the major river basin in Jakarta and West Java such as Citarum River Basin, Ciliwung River Basin and Cisadane River Basin as source of drinking water. Sample collection was implemented in April – June 2023. A total of 26 water samples collected from influent and effluent of domestic WWTPs (5 samples, respectively), influent and effluent of hospital WWTPs (4 samples, respectively), influent and effluent of municipal dumpsite leachate WWTPs (4 samples, respectively). Sampling location showed in table 1. Figure 1 shows the sampling activities in domestic, hospital, and municipal dumpsite leachate WWTPs.

Table 1. Sampling locations

Sample ID	Location		GPS Coordinate	
D-1 (In)	Depok City	D-WWTP Pondok Terong, Depok	S 6°26'53.02504"	E 106°48'4.31111"
D-1 (Out)	Depok City	D-WWTP Pondok Terong, Depok	S 6°26'53.02504"	E 106°48'4.31111"
D-2 (In)	Depok City	D-WWTP Pondok Terong, Depok	S 6°26'52.81282"	E 106°48'4.26031"
D-2 (Out)	Depok City	D-WWTP Pondok Terong, Depok	S 6°26'52.69902"	E 106°48'4.13597"
D-3 (In)	Tangerang City	D-WWTP Tanah Tinggi	S 6°10'28.62462"	E 106°38'51.80964"
D-3 (Out)	Tangerang City	D-WWTP Tanah Tinggi	S 6°10'40.62126"	E 106°38'18.82673"
D-4 (In)	Jakarta	D-WWTP Krukut	S 6°21'64.41085"	E 106°81'6.46917"
D-4 (Out)	Jakarta	D-WWTP Krukut	S 6°21'64.41085"	E 106°81'6.46917"
D-5 (In)	Jakarta	D-WWTP Setiabudi	S 6°20'47.18"	E 106°82'8.488"
D-5 (Out)	Jakarta	D-WWTP Setiabudi	S 6°20'47.18"	E 106°82'8.488"
TPA-1 (In)	Depok City	TPA-WWTP Rawa Kucing	S 6°8'6.42926"	E 106°37'11.52736"
TPA-1 (Out)	Depok City	TPA-WWTP Rawa Kucing	S 6°8'6.42926"	E 106°37'11.52736"
TPA-2 (In)	Tangerang Selatan Regency	TPA-WWTP Tangerang Selatan	S 6°19'27.95117"	E 106°39'35.48948"
TPA-2 (Out)	Tangerang Selatan Regency	TPA-WWTP Tangerang Selatan	S 6°19'27.95117"	E 106°39'35.48948"
TPA-3 (In)	Tangerang Selatan Regency	TPA-WWTP Tangerang Selatan	S 6°19'36.00246"	E 106°39'43.59298"
TPA-3 (Out)	Tangerang Selatan Regency	TPA-WWTP Tangerang Selatan	S 6°19'36.00246"	E 106°39'43.59298"
TPA-4 (In)	Jakarta	TPA-WWTP Bantar Gebang, Bekasi	S 6°34'77.90"	E 106°99'78.63"
TPA-4 (Out)	Jakarta	TPA-WWTP Bantar Gebang, Bekasi	S 6°34'77.90"	E 106°99'78.63"
RS-1 (In)	Jakarta	RS-WWTP Cawang	S 6°36'21.86"	E 107°11'80.19"
RS-1 (Out)	Jakarta	RS-WWTP Cawang	S 6°36'21.86"	E 107°11'80.19"
RS-2 (In)	Jakarta	RS-WWTP Kebayoran Lama	S 6°14'28.47"	E 106°47'33.43"
RS-2 (Out)	Jakarta	RS-WWTP Kebayoran Lama	S 6°14'28.47"	E 106°47'33.43"
RS-3 (In)	Yogyakarta City	RS-WWTP Yogyakarta	S 7°49'33.0"	E 110°22'40.6"
RS-3 (Out)	Yogyakarta City	RS-WWTP Yogyakarta	S 7°49'33.0"	E 110°22'40.6"
RS-4 (In)	Surabaya City	RS-WWTP Surabaya	S 7°16'05.4"	E 112°25'29.1"
RS-4 (Out)	Surabaya City	RS-WWTP Surabaya	S 7°16'05.4"	E 112°25'29.1"

