Indonesia–Taiwan Cooperation Workshop on Marine Plastic Debris Governance

Director Lee, Shan-Ying
Ocean Affairs Council, Taiwan

海洋委員會
Ocean Affairs Council

The Ocean

Today's workshop represents more than an academic or technical exchange — it is a continuation of a shared commitment between Indonesia and Taiwan to address one of the most pressing environmental challenges of our time: marine plastic pollution.

Oceans cover 70% of Earth's surface and are home to countless lifeforms, shaping climate, food, and the planet's balance

The Shared Challenge We Face

Marine debris is a global issue that crosses borders.

It threatens marine biodiversity, fisheries, and coastal livelihoods.

The Indo-Pacific is both vibrant and vulnerable due to dense populations and active maritime trade.

No country can solve this alone

Taiwan's National Ocean Policy White Paper

A Shared Ocean, A Sustainable Future.

Priorities include:

- **Marine debris monitoring and data integration.**
- **Port and fishing gear recovery.**
- **Marine waste recycling and circular economy.**
- **Public engagement and ocean literacy.**

Our ocean future depends on cooperation beyond borders.

Indo-Pacific Marine Debris Cooperation Platform (IPMDCP)

Clean Oceans are our commitment, the Indo-Pacific is our momentum.

~Minister, Ph.D., Kuan Bi-ling

Taiwan–Indonesia Partnership: From Dialogue to Action

- Exchange best practices and policies.
- Build local capacity through training and research.
- Promote cross-sector collaboration.
- Create a scalable cooperation model for ASEAN and Indo-Pacific.

Partnership with Indonesia marks the first step toward regional cooperation.

Harnessing Technology & Community Power

Combine innovation and inclusion:

- Use AI, modeling, and digital mapping for better management.
- Empower communities, NGOs, and youth as ocean stewards.

Taiwan's community actions + Indonesia's recycling innovation = regional movement for change

Multi-Stakeholder Partnerships

Collaboration with:

- Private sector → green innovation
- Academia → science-based decisions
- Civil society → awareness & accountability

Governments cannot act alone.

Toward a Sustainable Indo-Pacific

The Indo-Pacific covers half the world's population and two-thirds of its oceans. Taiwan–Indonesia collaboration has regional and global significance.

Together, turn:

- Challenges into opportunities
- Marine waste into innovation
- Cooperation into sustainability

- **The ocean connects us all — it knows no borders.**
- **Let's act beyond boundaries for a cleaner, sustainable Indo-Pacific.**

Cherishing our oceans, Taiwan and Indonesia are moving forward together on this shared path.

Thank You

THE STATUS QUO OF MARINE PLASTIC DEBRIS IN INDONESIA

Indonesia Marine Debris Management Cooperation Project
The Habibie Center (THC) – Ocean Affairs Council of Taiwan (OAC)

5-6 November 2025

Research Center for Oceanology (RCO)
The Indonesian Research and Innovation Agency (BRIN)

Muhammad Reza Cordova
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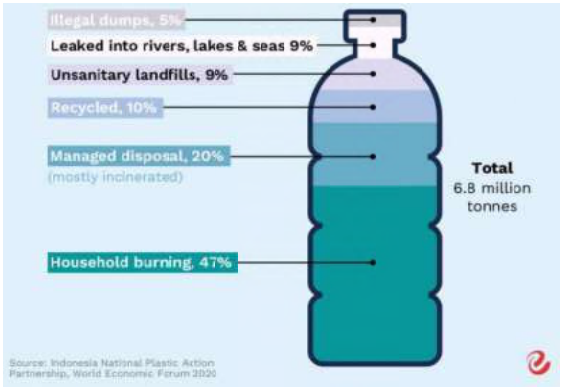
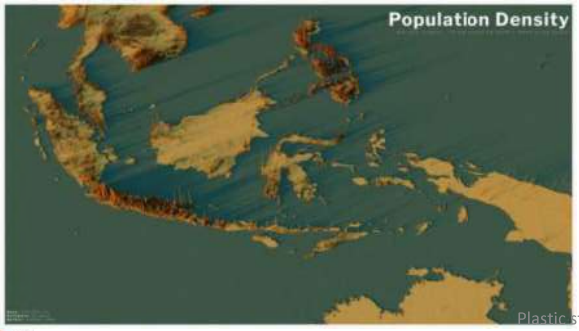
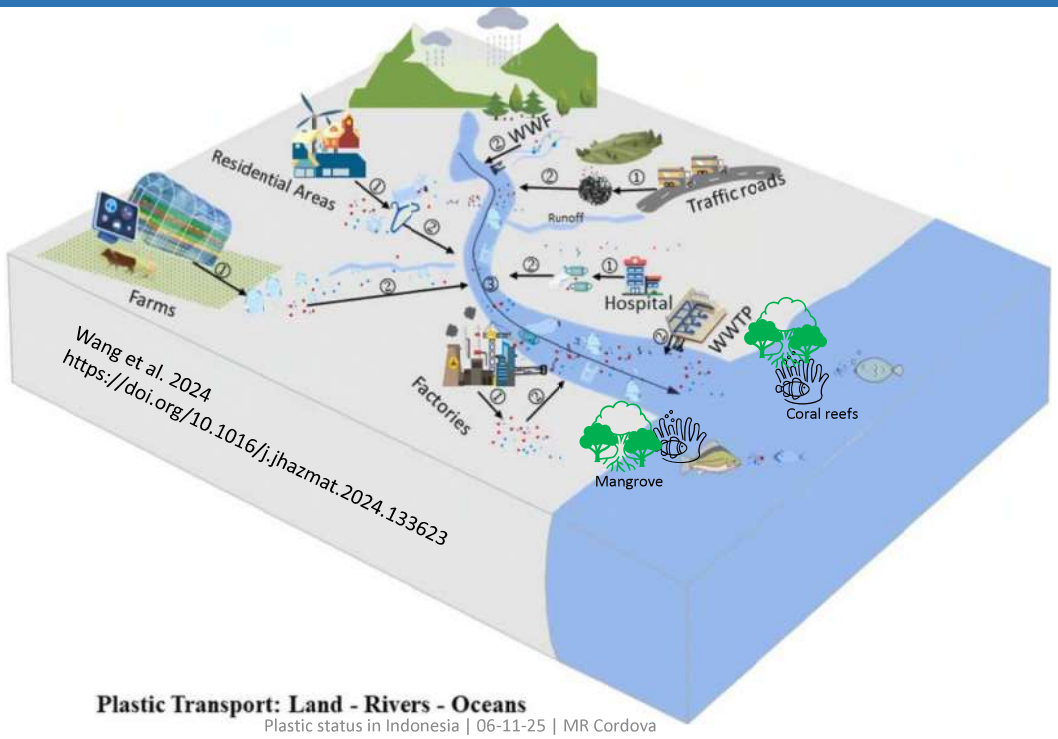
Introduction: Why plastic leakage matters?

