



Impact of Marine Debris on Marine Ecosystem

Rinny Rahmania

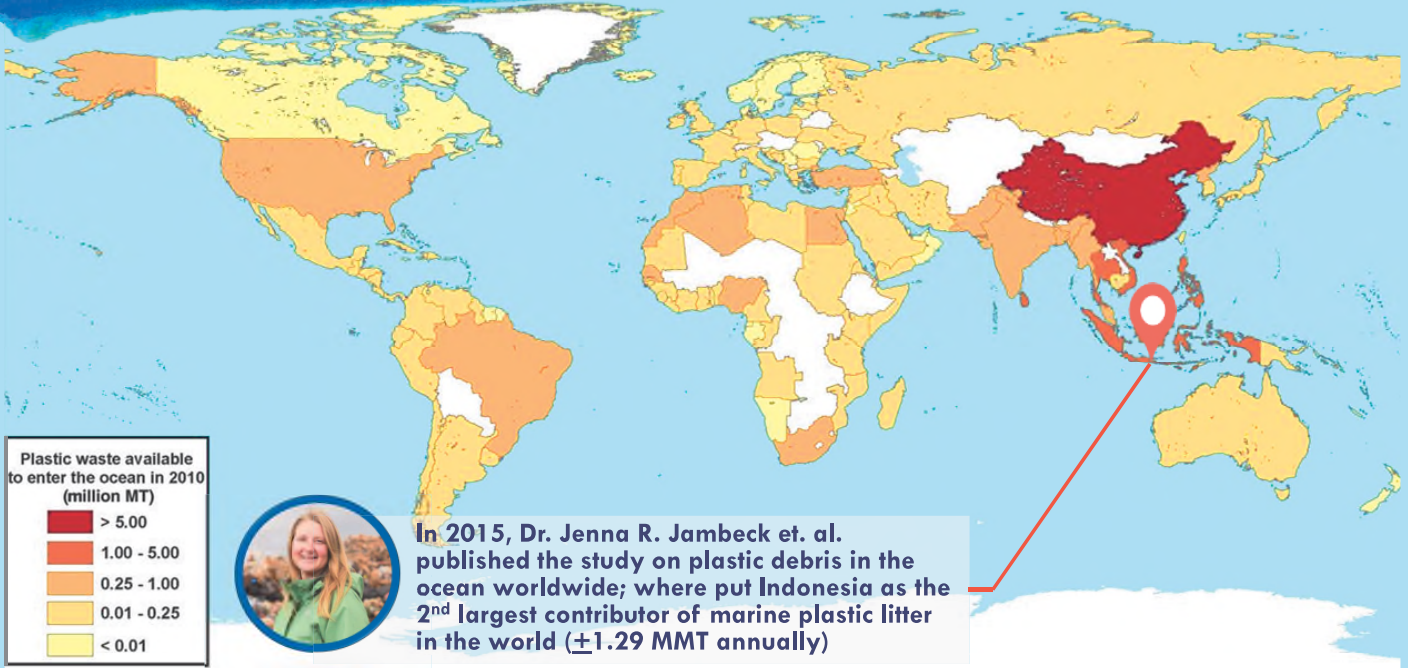


Pusat Riset Kelautan
BADAN RISET DAN SDM KELAUTAN DAN PERIKANAN

Komplek Bina Samudera Jl. Pasir Putih II Lantai 4, Ancol Timur, Jakarta Utara 14430 – DKI Jakarta
Telp. : (021) 64700755 ext 3120 | Fax. : (021) 64711654 | <http://pusriskel.litbang.kkp.go.id/>

Illustration source: <https://stock.adobe.com/images/ecological-disaster-of-plastic-rubbish-in-the-ocean-dead-turtle-dying-fish-seabirds-and-fish-on-a-background-of-debris-176652525>

Study on global plastic debris in the ocean



Reference: Plastic waste inputs from land into the ocean (Jambeck et. al., 2015).

Marine debris impacting Indonesia's marine ecosystem?

