TYPE AND DISTRIBUTION OF MICROPLASTIC CONTAMINATION IN BEACH SEDIMENT ALONG THE COAST OF PHETCHABURI PROVINCE

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ARTICLE HISTORY
Received: 21 April 2023 **Revised:** 10 May 2023 **Published:** 22 May 2023

ABSTRACT
A study of contamination, type and distribution of microplastics in beach sediment of the coast of Phetchaburi Province was conducted. Four sampling stations were carried out as follows: 1) Puek Tian Beach, 2) North Cha-am Beach, 3) South Cha-am Beach and 4) Rama 6 Beach. The data collection and sample identification methods were applied according to the National Oceanic and Atmospheric Administration (NOAA) Protocol, and then the particle characterization was performed using FTIR. All the 4 stations were found to be contaminated with microplastics. In the dry season, North Cha-am Beach showed the most occorrence of microplastic debris = 370±105 pieces/square meter (pcs/m2) followed by Puek Tian Beach = 342±136 pcs/m2, South Cha-am Beach = 299±160 pcs/m2, and Rama 6 Beach = 35±20 pcs/m2. In the rainy season the most contaminated microplastics were found at South Cha-Am Beach = 3516±1603 pcs/m2 followed by North Cha-Am Beach = 1915±850 pcs/m2, Puktien Beach = 628±180 pcs/m2 and Rama 6 Beach = 4±2 pcs/m2. Eight types of microplastic contamination were found. The most common microplastic type found was Polyethylene terephthalate (PET), followed by Polyethylene (PE) at 2,403 and 1,163 pcs/m2 respectively with the size range of 300-1,000 micrometers.
Keywords: Contamination, Types, Distribution, Microplastics, West Coast Gulf of Thailand

CITATION INFORMATION: Jualong, S., Towatana, P., Pardit, S., & Wasinamekin, W. (2023). Type and Distribution of Microplastic Contamination in Beach Sediment Along the Coast of Phetchaburi Province. *Procedia of Multidisciplinary Research, 1*(5), 25.

INTRODUCTION

Marine litter is currently a major pollution problem worldwide. According to the data of the Department of Marine and Coastal Resources (2017), it was found that the source of marine waste came from land-based source mostly from human activities including fishing and tourism, etc. It was found that 80 percent of this marine waste, most of which was plastic debris. This plastic waste will be able to float on the sea surface as well since the density of most plastic synthesized and used in human activities is less than that of seawater. Furthermore, these patches of plastic waste will not decompose in a short period of time as new patches are added to the oceans all the time. However, it is able to disintegrate into smaller sizes, known as microplastics, which can spread both in sea water and sediments. They can enter the respiratory system and gastrointestinal tract of aquatic animals, as well as humans who consume those aquatic animals.

Objective

1) investigate the existing situation of microplastics contamination in the marine environment areas likely to be affected by human activities and plastic pollution and

2) provide necessary information for developing management planning for solving existing marine litter problem as soon as problem

LITERATURE REVIEW

Microplastics are plastic fragments that are smaller than 5 millimeters in size. They derive from degradation of large plastic waste or plastics that have been originally created to be small to suit the purpose of use, such as small plastic beads in cosmetic products as well as plastic pellets for the production of plastic parts of industries related to marine activities. This causes problems for the marine environment, such as navigation, fishing and coastal ports. The plastic materials that are components of these industries, such as fishing nets, may be corroded or damaged. and contaminated into the sea. These microplastics can be found in many parts of the environment, such as beaches, river estuaries, shorelines and water bodies, where they are difficult to control or eliminate. This makes microplastic occurrence be a major marine and coastal pollution problem with a tendency to affect both marine and coastal ecosystems. In the case of microplastic ingestion of living organisms leads toxins into the food chain and the impact on the livelihood of living organisms in the ecosystem Therefore, data on the distribution of microplastics in the marine and coastal environments is necessarily investigated to understand the situation of microplastic contamination in beach sediment in Phetchaburi Province. Therefore, this study aimed to investigate the distribution of microplastic waste in the sediments of Puek Tian Beach, North Cha-am Beach, South Cha-am Beach and Rama 6 Beach, Phetchaburi Province as well as sea currents that are important factors contributing to the high volume of microplastic diffusion,despite coastal erosion in these area

An estimated 5-13 million tons of plastics are exported to the ocean each year, those floating on the ocean surface are only around 0.3 million tons/year, suggesting that a significant fraction of plastics are assimilated by marine organisms or have accumulated in sediments (Matsuguma et al., 2017). For the analysis techniques, the most common approach is to extract plastic particles from the sediment by using a density separation, and analyze the features of microplastics including morphology, particle size and color etc. (Van Cauwenberghe et al. (2015).