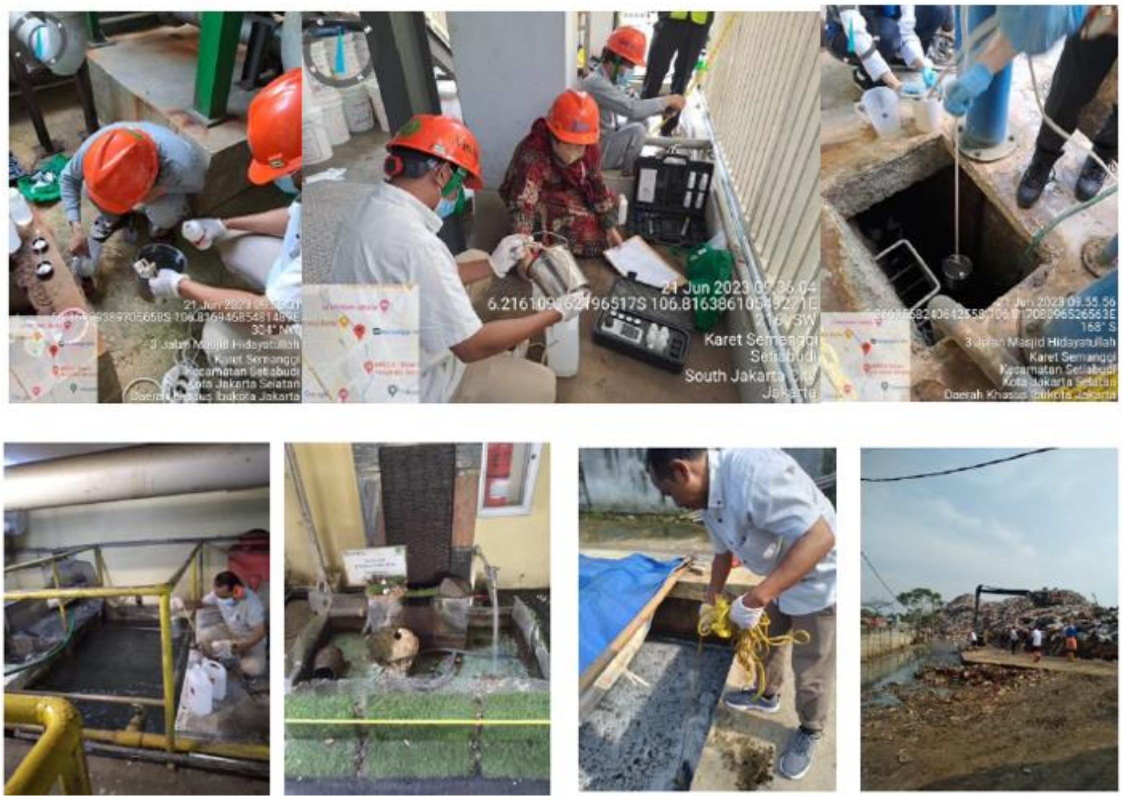


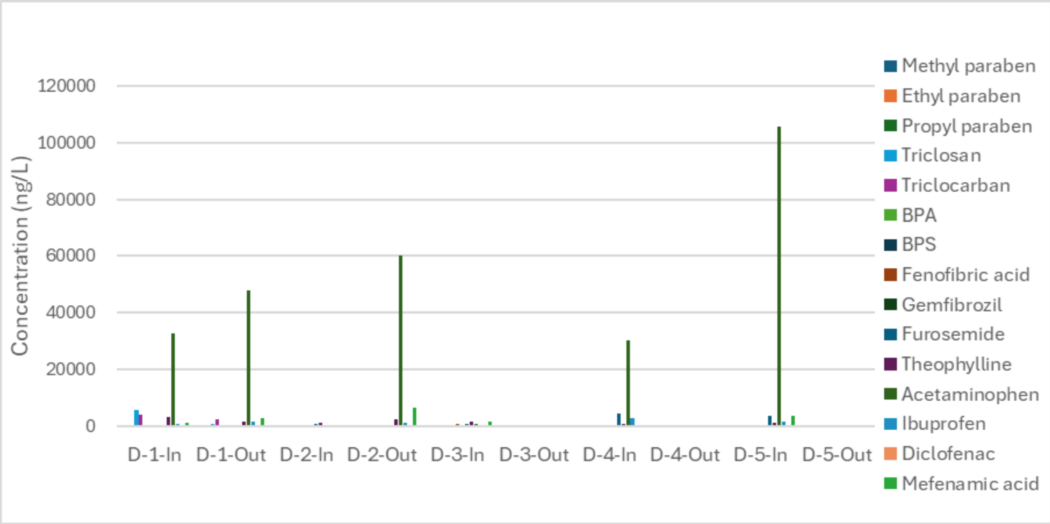
Figure 1. Sampling activities

PPCPs Analysis

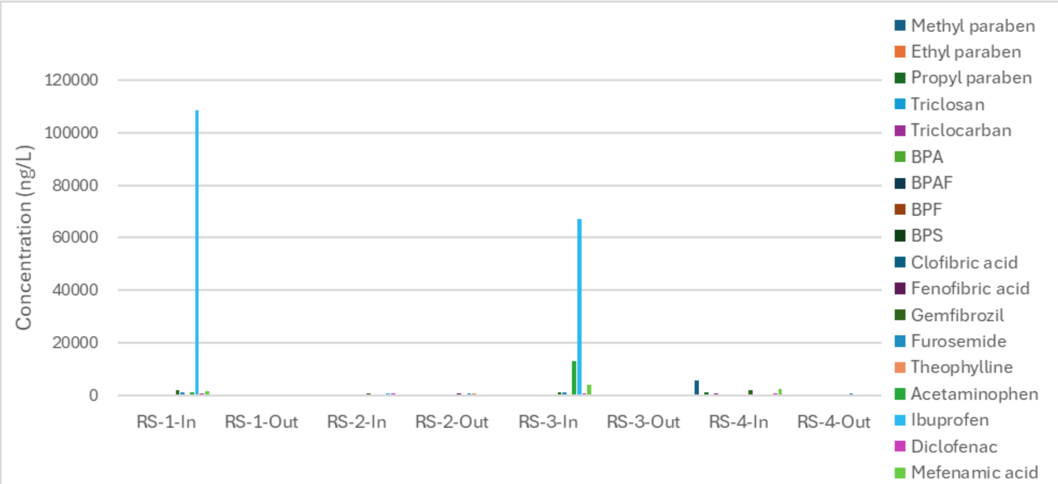
Analysis of samples was conducted at Laboratory of Environmental Chemistry and Ecotoxicology, Center for Marine Environmental Studies (CMES), Ehime University, Japan. PPCPs analysis using Prominence UFLC XR (Shimadzu, Kyoto, Japan) with Asentis Express C18 (Supelco, Bellefonte, USA) column. The mobile phase used in analysis were 0.1% CH_3COOH in Milli-Q water/methanol (95:5, v/v) and acetonitrile/methanol (50:50, v/v).