Source: http://www.coraltriangleinitiative.org/sites/default/files/resources/Statistics_on_the_CTI.pdf



	Indonesia
Geographic Indicators*	
Coral reef area (x1000 km ²)**	51
Mangrove area (x1000 km ²)**	42,6
Number of coral species***	574
Number of fish species§	2122
Number of mangroves species**	45
Number of seagrass species**	13
Percent reef at risk**	82
Geographic Data§§	
Total population (million)	232,5
Life expectancy at birth	71
Urban population	54%
Agricultural population, including forestry and fisheries (x1000)	86 804
Per capita daily calorie intake	2 535
Per capita daily protein intake (% kcal)	9
Land area (km ²)	1,9 million
Total marine water area (including EEZ) (km ²)	2,7 million
Shelf area (to depth 200 m) (km ²)	2 700 000
Length of coastline (km ²)	81 000
Fisheries Data§§	
Fisheries GDP (million USD)	
Per capita fish supply (kg/year)	21,3 (2003 data)
Estimated employment - Primary sector (including aquaculture)	5 193 445 (2005 data)
Gross value of fisheries output (million USD)	5 202 (2004 data)
Value of fisheries imports (million USD)	139,8 (2004 data)
Value of fisheries exports (million USD)	1 654,1 (2004 data)

* Hoegh-Guldberg et al., 2009
 ** Spalding et al., 2001
 *** Veron, 2009
 § Allen, 2008
 §§ Food and Agricultural Organization (FAO)

Marine Debris (MD)



Outline

1 MD research in Indonesia

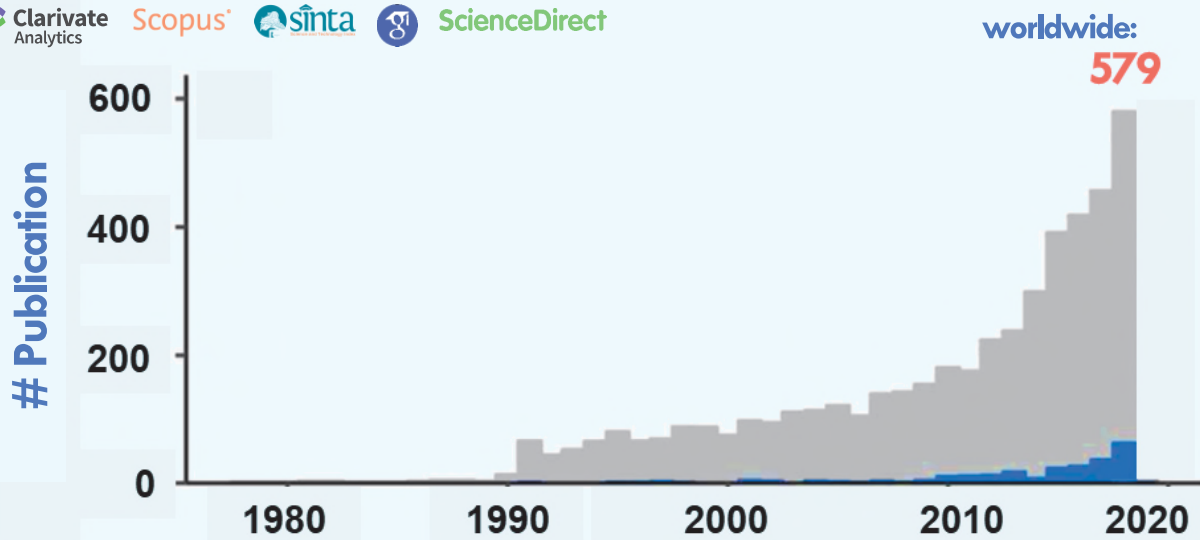
2 MD impact on ecosystem

3 What next?

Scientific publication on marine debris research

(Purba, N. P., et al., 2019)