MATERIALS AND METHODS

Study Area

Samples were collected to study the contamination and distribution of microplastics in sediment in the upper Gulf of Thailand at 4 stations including: Puek Tian Beach (PT), North

Cha-am Beach (CH-1) and South Cha-am Beach (CH-2), and Rama 6 Beach (RM6), Phetchaburi Province (Table1 and Fig.1)
Station name, coordinates (latitude, longitude, altitude above sea level), number of operability sampling periods and temporal resolution.

Table 1 Sampling station and coordinates of sediment sampling stations in Phetchaburi Province during February (dry season) and June (rainy season) 2018

Sampling Station		Lat	Long
PT	Puek Tian Beach	12.944337	100.032937
CH-1	North Cha-am Beach	12.808328	99.990407
CH-2	South Cha-am Beach	12.74.000	99.97540
RM-6	Rama 6 Beach	12.688395	99.963643

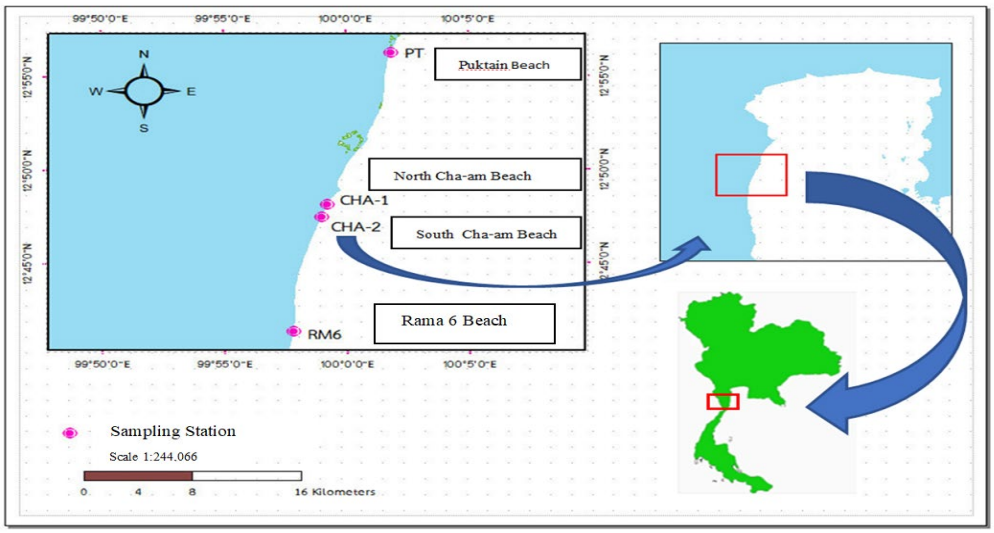

Figure 1 Map and coordinates of sediment sampling stations in Phetchaburi Province during February (dry season) and June (rainy season) 2018
Source: From this study

RESULTS

1) The amount of microplastic

Microplastics in sediment obtained from all the 4 sampling stations in Phetchaburi Province, the amount of microplastics ranged from 4-3,516 pcs/ m^2 as shown in Table 2. The study revealed that in the dry season, microplastic contamination appeared at all the 4 stations. The most microplastics were found at CH-1 with 370±105 pcs/m^2, followed by PT with 342±136 pcs/m^2, CH-2 with 299±160 pcs/m^2, and RM-6 with 35±20 pcs/m^2. In the rainy season, the most contaminated microplastics were found at CH-2= 3,516±1603 pcs/m^2, followed by CH-1 = 1,915±850 pcs/m^2, PT = 628±180 pcs/m^2, and RM-6 = 4±2 pcs/m^2.
Microplastics were found at all the stations in both seasons (Table 2 and Fig. 2) . The distribution of microplastics is related to ebb and flow factors, which are caused by accumulation along the tidal range, especially during high tide they often accumulating along the algae or other vegetation on the beach. The main influence is from human activities such as tourism, aquaculture, harbour construction including the flow rate of the river (Turner and Holmes, 2015; Howell et al., 2012) as shown in Fig.3 and Table 2.