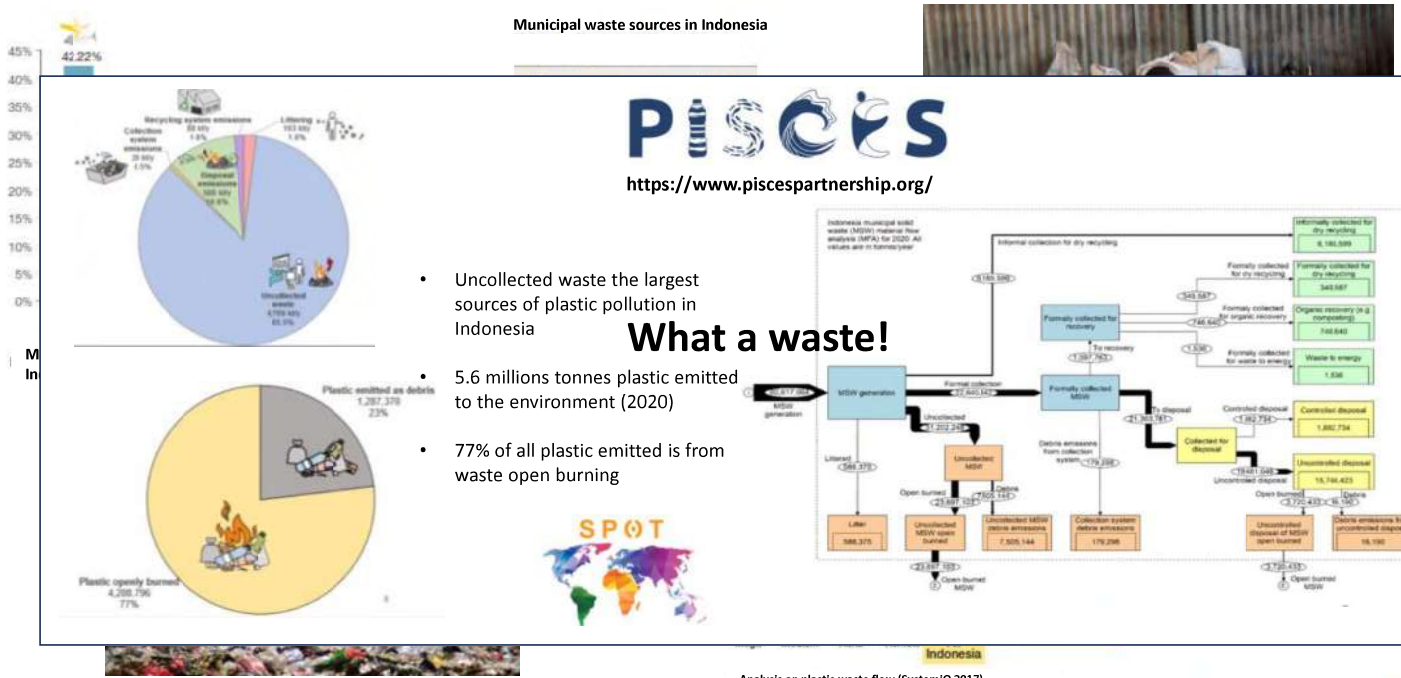




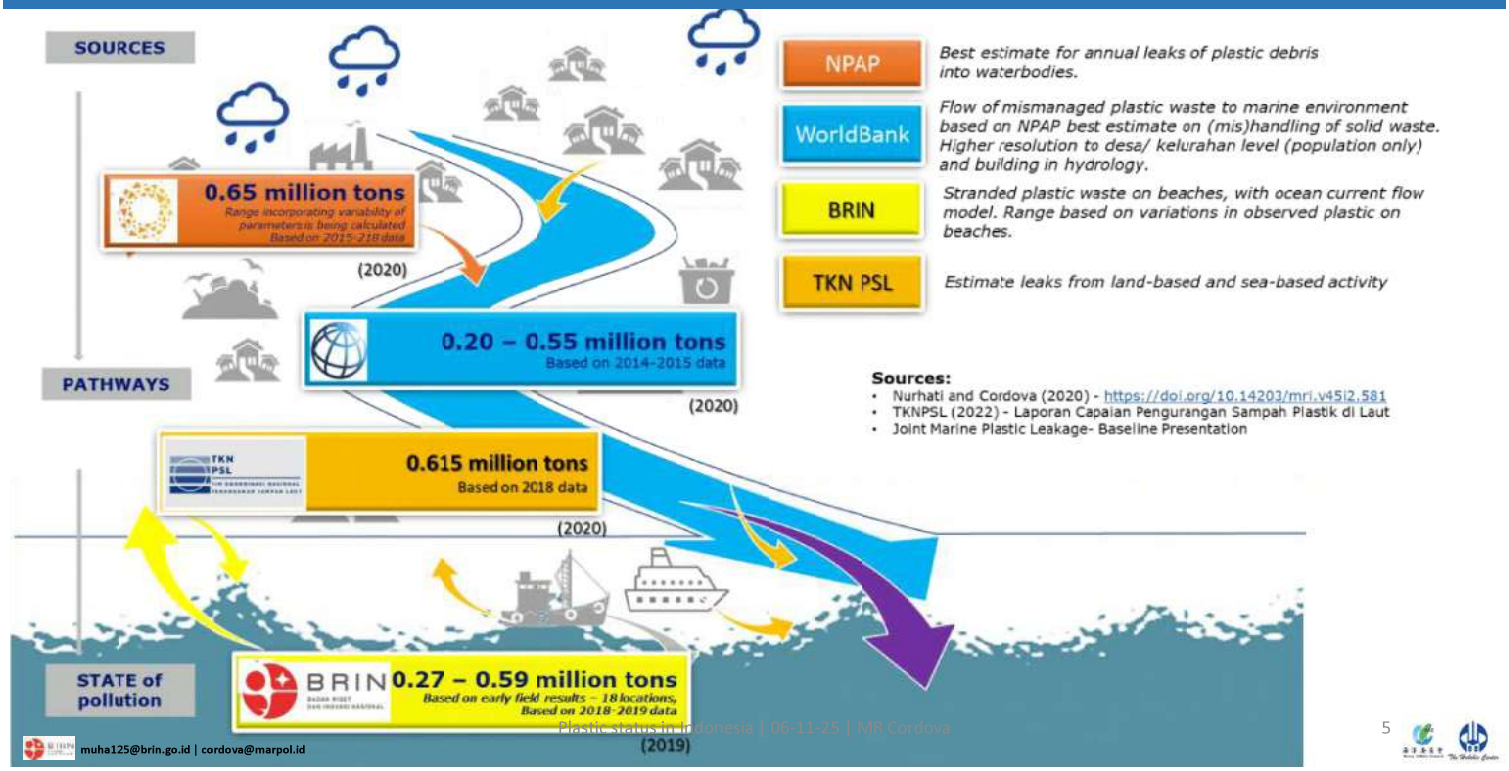
Conceptual framework, from rivers to seas