Clarivate Analytics Scopus[®] SINTA ScienceDirect

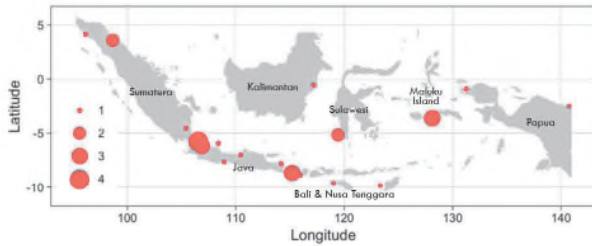


Reference: Purba, N. P., et.al, 2019, Marine debris in Indonesia: A review of research and status, Marine Pollution Bulletin 146 (2019) 134–144

Scientific publication on marine debris research

(Purba, N. P., et al., 2019)

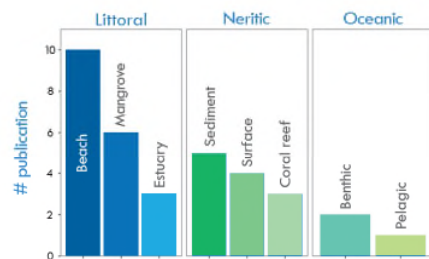
Spatial distribution of published MD studies in Indonesia



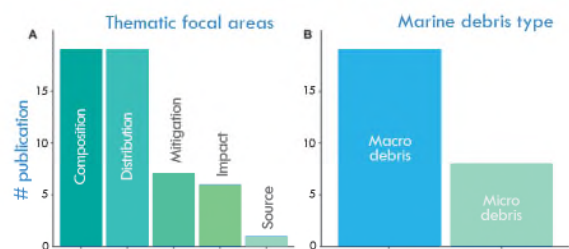
Distribution of published MD studies in Indonesia across publication types and field



Distribution of published MD studies in Indonesia across marine zones and ecosystems

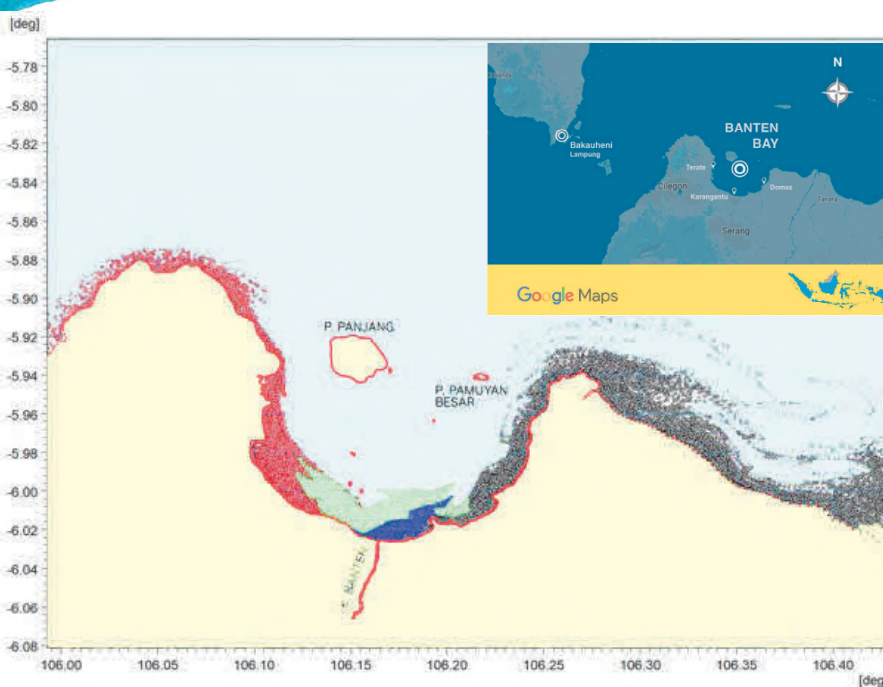


Distribution of published MD studies in Indonesia across thematic focal areas and marine debris type



Example: Research on MD dispersal in Banten Bay – Java Island

(Marine Research Center – MoMAF, 2018)