Result of Laboratory Analysis

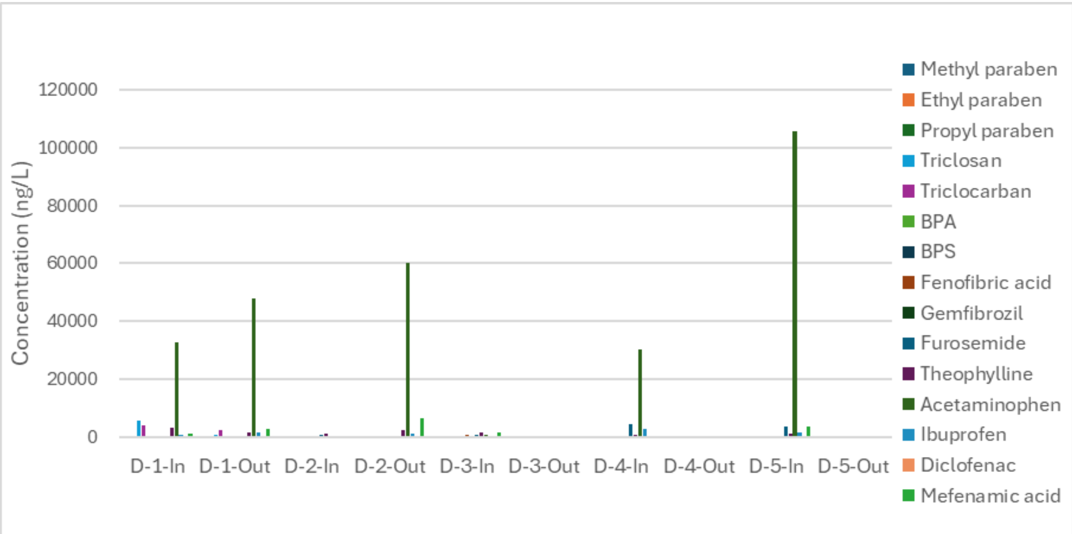
Results of the laboratory analysis on PPCPs in water samples collected from influent and effluent of domestic, hospital, and municipal dumpsite leachate WWTP showed at figure 2(a), 2(b), and 2(c) respectively.



(a)



(b)



(c)

Figure 2. PPCPs analysis of influent and effluent in domestic (a), hospital (b), and

The highest concentration of PPCPs compound in influent of domestic, hospital, and municipal dumpsite WWTPs were acetaminophen (105752 ng L^{-1}), ibuprofen (108753 ng L^{-1}), and BPA (6560000 ng L^{-1}) respectively. Ibuprofen and acetaminophen are effective and common anti-fever agents, which have been used for both adults and children as two over-the-counter drugs. Both ibuprofen and acetaminophen possess different toxicities to organisms. The main sources of ibuprofen and acetaminophen in the environment are derived from human excretions via urine or feces. Theoretically if they could be completely removed in municipal wastewater treatment plants (WWTPs), their potential ecological risks to natural environment could be well controlled (Wu et al., 2023).

Previous study showed that ibuprofen and paracetamol are pharmaceuticals compounds found in the wastewater (Li et al., 2020; Phong Vo et al., 2019). They are commonly used to treat aches and pains (de Oliveira et al., 2019). Due to their persistence or continuous environmental exposure, many micropollutants can pass through wastewater treatment systems since most of the current WWTPs are not designed to remove micropollutants. Moreover, most WWTPs are also lack of well-established micropollutant precautions and performance monitoring (Ahmed et al., 2017; Li et al., 2019). Thus understanding of current status of PPCPs in wastewater treatment plant from developing countries is of concern for policy maker to better improvement of the WWTPs facilities, in particular around sewage (domestic) treatment plants and hospitals in Indonesia.

Bisphenol A (BPA) is included among the chemicals identified as potential endocrine disruptors (Carlisle *et al.* 2009). BPA is an organic compound used in industrial applications to make hard and clear plastics in the primary production of polycarbonate plastics and epoxy resins, flame-retardants, and other specialty products worldwide. It can be found in many consumer products such as baby milk bottles, reusable beverage bottles, plates, mugs and food storage containers (Le et al. 2008). BPA is released into the environment through air, land, and water during manufacturing, processing, and leaching from end of life treatment. In water environments, BPA is released through sewage treatment effluent (via human-ingested BPA being eliminated into sewage), landfill leachate (via hydrolysis of BPA from plastics), or natural degradation of polycarbonate plastics (Kang et al. 2006).

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