Table 2 Average amount of microplastics (pcs/m^2) and amount of microplastics found in sediment (pcs/m^2), divided by size 5-1 mm., 1-0.3 mm. and 0.3-0.02 mm from 4 sampling stations in Phetchaburi Province in the dry and rainy seasons 2018

Sampling Station, 2018	Average amount of microplastics (pcs/m^2) found in sediment		Amount of microplastics (pcs/m^2) based on size					
			5,000-1,000 µm		1,000-300 µm		300-20 µm	
	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season
PT	342±136	628±180	0	1	78	315	264	312
CH-2	299±160	3516±1603	15	4	0	3000	284	512
CH-1	370±105	1915±850	5	4	203	306	162	1605
RM-6	35±20	4±2	35	4	0	0	0	0

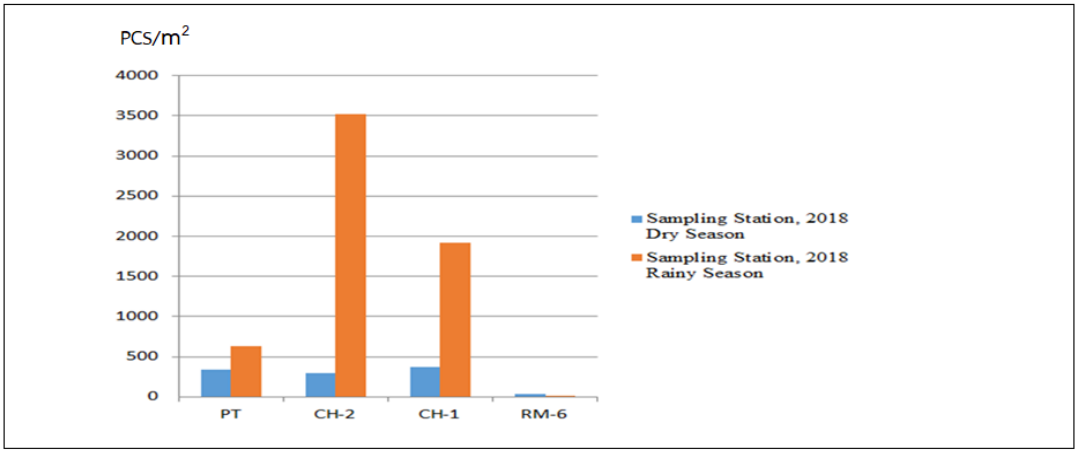

Figure 3 Graph of the amount of microplastics found in sediment samples collected in the dry and rainy seasons in Phetchaburi Province, 2018.
Source: From this study in laboratory

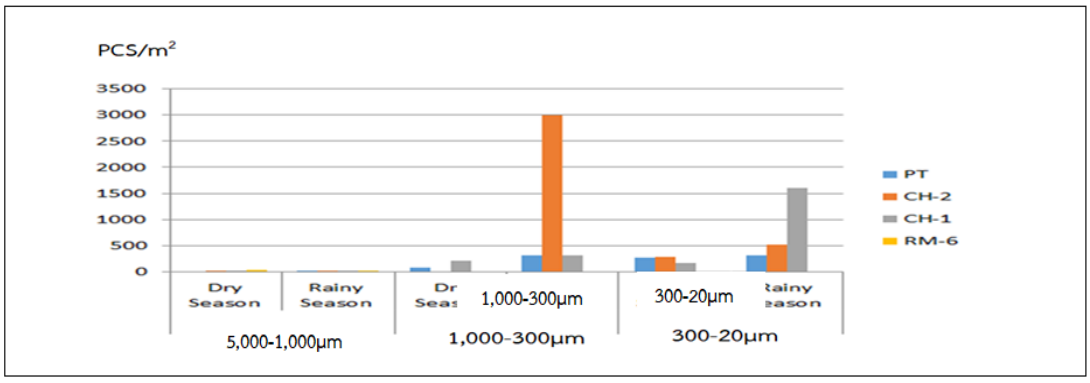

Figure 4 Graph of microplastic size found in sediment samples in dry and rainy seasons in Phechaburi Province, 2018.
Source: From this study in laboratory