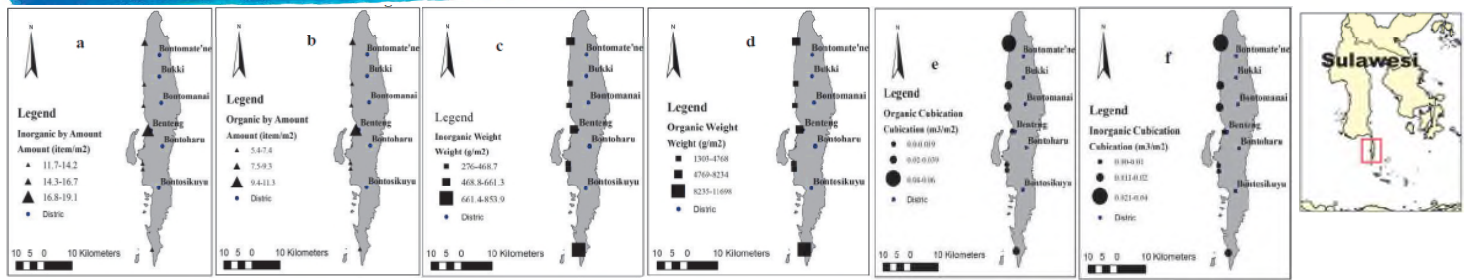
- MD dispersal due to ocean tides
- MD dispersal due to ocean tides and river debit
- MD dispersal due to ocean tides and during west monsoon
- MD dispersal due to ocean tides and during east monsoon

This study is located in Java Island, near the high populated city of Serang and Jakarta. This study shows that it is difficult to determine the origin of MD that floating in the studied area; moving around drifted by wind and current from time to time.

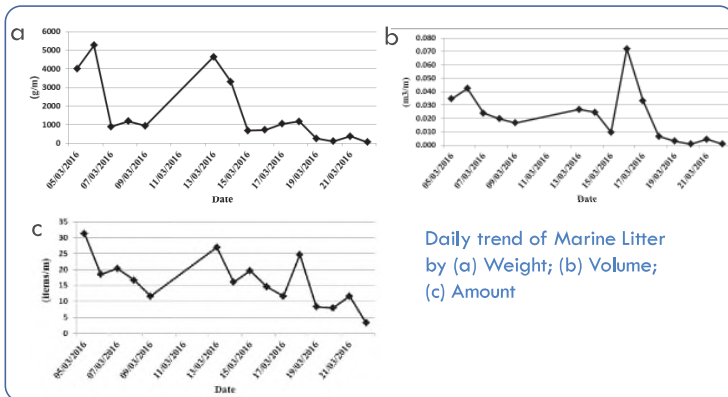
MD should be treated as common problem instead of pointing fingers.

Example: MD stranded on small island (Selayar island)

(Hermawan, R., Damar, A., and Hariyadi, S., 2017)



(a) (b) Spread of Marine Litter by Amount; (c) (d) by Weight; (e) (f) by Volume



Daily trend of Marine Litter by (a) Weight; (b) Volume; (c) Amount

This small island has low population, yet the number of MD that found in this island is considered high. The impact on the ecology in the waters especially in the intertidal area, arising from floating MD that stranded there. Litter piled up on the beach, covering the seagrass and organism, covered by plastic wrap, timber and glass bottles. A lot of plastic wrappers and timber found on this intertidal area. During low tide floating materials were covered and piled up on vegetation or organism. Impact on seagrass and organism that are covered and piled up such as broken leaves, tissue abrasion causing partial or mortality. Effect and broken seagrass leaves become litter and washed away by water current to the beach.

Several papers related to the abundance and characteristics, source, composition of microplastics

1. Abundance and characteristics of microplastics in the northern coastal waters of Surabaya, Indonesia.
2. Accumulation of Beach Litter on Islands of the Pulau Seribu Archipelago, Indonesia.
3. Analysis of sources and composition of marine debris in western and southern Aceh, Indonesia.
4. Beach macro-litter monitoring and floating microplastic in a coastal area of Indonesia.
5. Distribution of Macro Debris at Pangandaran Beach, Indonesia.
6. Distribution of Macro Debris in Savu Sea Marine National Park (Kupang, Rote, and Ndana Beaches), East Nusa Tenggara, Indonesia.
7. Distribution of Marine Debris in Biawak Island, West Java, Indonesia.
8. Investigation of Marine Debris in Kuta Beach, Bali.
9. Marine Debris on Small Islands: Insights from an Educational Outreach Program in the Spermonde Archipelago, Indonesia
10. Microplastic tracking from Pacific garbage to Northern Indonesia Sea.
11. Microplastics abundance in coastal sediments of Jakarta Bay, Indonesia
12. Microplastics Patch Based on Hydrodynamic Modeling in The North Indramayu, Java Sea
13. Occurrence of beach debris in Tunda Island, Banten, Indonesia
14. Simultaneous grading of microplastic size sampling in the Small Islands of Bintan water, Indonesia



