

Impacts of beach cleanup on marine debris and microplastic levels in touristic coastline area in Krabi, Thailand

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Abstracts

Marine debris and microplastic contamination in the environment are increasing worldwide problem, which results in an array of negative effects to environment and biota. This study provides the supporting data of marine debris and microplastics detected on the beach and in the sand sediment in relation to beach cleanup activities in Krabi Province, southern Thailand. The study assessed the quality and quantity of marine debris and the quality, size, and quantity of microplastics at four different beaches, contrasting those under the influences of beach cleanup activities. Marine debris was counted ground survey following the International Coastal Cleanup (ICC) methods, beach cleanliness was estimated using the Clean Coast Index (CCI) as well as the Globe protocols (tree height, land cover) to identify the study site. A visible microplastic size (1-5 mm) were examined and photographed using a clip-on microscope attached to mobile phone. Marine debris and visible microplastics were detected at all study areas are in tourist attractions sites (Ao Nang, Railay beach, Nopparat Thara beach/pier and Poda Island). The top five of marine debris found during our study were plastic pieces, foam pieces, cigarette butts, Rope pieces and Plastic bags respectively. However, these areas were considered as clean beach according to the CCI index of 2-5. This could due to the close cleanup beaches by hotel staffs, marine national park and local authorities which support the Krabi Go Green Campaign. Recommendations for continuation of beach cleanup is highly recommended for future assessment for the Krabi Provincial Organization and other coastal areas.

Keywords: Marine debris, visible microplastic, tourism, beach cleanup, Krabi, Thailand

Introduction

One of the significant problems that needs to be concerned will be Marine debris and micro-plastics. Marine debris is any man-made solid waste discarded to the marine area which have gained public interest as a global environment problem in recent years. As more human activities are causing plastic debris to the oceans, Thailand was reported in 6th position in the world in producing plastic debris to the Oceans (Jambeck et al., 2015).

Marine debris is defined as any persistent, man-made solid waste discarded into the marine environment (Galgani et al., 2015). Most of it is made of plastic (Barnes et al., 2009) that originates from both land- and ocean-based sources which is well documented for 80% land-based sources relating to human activities. Unfortunately, marine debris found spreadout over our oceans by currents from industrialized and densely populated areas to even the most remote and unpopulated coastal regions (McDermid and McMullen, 2004; Barnes et al., 2009; Hirai et al., 2011).

Microplastics are minute fragments of plastic debris, which are divided into small (<1 mm in diameter) and large (1–5 mm in diameter) particles (Horton et al., 2017). The main component of microplastic is usually synthetic polymers for example nylon, polyester, acrylic, poly-propylene, polystyrene, polyester, polyurethane, and polyamide fibers. (Barnes et al., 2009; Vianello et al., 2013). Microplastics were reported to be harmful to environment and organisms. Microplastic was reported to be ingested in a wide range of marine taxa, including crustaceans, molluscs, fish, birds, and mammals (Alomar & Deudero, 2017; Horton et al., 2017; McDermid & McMullen, 2004).

Krabi is famous for its scenic view and breathtaking Beaches and Islands, this province is one of the most tourist attractions in Thailand where marine debris and microplastics debris could be affected by tourism. Local Krabi people and also many attempts from outsides have been keen to launch campaigns such as waste reduction, recycling and clean-up project design to tackle the plastic debris issues at tourist areas in order to achieve zero waste in the coastal area. In this study, we conducted the simple field examination to survey the type, amount and source of marine debris, and to compare how beach cleanup frequencies could affect number of marine debris and visible microplastics among the study locations.

Research Questions

What is the impact of tourism activities on the amount of microplastic around the beach area?

Research Hypothesis

We predicted that high beach cleanup frequency beaches would have lower amounts of marine debris, microplastics and CCI.

Materials and methods

1). Materials

We do field study to collect marine debris and microplastic using these following items:

1. plastic rope

2. metal shovels
3. 1.5 Kg balancing scale
4. aluminum tray
5. large plastic zip lock
6. small plastic zip lock
7. pack of plastic gloves
8. aluminum sieves
9. plastic buckets
10. plastic box
11. ruler
12. pack of rubber gloves
13. clip-on microscope attached to mobile phone
14. dissection kits (forceps, needles, dipper)
15. Especially during covid-19, we protect ourselves using personal protective equipment (PPE) for example facial masks, gloves, alcohol gels