Scientific data to policy



Conceptual framework, from rivers to seas



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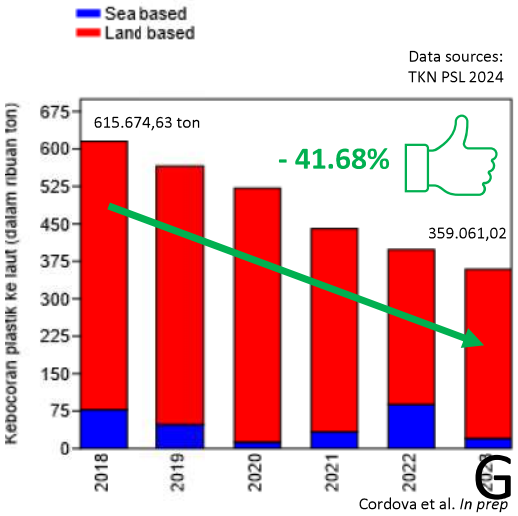
Conceptual framework, plastic leakage to the sea



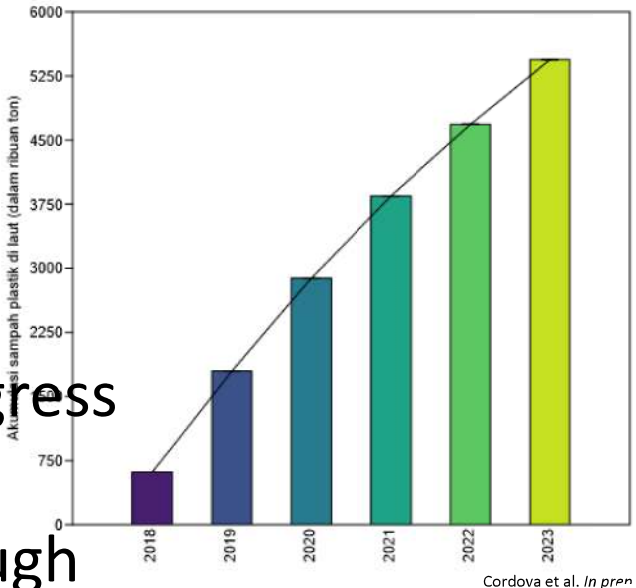
HOWEVER

Good progress

But….

Not enough

Increasing accumulation of plastic waste in the Indonesian seas and world ocean



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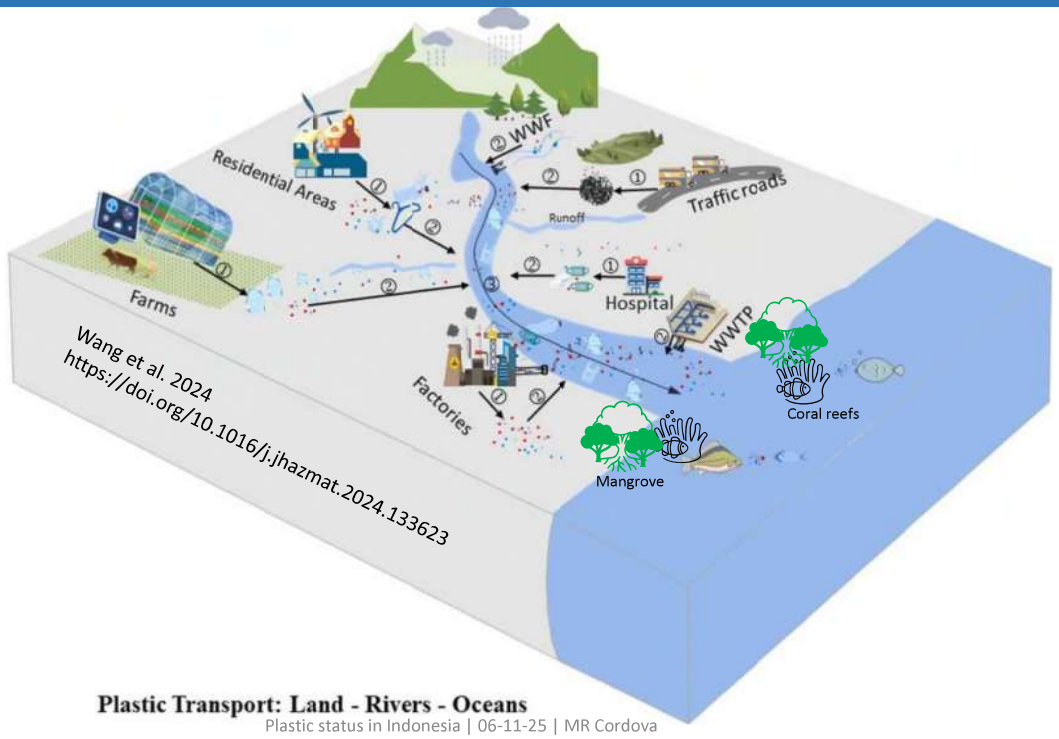
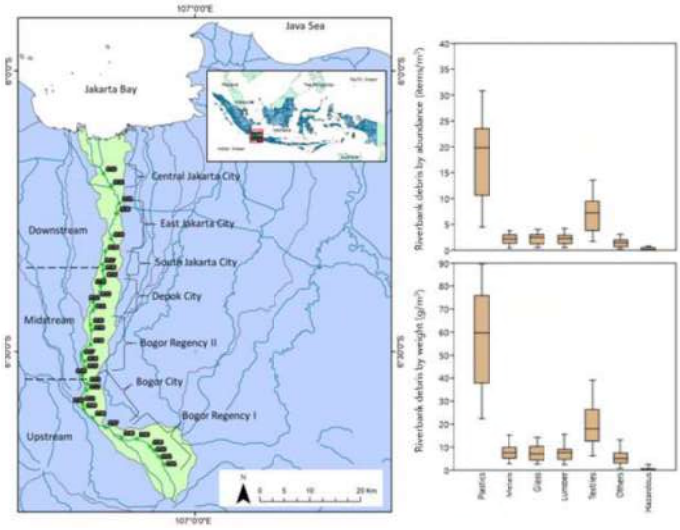
Conceptual framework, plastic leakage to the sea