Outline

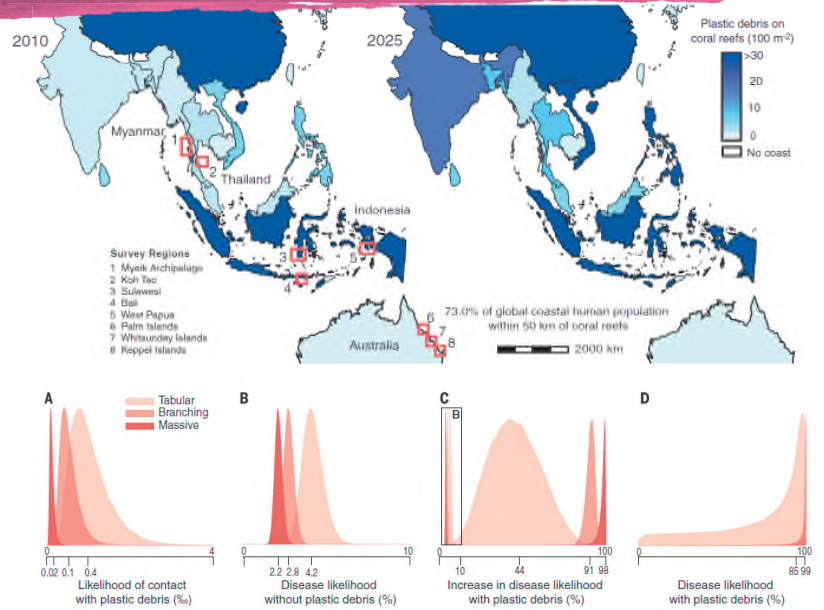
- 1 MD research in Indonesia
- 2 MD impact on ecosystem
- 3 What next?

Impacts of MD on Marine Ecosystem

1. Impact on Coral Reef

(Source: Lamb, J.B., et. al., 2018, Plastic waste associated with disease on coral reefs. Science 359, 460–462, 2018)

The influence of plastic waste on disease risk were assessed in 124,000 reef-building corals from 159 reefs in the Asia-Pacific region. The likelihood of disease increases from 4% to 89% when corals are in contact with plastic. Structurally complex corals are eight times more likely to be affected by plastic, suggesting that microhabitats for reef-associated organisms and valuable fisheries will be disproportionately affected. Plastic levels on coral reefs correspond to estimates of terrestrial mismanaged plastic waste entering the ocean. This study estimates 11.1 billion ton plastic items are entangled on coral reefs across the Asia-Pacific and project this number to increase 40% by 2025.