2). Methods

2.1 Study sites

This study and data were conducted mainly at four beach fronts: Railay, Ao Nang, Nopparat Thara Pier and Poda at Kabri Province, Southern Thailand (Figure 1). Railay Beach (Lat 8.012616 N, Lon 98.837196 E) was a kind of private with high tourist activities, with frequent cleanup (daily cleanup) by hotel staff (Figure 1a). 2). Ao Nang Beach (Lat 8.032704 N, Lon 98.820105 E) was an open-access beach with optimal numbers of tourists visiting and with regular beach cleanup (usually 3-4 times a week) from nearby hotel staffs/ local authorities/cleanup campaign activities (Figure 1b). 3). Nopparat Thara Beach/Pier (Lat 8.0429 N, 98.8093 E) was an open-access beach where is the pier for tourist boat to visit nearby popular islands and crowded with locals, with frequent beach cleanup from local authorities (daily cleanup) (Figure 1c) and 4). Poda Island (Lat 8.0427 N, Lon 98.8055 E) was an Island under the administration of Hat Nopparat Thara-Mu Ko Phi Phi Marine National Park also with frequent beach cleanup/cleanup campaign activities (Figure 1d). The types of land use were classified using GLOBE Landcover application and we also measured tree height around the beach using GLOBE tree application.



Figure 1 Map of study sites at Krabi province, Thailand. (a) Railay Beach, (b) Ao Nang Beach, (c) Nopparat Thara Beach, (d) Poda Island at Krabi Province, Southern Thailand. **Note:** (pale blue spot is for additional observed site at Ao Nammao Pier)

2.2 Data collections

Marine debris (size larger than 5 mm) was collected in the 250 m² plot area covering the area from the shoreline to the upper beach limit (determined by the presence of vegetation line). Sampling was performed according to the operational guidelines for rapid beach debris assessment described by the NOAA guidebook Cheshire et al. (2009).

Types, amounts and sources of marine debris were determined following the International Coastal Cleanup (ICC) method. These marine debris was then classified into three major groups: (1) recycled waste, (2) general waste and (3) hazardous waste (Table 1) and then counts.

Marine debris was also calculated with the Clean Coast Index (CCI) which was equaled to the marine plastic debris concentration (B) multiplied by a constant number of 20 (see Table 2). The CCI values from 0-2 indicated very clean beaches, 2-5 clean, 5-10 moderately clean, 10-20 dirty and > 20 extremely dirty (Portman & Brennan, 2017).

All sands were transferred into prepared bags and sealed properly. Photos were taken by the clip-on microscope equipped with a camera. The number of microplastics in sediment was counted by scanning for microplastics. Microplastics were extracted by the use of tweezers for the analysis of the types of microplastics by hand sorting (Fiber, granular, film and fragment) (Nuelle et al., 2014).

Results and Discussions

1) Marine debris and marine plastic debris

Table 1 Three major groups of marine debris found in 4 study areas

Marine debris categories		
Recycled waste*	General waste	Hazardous waste
Plastic bags	Plastic pieces	Facial masks
Paper	Foam pieces	Glow stick
Bottle cap (plastic)	Cigarette butts	
Packaging tube	Construction materials	
Plastic bottles	Food wraps	
Aluminum foils	Rope pieces	
Glass pieces	Rubber pieces	
	Single-use plastics (cup, plates)	
	Straw/stirrers	
	Clothing	
	Toys	

* **Notes:** Some items are recyclable but due to its small size and dirtiness in fact they are very difficult to recycle