Plastic journey from rivers to the sea

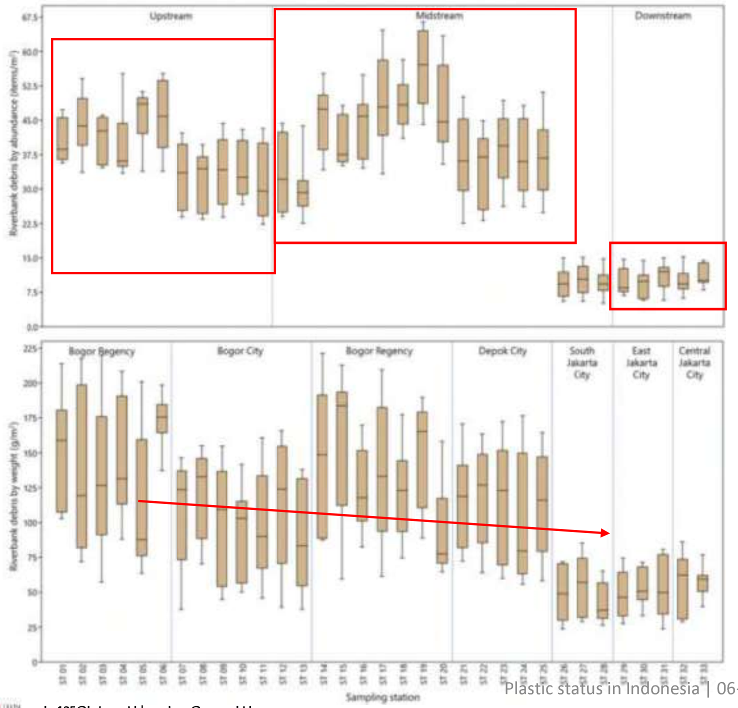


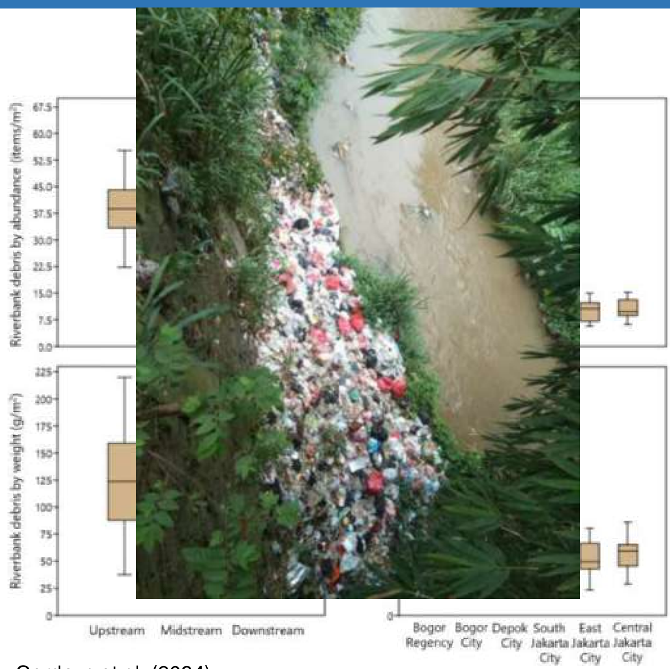
Area	Top-10 plastic debris category									
	1	2	3	4	5	6	7	8	9	10
Ciliwung riverbank	Styrofoam (cushion)	Plastic shopping bags	Cigarettes butts	Disposable medical mask	Styrofoam (food wrapper)	Food wrappers	Plastic sachet (non-food pack/ wrapper)	Plastic cups	Straw, cotton buds, pieces	Other plastic bags
% share Bogor Regency	10.13 Cigarettes butts	10.11 Styrofoam (cushion)	10.04 Plastic shopping bags	9.93 Disposable medical mask	9.90 Plastic sachet (non-food pack/ wrapper)	9.87 Styrofoam (food wrapper)	9.85 Food wrappers	3.79 Other plastic bags	3.79 Plastic cups	3.78 Drinking plastic bottles
% share Bogor City	10.08 Food wrappers	10.31 Disposable medical mask	9.73 Styrofoam (food wrapper)	8.90 Plastic sachet (non-food pack/ wrapper)	8.94 Plastic shopping bags	8.78 Cigarettes butts	8.02 Styrofoam (cushion)	3.85 Straw, cotton buds, pieces	3.66 Plastic cups	3.62 Drinking plastic bottles
% share Bogor Regency	10.8 Cigarettes butts	10.04 Plastic sachet (non-food pack/ wrapper)	9.9 Food wrappers	9.41 Styrofoam (cushion)	9.37 Plastic shopping bags	9.2 Styrofoam (food wrapper)	8.97 Disposable medical mask	3.78 Plastic cups	3.59 Other plastic bags	3.29 Shoes, sandals, gloves, cuts
% share Depok City	9.83 Styrofoam (cushion)	9.63 Disposable medical mask	9.5 Plastic sachet (non-food pack/ wrapper)	9.39 Styrofoam (food wrapper)	9.49 Food wrappers	9.21 Cigarettes butts	9.08 Plastic shopping bags	4.21 Drinking plastic bottles	3.51 Straw, cotton buds, pieces	3.17 Other plastic bags
% share South Jakarta City	10.55 Food wrappers	9.51 Styrofoam (food wrapper)	9.5 Styrofoam (cushion)	9.32 Disposable medical mask	9.22 Cigarettes butts	9.06 Plastic shopping bags	8.35 Plastic sachet (non-food pack/ wrapper)	4.28 Other plastic bags	3.94 Diapers	3.80 Plastic label, plastic lids
% share East Jakarta City	9.84 Plastic shopping bags	9.25 Styrofoam (food wrapper)	9.1 Styrofoam (cushion)	8.77 Disposable medical mask	8.71 Food wrappers	8.66 Plastic sachet (non-food pack/ wrapper)	8.36 Cigarettes butts	4.85 Drinking plastic bottles	4.27 Plastic utensil	3.80 Plastic cups
% share Central Jakarta City	10.52 Disposable medical mask	9.97 Plastic shopping bags	9.49 Cigarettes butts	9.31 Plastic sachet (non-food pack/ wrapper)	9.19 Food wrappers	8.92 Styrofoam (cushion)	8.58 Styrofoam (food wrapper)	4.27 Straw, cotton buds, pieces	4.25 Other plastic bags	4.24 Drinking plastic bottles
% share Upstream	10.44 Cigarettes butts	10.19 Styrofoam (food wrapper)	9.53 Plastic shopping bags	9.47 Disposable medical mask	8.84 Styrofoam (cushion)	8.75 Food wrappers	8.5 Plastic sachet (non-food pack/ wrapper)	4.55 Straw, cotton buds, pieces	4.04 Drinking plastic bottles	3.99 Diapers
% share Midstream	10.47 Styrofoam (cushion)	9.9 Plastic sachet (non-food pack/ wrapper)	9.37 Styrofoam (food wrapper)	9.31 Disposable medical mask	9.28 Plastic shopping bags	9.06 Food wrappers	8.99 Cigarettes butts	3.76 Other plastic bags	3.45 Plastic cups	3.42 Straw, cotton buds, pieces
% share Downstream	10.14 Plastic shopping bags	9.83 Disposable medical mask	9.79 Cigarettes butts	9.79 Styrofoam (cushion)	9.55 Styrofoam (food wrapper)	9.5 Food wrappers	8.89 Plastic sachet (non-food pack/ wrapper)	3.88 Drinking plastic bottles	3.81 Plastic cups	3.63 Straw, cotton buds
% share	9.46	9.43	9.42	9.23	9.11	9.08	9.03	3.99	3.9	

Key Finding: The Ciliwung River demonstrates the step-by-step journey of plastic waste, from densely populated areas to the open ocean.