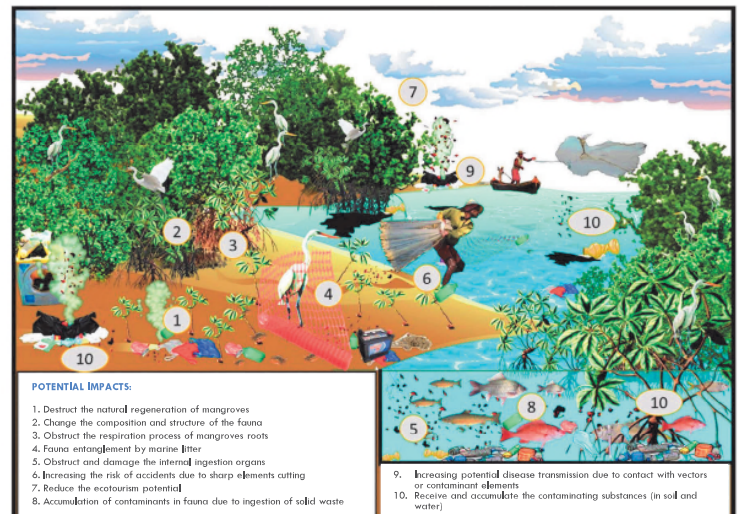


Coral morphological complexity influences risk to plastic debris and disease. (A to D) Posterior probability density functions of coral species grouped into three broad morphological classifications. Structural complexity is determined by coral species. Minimum, maximum, and peak values are shown for each structural complexity classification group: massive (dark red), branching (medium red), and tabular (light red). For ease of comparison, the inset in (C) represents the likelihood of disease without plastic debris [as shown in (B)].

Impacts of MD on Marine Ecosystem

2. Impact on Mangrove Ecosystem

(Source: Ordóñez, O.G. and Arenas, M. R. B., 2019, Impacts of marine debris contamination in the mangrove ecosystem of the Ciénaga Grande de Santa Marta, Colombian Caribbean, Mar. Cost. Vol. 11 (2): 145-165, Jul-Dec 2019)



Environmental impacts observed in mangroves due to the presence, accumulation, and degradation of MD in the area.

Potential environmental impacts of mangroves due to the presence, accumulation, and degradation of MD.

Impacts of MD on Marine Ecosystem

2. Impact on Mangrove Ecosystem – actual condition in Indonesia



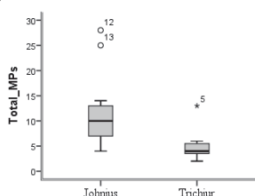
What are impacts of MD on Marine Ecosystem

2. Impact on Fauna: Entanglement and Ingestion

Abundance of microplastics in marine organism

[Reference: Ismail, M. R., Lewaru, M. W., and Prihadi, D. J., 2019, Microplastic Ingestion by Fish in The Pangandaran Bay, Indonesia, World News of Natural Sciences 23 (2019) 173-181]

No	Species / organism	Feeding Habits	MPs*		Location of Fishing	Reference
			Fragmen	Fiber		
1	<i>Scarus quoyi</i>	Herbivore	100%	0%	Java Sea	(Ismail et al., 2018)
2	<i>Chaetodon guttatisimus</i>	Herbivore	100%	0%	Java Sea	
3	<i>Priacanthus tayanus</i>	Herbivore	100%	0%	Java Sea	
4	<i>Valamugil sebeli</i>	Herbivore	95%	5%	Java Sea	
5	<i>Lutjanus lutjanus</i>	Carnivore	93.29%	6.71%	Java Sea	
6	<i>Lethrinus atkinsoni</i>	Carnivore	99.39%	0.61%	Java Sea	
7	<i>Pterorhinchus chrysotaenia</i>	Omnivore	94.81%	5.19%	Java Sea	
8	Macrofauna	Plankton	100%	n.a.	Ambon Bay	(UsepuTTY, 1997)
9	<i>Epinephelus</i> sp.	Carnivore	n.a.	n.a. (dominant)	Pelabuhanratu bay and ancil bay	(Hapticsari, 2016)
10	<i>Lutjanus</i> sp.	Carnivore	n.a.	n.a. (dominant)		
11	<i>Johannes</i> sp.	Omnivore	52.33%	25.78%	Pangandaran Bay	This Study
12	<i>Trichurus</i> sp.	Carnivore	43.37%	37.66%		