Table 3 Types of microplastics (pcs/m^2) found in sediment samples collected in the dry and rainy seasons in Phetchaburi Province, 2018.

Type of Microplastics	Puktain		South Cha-am	South Cha-am	North Cha-am		Rama 6		Sum Dry Season	Sum Rainy Season
	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season	Dry Season	Rainy Season		
Polyethylene terephthalate (PET)	79	1,893	34	274	0	105	18	2	130	2,273
Acrylonitrile-butadiene-styrene (ABS)	16	0	0	0	0	0	0	0	16	0
Polyethylene (PE)	157	0	67	821	0	105	9	5	233	930
Polypropylene (PP)	16	270	34	0	171	0	9	0	229	270
Chloroprene Rubber (CR)	0	270	0	274	0	0	0	1	0	545
Polyvinylchloride (PVC)	0	0	101	274	0	0	0	0	101	274
Polystyrene (PS)	31	541	0	0	0	0	0	1	31	542
Styrene-Butadiene Rubber(SBR)	0	0	101	274	0	0	0	0	101	274
Polyurethane (PU)	0	270	34	0	0	0	0	0	34	270
Polystyrene (PS)	0	270	0	0	171	419	0	1	171	690

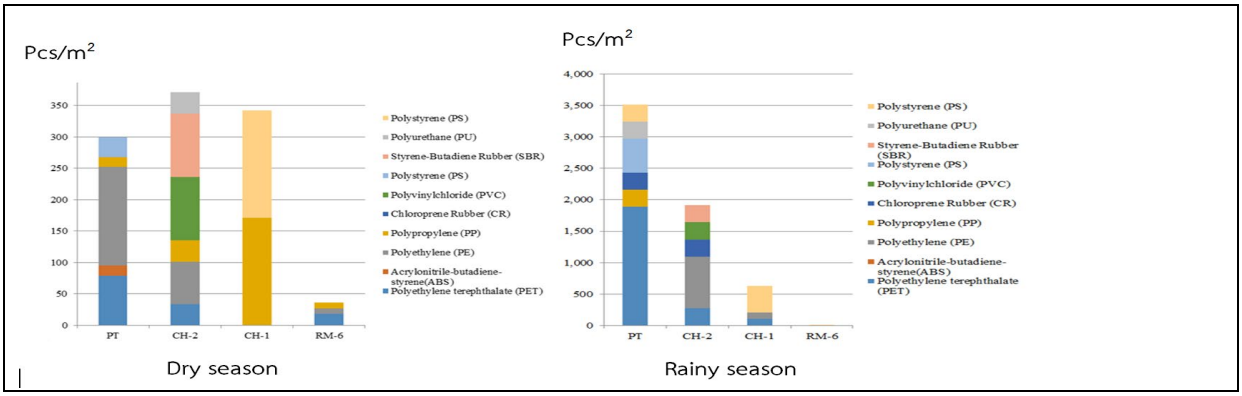

Figure 5 Graph showing types of microplastics found in sediment samples collected in dry and rainy seasons in Phetchaburi Province, 2018.
Source: From this study in laboratory

2) Quantities of Microplastic Classified by Type

The most common type of microplastics was Polyethylene terephthalate (PET) at PT in the rainy season with the amount of 1,893 pcs/m^2, followed by CH-2 = 274 pcs/m^2 in the rainy season.

The second most common type was Polyethylene (PE) at CH-2 in the rainy season, amounting to 821 pcs/m^2, followed by PT in the dry season, amounting to 157 pcs/m^2 (Figure 3, Figure 6 and Table 3).