Cordova et al. (2024)
https://doi.org/10.1016/j.marpolbul.2024.116662

Plastic journey from rivers to the sea





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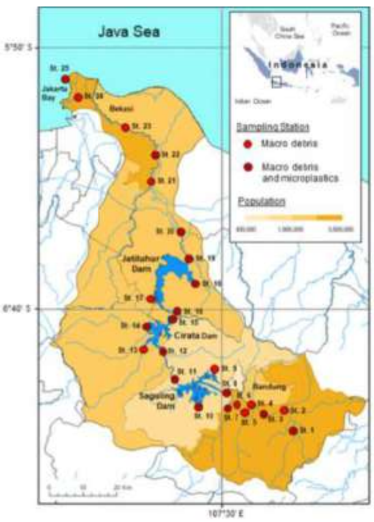

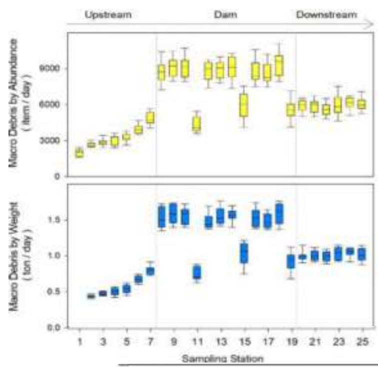

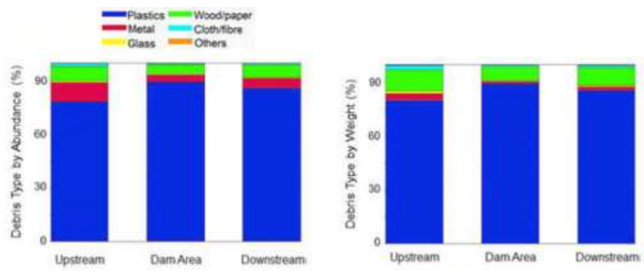

Plastics category	Upstream		Dam Area		Downstream	
	Abundance	Weight	Abundance	Weight	Abundance	Weight
Balls, tire, balloon	3.00	0.43	0.40	2.57	0.46	2.66
Broken or other types of plastic	2.80	0.96	0.90	2.31	1.06	2.42
Carpet, sofa cover, motorcycle seat	2.69	0.45	0.44	2.50	0.48	2.87
Cosmetic, toiletry	2.87	0.99	1.06	2.85	0.98	3.08
Crackle plastic bag	**14.75**	**15.99**	**16.11**	**13.04**	**16.95**	**12.46**
Duct tape, isolation	1.91	0.96	0.93	2.08	1.04	2.21
Lunch box, spoon, fork	1.89	1.81	1.96	1.47	2.06	1.57
Pipe, hose, cable	3.05	1.02	0.98	3.06	0.92	3.07
Plastic bottle and cap	8.28	**17.81**	13.84	6.62	13.08	10.68
Plastic cup	8.16	15.15	12.50	6.46	**14.61**	6.69
Plastic lighter, e-cigarette, cigarette butt	3.03	0.50	0.53	2.76	0.51	3.05
Plastic sachet	**17.99**	**16.16**	**26.61**	**26.04**	**23.38**	**20.58**
Rope, net, fishing line, fishing line	0.58	0.95	0.91	0.98	0.99	1.31
Rubber, rubber band	3.23	0.98	1.03	2.96	1.01	2.97
Shoe, sandal, glove	4.03	0.90	0.99	4.04	1.01	3.49
Straw, cotton bud	2.66	1.94	1.88	2.62	2.12	2.86
Styrofoam	2.44	6.97	3.08	2.20	5.16	2.44
Thick plastic wrap	**15.15**	15.14	**14.80**	**13.98**	13.15	**14.09**
Medicine wrap and bottle	[illegible]	0.90	1.03	1.48	1.04	[illegible]

Key Finding: The Citarum River, already heavily polluted, carries a significant load of plastic waste, with textile industry discharge playing a major role.

https://doi.org/10.1016/j.marpolbul.2022.113338

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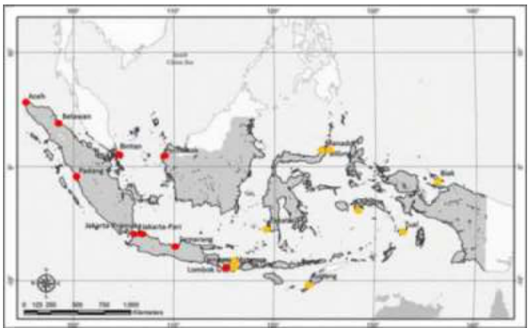
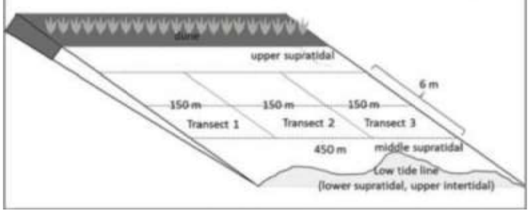
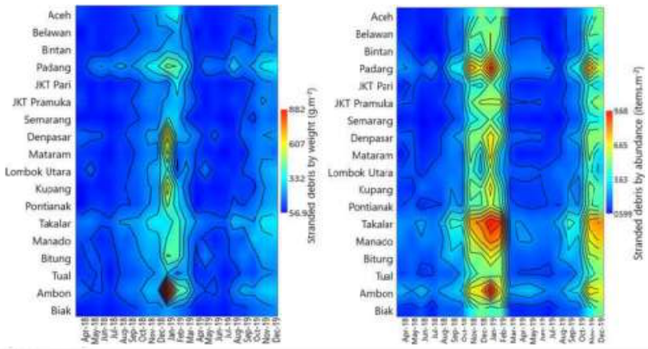
Plastic journey from rivers to the sea







Area	Top-10 plastic debris category									
	1	2	3	4	5	6	7	8	9	10
All beaches	Plastic sachet/ multilayer	Thin plastic wrap/bag	Plastic bottles	Straw, cotton buds, pieces	Plastic cup	Styrofoam packaging	Thick plastic wrap, sack	Cigarettes filter butts	Rope, fishing line, fishing rod, plastic rope/small net pieces	Shoes, sandals, gloves
% share	12.15	11.96	11.42	8.05	7.64	6.99	6.81	6.47	4.78	3.15
Aceh	Plastic bottles	Plastic cup	Cigarettes filter butts	Plastic sachet/ multilayer	Styrofoam packaging	Straw, cotton buds, pieces	Rope, fishing line, fishing rod, plastic rope/small net pieces	Diapers, sanitary and period products	Food boxes, plastic utensil	Wrap cosmetics, toiletries, etc.
% share	13.59	13.22	12.30	9.87	8.29	7.01	6.15	5.86	4.15	2.57
Belawan	Plastic sachet/ multilayer	Thin plastic wrap/bag	Plastic bottles	Styrofoam packaging	Shoes, sandals, gloves	Plastic cup	Straw, cotton buds, pieces	Rope, fishing line, fishing rod, plastic rope/small net pieces	Plastic cable, Pipe, hoses, pieces	Diapers, sanitary and period products
% share	20.77	15.02	13.09	9.26	5.88	5.13	4.88	3.88	3.38	2.51
Bintan	Thin plastic wrap/bag	Plastic sachet/ multilayer	Plastic bottles	Thick plastic wrap, sack	Straw, cotton buds, pieces	Plastic cup	Shoes, sandals, gloves	Diapers, sanitary and period products	Food boxes, plastic utensil	Cigarettes filter butts
% share	14.60	14.43	12.68	12.43	10.63	9.26	5.74	3.04	2.65	2.40
Padang	Plastic bottles	Thin plastic wrap/bag	Plastic sachet/ multilayer	Cigarettes filter butts	Plastic cup	Rope, fishing line, fishing rod, plastic rope/small net pieces	Thick plastic wrap, sack	Straw, cotton buds, pieces	Styrofoam packaging	Plastic cable, Pipe, hoses, pieces
% share	12.54	12.35	10.65	9.87	7.66	7.64	7.55	7.53	7.33	2.25
JKT Pari	Plastic sachet/ multilayer	Styrofoam packaging	Thin plastic wrap/bag	Plastic cup	Plastic bottles	Straw, cotton buds, pieces	Shoes, sandals, gloves	Cigarettes filter butts	Thick plastic wrap, sac	Rope, fishing line, fishing rod, plastic rope/small net pieces
% share	14.24	14.00	13.09	13.04	7.64	6.17	5.46	3.76	3.16	2.86
JKT Pramuka	Styrofoam packaging	Plastic sachet/ multilayer	Thin plastic wrap/bag	Straw, cotton buds, pieces	Plastic cup	Shoes, sandals, gloves	Thick plastic wrap, sack	Cigarettes filter butts	Plastic bottles	Rope, fishing line, fishing rod, plastic [illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	9.91	3.81	3.68	3.44	[illegible]
Semarang	Thin plastic wrap/bag	Plastic sachet/ multilayer	Cigarettes filter butts	Styrofoam packaging	Plastic bottles	Straw, cotton buds, pieces	Diapers, sanitary and period products	Plastic cup	Rope, fishing line, fishing rod, plastic rope/small net pieces	[illegible]