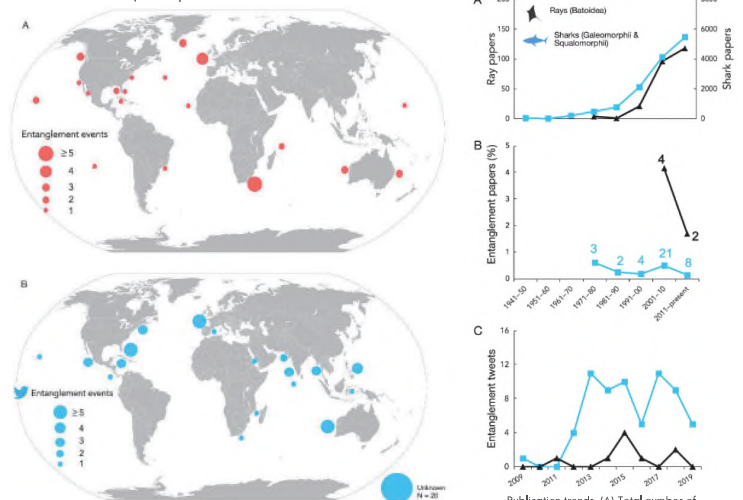


*) MP=microplastic Fish

Microplastic was found in the digestive tract of all fish with fragmen (49.74%), fiber (22.8%) and films (27.46%), with sizes ranging from 0.12 to 5 mm.

Shark and Ray Entanglement

[Reference: Parton, K. J., Galloway, T. S., and Godley, B. J., 2019, Global review of shark and ray entanglement in anthropogenic marine debris, Endangered Species Research, Vol. 39: 173–190, 2019]



Global distribution of entanglement events from (A) published scientific literature and (B) distinct tweets from Twitter from 2009 to 2019. Circles are proportional to magnitude

Publication trends. (A) Total number of peer-reviewed articles on sharks and rays from 1941 to 2019. Based on Web of Science searches. (B) Entanglement papers as a percentage of total number of papers on sharks and rays, with numbers of publications annotated. (C) Total tweets featuring elasmobranch entanglement from the first recorded elasmobranch entanglement tweet in 2009 to 2019.

Several papers related to marine debris impact to coastal ecosystems

1. Daily Accumulation and Impacts of Marine Litter on The Shores of Selayar Island Coast, South Sulawesi.
2. Microplastic in Marine Environment and its Impact
3. Marine litter disrupts ecological processes in reef systems
4. Marine Debris & Plastics: Environmental Concerns, Sources, Impacts and Solutions
5. Indonesia's globally significant seagrass meadows are under widespread threat
6. Impacts of pollution on marine life in Southeast Asia
7. Impacts of macro - and microplastic on macrozoobenthos abundance in intertidal zone
8. From Coral Triangle to Trash Triangle - How the Hot spot of Global Marine Biodiversity Is Threatened by Plastic Waste
9. Domestic Waste and TBT Pollution in Coastal Areas of Ambon Island (Eastern Indonesia)
10. Daily Accumulation and Impacts of Marine Litter on The Shores of Selayar Island Coast, South Sulawesi
11. Marine litter disrupts ecological processes in reef systems

Outline



1 MD research in Indonesia

2 MD impact on ecosystem

3 What next?

What next?

MD is a complex problem and transboundary in nature.

Considering the geographical factor and the scale of MD impact on our marine ecosystem that also affecting biodiversity as well as human being, we need to have a collaboration/joint research on marine debris to study the impact of MD to our marine ecosystem in an efficient and effective manner; **and the more important thing is to find applicable solutions/prevention.**

The future research that can be done are listed below:

- Source and fate of microscopic fragments/plastic fibers;
- Accumulation and dispersion of toxic substances found in or on plastic;
- Impact of MD on the species from the base of food chain up to the human health;
- Bio-transfer of pollutants;
- Reduction of MD and/or other solutions (e.g. Improvement of waste management system, Circular Economy);
- Effectiveness assessment of the proposed solution
- etc.



Thank you

Correspondent address: rinny.rahmania@kkp.go.id;
rahmania.rinny@gmail.com

Pusat Riset Kelautan
BADAN RISET DAN SDM KELAUTAN DAN PERIKANAN

Komplek Bina Samudera Jl. Pasir Putih II Lantai 4, Ancol Timur, Jakarta Utara 14430 – DKI Jakarta
Telp. : (021) 64700755 ext 3120 | Fax. : (021) 64711654 | <http://pusriskel.litbang.kkp.go.id/>

Illustration source: <https://stock.adobe.com/images/ecological-disaster-of-plastic-trash-in-the-ocean-dead-turtle-and-fish-seabirds-and-fish-on-a-background-of-debris->