The highest proportion of PET plastic was found since this type of plastic is commonly used in the food and appliance industries. It's also cheap and can accumulate in sediments more than other types of plastic.

3) Microplastic Size

3.1) Size 5000-1000 µm, the highest amount of microplastics were found in RM-6, followed by CH-2, Phetchaburi Province during the dry season, amounting to 35 and 15 pcs/m^2 respectively.

3.2) Size 1000-300 µm, the most miroplastics were found at CH-2, followed by PT, Phetchaburi Province during the dry season, amouning to 3,000 and 315 pcs/m^2 respectively.

3.3) Size 300-20 µm, the most common microplastics were present at CH-1, followed by CH-2,. Phetchaburi Province, amounting to 1,605 and 512 pcs/m^2, respectively as shown in Table 2 and Figure 4.

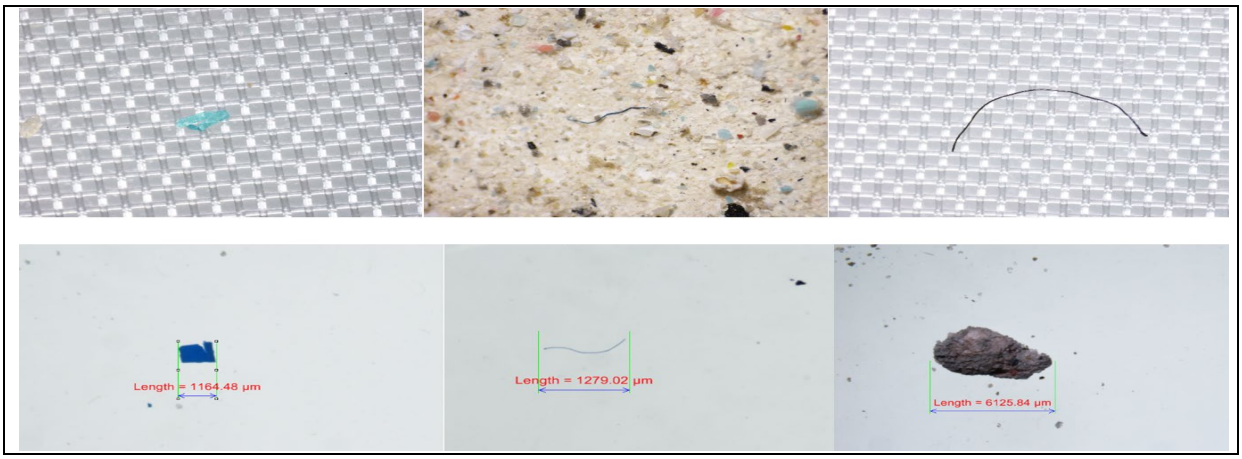

Figure 6 Examples of microplastic shapes collected from coastal sediment in Phetchaburi Province.
Source: From Microscope in laboratory

4) Types of Microplastic Polymers
The results of polymer analysis of microplastics were divided into 1 0 types, namely Polyethylene Terephthalate (PET), Polyethylene (PE), Polypropylene (PP), Polyester (PES), Acrylonitrile-butadiene-styrene(ABS), Polyvinylchloride (PVC), Chloroprene Rubber (CR), Polystyrene (PS), Styrene-Butadiene Rubber (SBR), Polyurethane (PU) as shown in Figure 5.