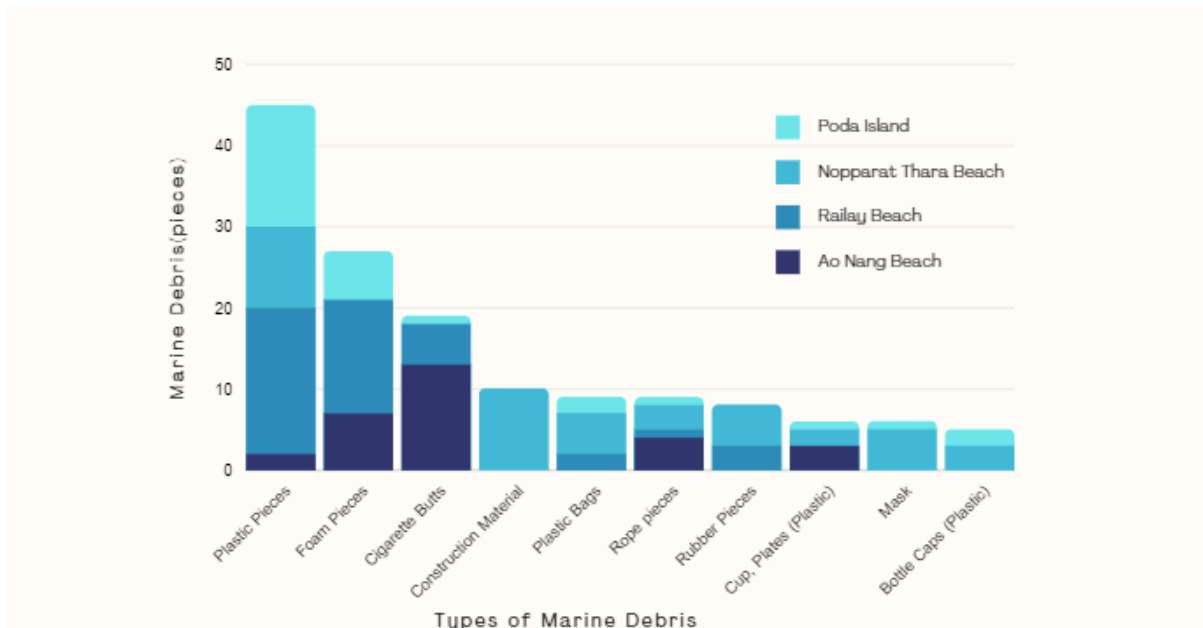


Figure 2 Types and amounts of marine debris at 4 study sties

More than 85% of marine debris collected were plastics. Major marine debris found were plastic pieces, foam pieces, cigarette butts, construction material including other small pieces of single-use plastic (i.e. cup, plates) consecutively. We also found some facial masks at Nopparat Thara Beach/Peir and Poda Island where many tourists frequently visit the places. These debris source could be from tourist or floating from nearby coastal area as they are new items (Table 1 and Figure 2).

Due to in the four areas are under care of either hotel staffs or the marine national park officers, as well as the Krabi Go Green & Zero waste campaign, tourist beaches have close caring in many ways including frequent beach cleanup. We can also assume by the Clean Coast Index (CCI) which is considered as a clean beach (2.72-3.44) (Table 2) while compared to one unclean beach (Hau Thanon, a fisherman village at Samui Island) which is very dirty with the CCI of 23.44 (Horpet, et.al., 2022). Nevertheless, some debris are still found and needed intensive care to keep all beaches cleaner from everyone.

It has also been also noted that after the main study, we observed marine debris from the field at Ao Nammao pier where there is a nearby private area with no cleanup activity is currently practiced, and it is likely that more marine debris and microplastic will be detected in this kind of area. Therefore, further study is probably needed to confirm the amount and type of marine debris and microplastic in unclean beach nearby in coastal Krabi province (Figure 1).

Table 2 Amounts and concentrations of marine debris, marine plastic debris, and microplastic debris at study locations.

Beach areas	Marine debris (items/m ²)	Marine plastic debris (items/m ²)	Clean Coast Index (CCI)	Microplastic debris				
	(A)	(B)		(items/m ²) (C)	Shape (% detection)			
					Fiber	Foam	Fragement	Film
Railay Beach	(57) 0.228	(43) 0.172	3.44	8 (32)	0 (0)	0 (0)	8 (100)	0 (0)
Ao Nang Beach	(34) 0.136	(34) 0.136	2.72	11 (44)	1 (9)	3 (27)	6 (55)	1 (9)
Noppharat Thara Beach & Pier	(56) 0.224	(39) 0.156	3.12	1 (4)	0 (0)	0 (0)	1 (100)	0 (0)
Poda Island	(44) 0.176	(35) 0.14	2.8	51 (204)	0 (0)	51 (100)	0 (0)	0 (0)

2) Microplastic

Table 2 showed that the visible microplastic particles (size 1-5 mm) were detected in all 4 study areas ranging from 4-44 items/m² in frequent cleanup area on the touristic coastline with the comparison of the highest number at Poda Island of 204 items/m². However, this high number found in one spot of broken foam pieces from larger part. This also reflected importance of remove larger piece of marine debris (in this case the large foam pieces) before it broke down into small and much more difficult to clean up debris.