Key Finding: Indonesia's extensive coastline acts as a sink for plastic pollution, with debris accumulation varying significantly by location and season.

https://doi.org/10.1016/j.marpolbul.2022.114035

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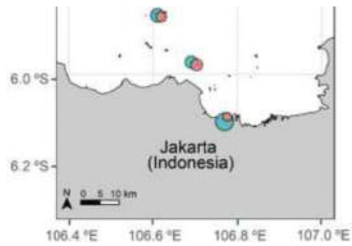
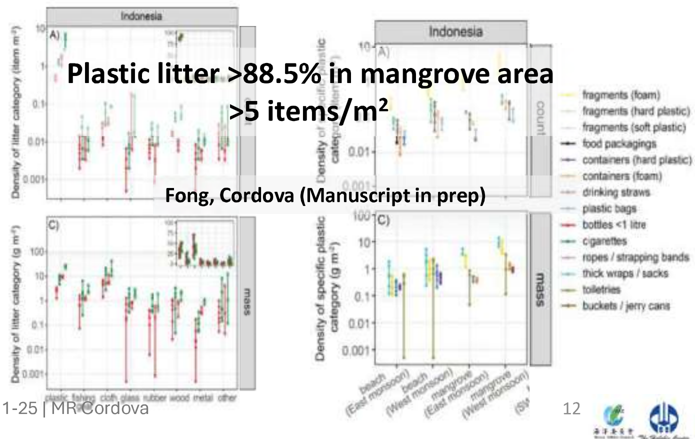
Plastic litter in mangrove

Photo sources: Cordova (2024)





Plastic litter >88.5% in mangrove area
>5 items/m²

Fong, Cordova (Manuscript in prep)

Top dominant plastic litter :
Styrofoam, single-use food packaging, plastic bag

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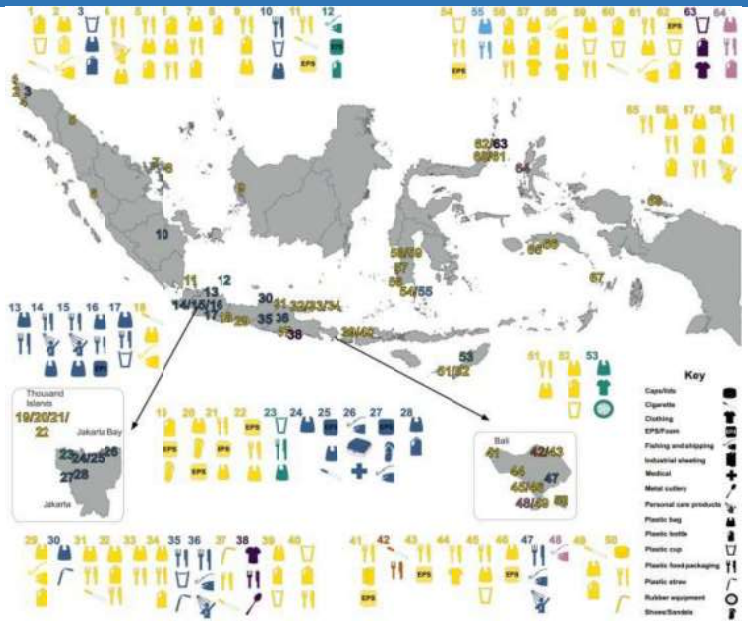
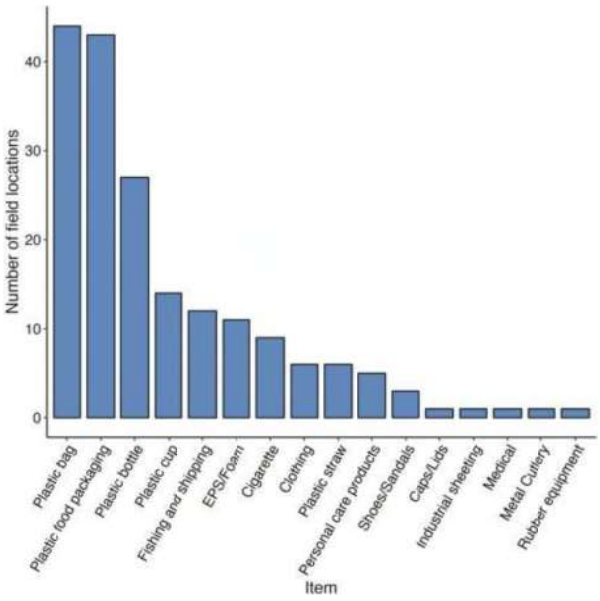
Macroplastic studies overview





Kelly et al. (2025)
https://doi.org/10.1016/j.rsma.2025.104460

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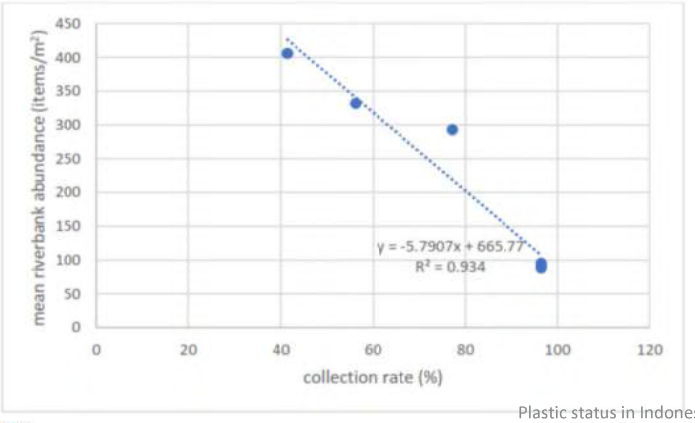
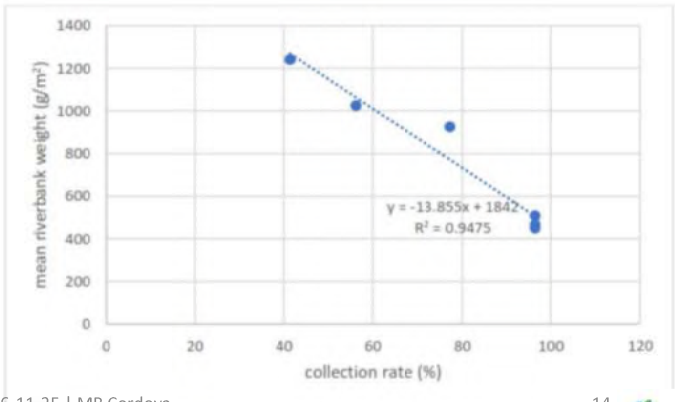
Plastic journey from rivers to the sea