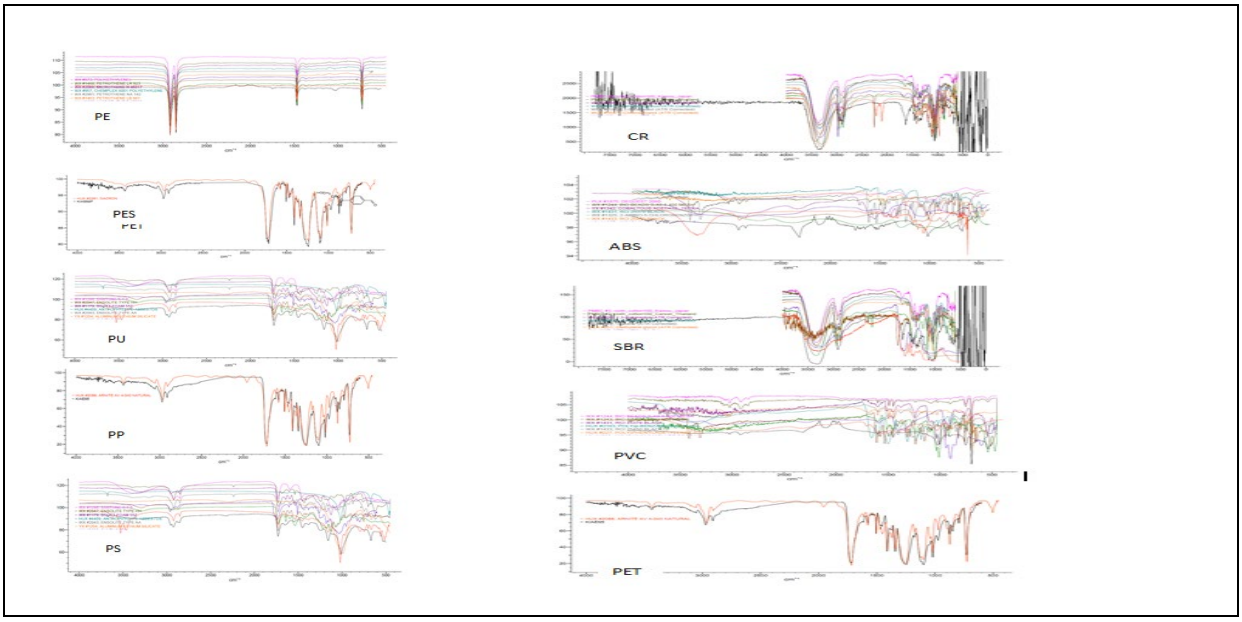

Figure 7 The example of Fourier Transform Infrared (FTIR) spectroscopy analysis of abundant polymers found in this study in Dry (A.) and Rainy (B.) seasons.
Source: From Fourier Transform Infrared (FTIR) spectroscopy analysis

DISCUSSION

Microplastic contamination in beach sediment was found in all the study sites, especially the CH-1 and CH-2 beaches, which are areas that are highly exploited for tourism or even RM-6 Beach, which is a controlled area with no human activity. According to the nature of the open bay, tides and currents are major factors influencing the accumulation of microplastics on beaches (Marine and Coastal Resources Research & Development Institute and Burapha

University, 2014) and the coastal areas of Phetchaburi Province. It is a fishing area that materials such as nets, strings and ropes are widely used for fishing activities. The study revealed that there were many types of polyethylene (PE) plastic, which was a precursor to the production of such fishing gear. (https://doi.org/10.1016/ j.marpolbul.) and also found transparent microplastic parts (Polyethylene terephthalate (PET)), which is classified as plastic used in the production of drinking water bottles, soft drink bottles and snack bags (https://www. plasticseurope.org/en.)The accumulation of microplastics in the beach area was partly due to waste being dumped into water sources both intentionally and unintentionally and was swept out to sea. Although there is a wastewater treatment system before releasing it into the sea, some of microplatic fragments are discharged through industrial and community sewer pipes. (Magnusson & Norén, 2014).

Suggestion

1) Comprehensiveand lifecycle approach to the issue is recommended. A focus on preventive options early in the lifecycle of textiles and tyres is likely to deliver pollution mitigation in the most costeffective manner

2) There are increasing concerns over the environmental and human health impacts associated to exposure to these pollutants. The potential for long-term and irreversible risks to ecosystems and human health calls for mitigation measures to be taken to halt the accumulation of plastics and microplastics in the environment.

ACKNOWLEDGMENT

This research was funded under Marine Waste Management Activities, Department of Marine and Coastal Resources. We would like to express our sincere thanks to the staff members of Bioproducts Assessment Group and the Oceanography Group, Marine and Coastal Resources Research Center, Upper Gulf of Thailand for their assistance in surveying, collecting and analyzing samples.

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Data Availability Statement: The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Conflicts of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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