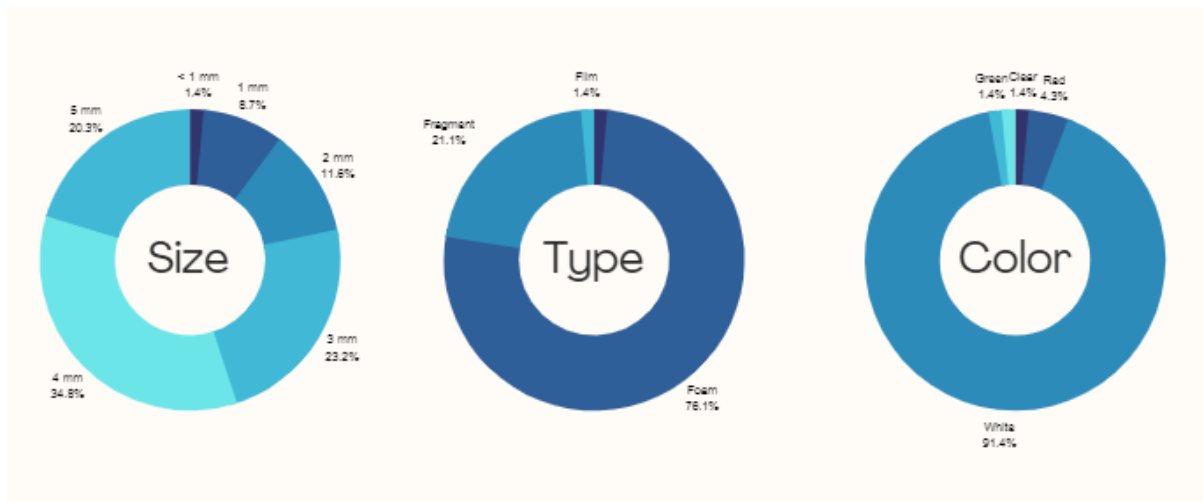


Figure 3. Size, type and color of visible microplastic (size 1-5 mm) identification from 4 study sites

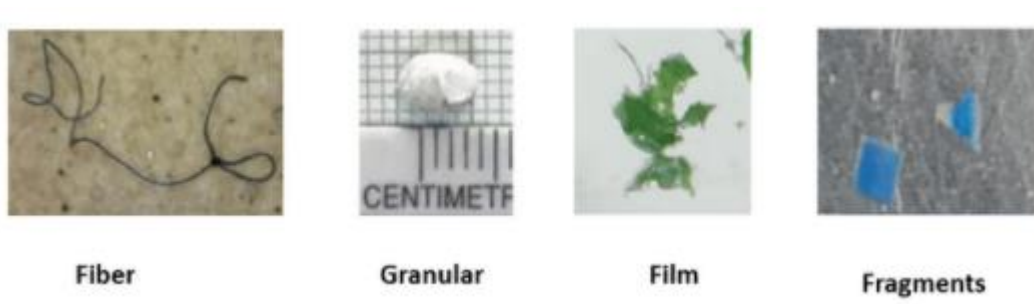


Figure 4. Photos of each type of visible microplastic (Fiber, Granular, Film and Fragments) size 1-5 mm at 4 study sites

More than 75% of visible microplastic detected were range 3-5 mm. where foam (> 75%), fragment (>21%) and file (>1%) were detected respectively. It is apparently that the white color of foam granules are the most found color (>90%) (Figure 3 and Figure 4).

Conclusion and Suggestion

- 1) The top 5 marine debris found were plastics pieces, foam pieces, cigarette butts, Rope pieces and Plastic bags.
- 2) The most common microplastics are foam 76.1%, fragment 21.1%, and film 1.4%.
- 3) All the study sites are clean according to the clean coast index (CCI) (2-5) due to the good care by hotel staffs and marine national park officers

4) Reduced microplastic load is one of the benefits of routine cleanup of marine debris by marine national park officers or hotel staffs who are taking care of the area. Therefore, there would be more tourists coming to visit the beaches and the income will increase. The ecosystem will also be getting better in a long term.

2022 IVSS: Badges

I Am A Collaborator: Because our group is working together with experts on mosquitoes habitat mapper application. Mr. Krisanadej Jaroensutasinee, Mrs. Mullica Jaroensutasinee, Ms. Sirirat Somchuea, and Ms Benjamas Khunpan which makes the work more efficient.

I Am A STEM Professional: In this section, our group works in a systematic process, problem solving, and systematic thinking. There is also attached information to support the project with a STEM Professional.

I Am a Data Scientist: We went to collect data in Krabi province by ourselves. We use a helper to collect data. It is possible in more detail with the application of the GLOBE Observer app, which can collect MHM data for analysis of human behavior.

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