Relationship between riverbank litter and local waste management

Sampling area	Riverbanks area (Ha)	Collection rate (%)	Mean abundance (items/m2)	Mean weight (g/m2)
Bogor Regency	3.06	41.40	406.01	1242.17
Bogor City	3.52	77.20	293.08	925.98
Depok City	0.59	56.22	331.98	1025.30
South Jakarta City	1.56	96.50	88.59	449.88
East Jakarta City	3.86	96.50	91.15	466.98
Central Jakarta City	0.72	96.50	95.06	508.40

Cordova et al. (2024)
https://doi.org/10.1016/j.marpolbul.2024.116662





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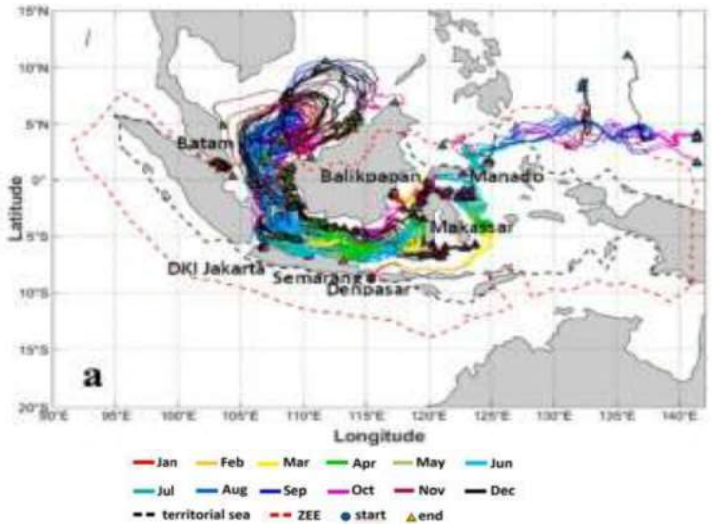
Plastic journey from rivers to the sea

Simulation results of released particles from seven city in Indonesia for a year



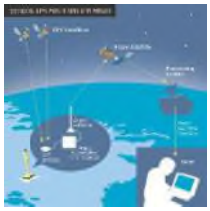
Kisnarti et al (2023)
https://doi.org/10.1016/j.marpolbul.2023.115779

Plastic journey from rivers to the sea

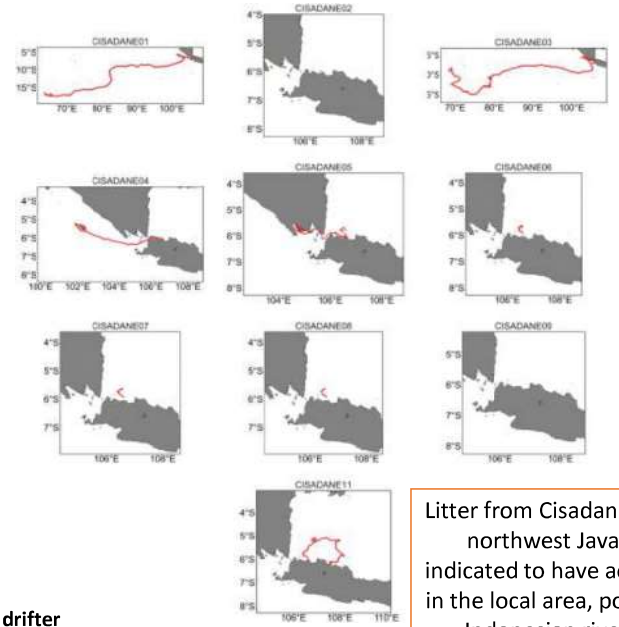
In situ : Satellite-based drifters released in river mouth

Iskandar et al (2021)
https://www.sciencedirect.com/science/article/abs/pii/S0025326X21005452?via%3Dihub

Dobler et al (2022)
https://www.mdpi.com/2077-1312/10/8/1009



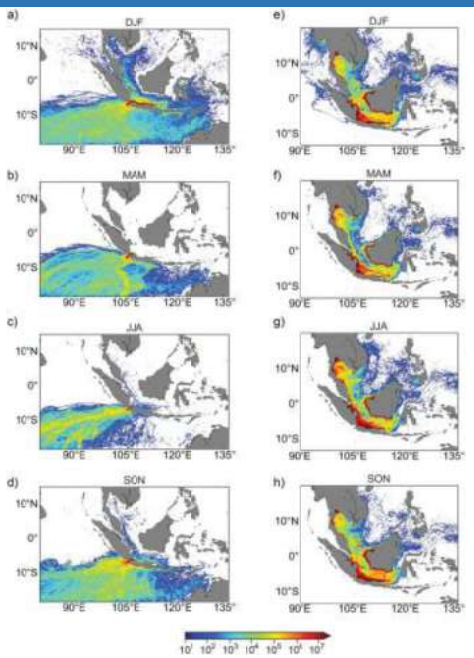
Drifters Released from Cisadane Between 16/07/20 – 19/01/21
Plotted in MDC, less than 1 year indicated in South Africa

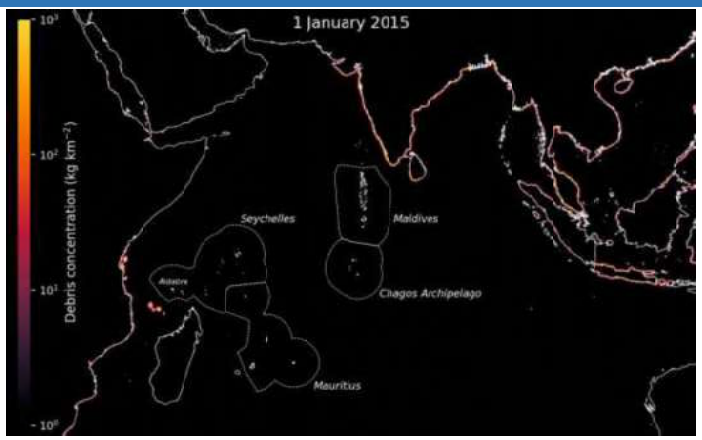


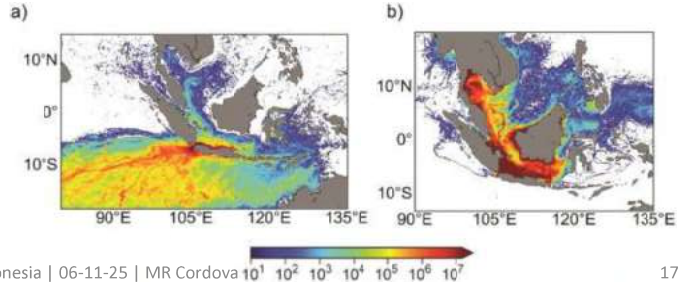
Litter from Cisadane and other northwest Java river is indicated to have accumulated in the local area, possibly in all Indonesian river outlet

10 drifter
- 2 entered the open Indian Ocean
- 2 across the Sunda Strait, stuck at Enggano and South Lampung
- 3 stuck at north Java
- 3 stuck at Kepulauan Seribu, possibly failure or human activity

Plastic journey from rivers to the sea







https://doi.org/10.1016/j.marpolbul.2021.112511
https://doi.org/10.3390/jmse10081009
https://doi.org/10.1016/j.marpolbul.2022.114497

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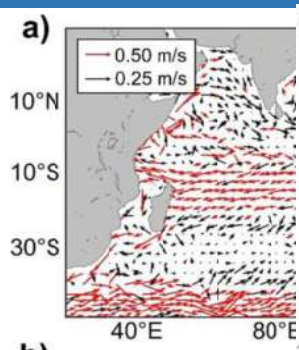
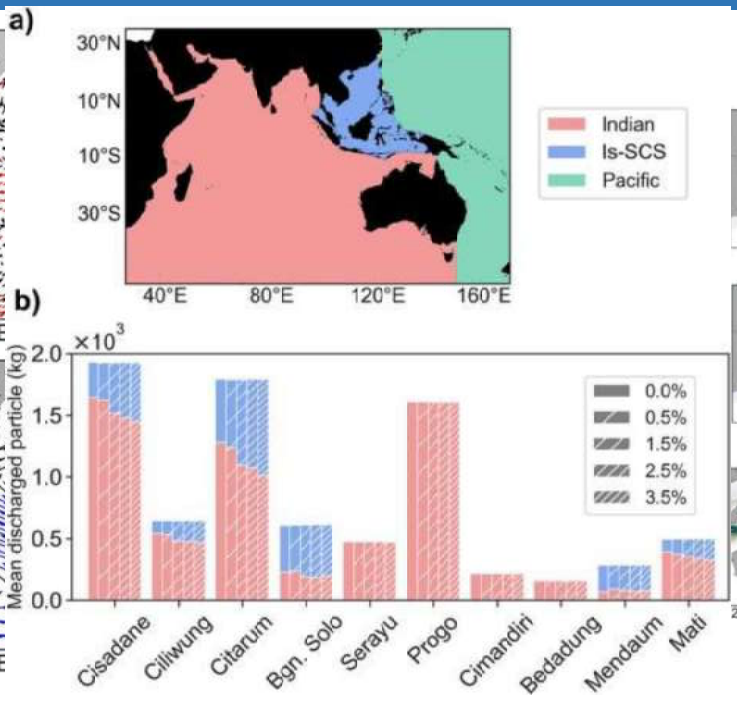
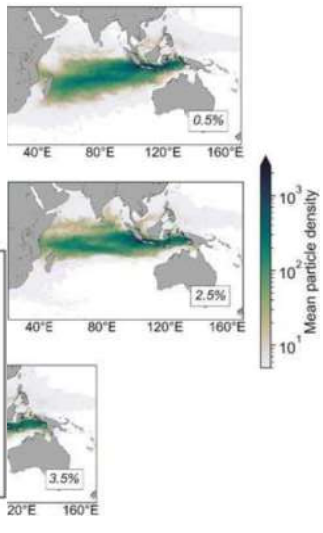
Plastic journey from rivers to the sea







Iskandar et al (2022)
https://doi.org/10.1016/j.marpolbul.2022.114331

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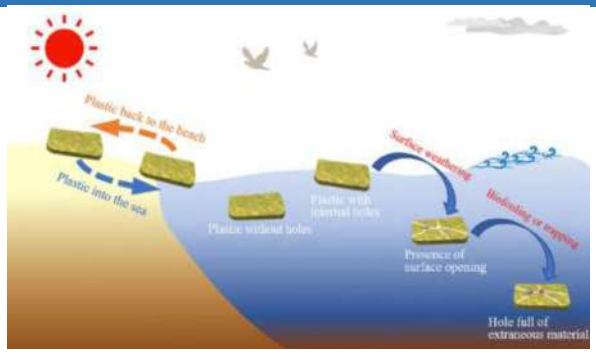
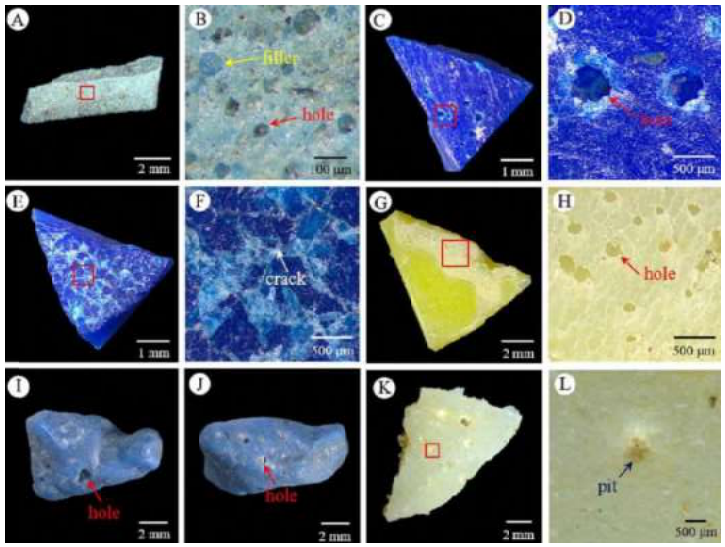
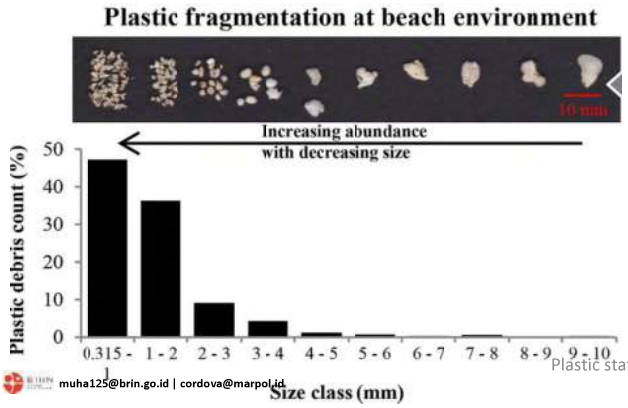
A cascade of consequences: microplastic



Plastic don't break down, they break apart !!



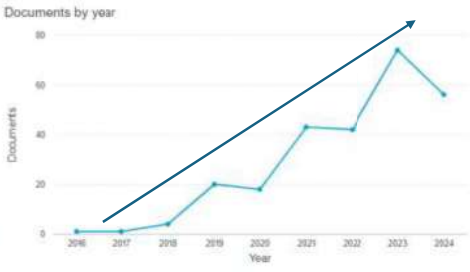
https://doi.org/10.1016/j.marpolbul.2023.115180
https://doi.org/10.1016/j.envpol.2016.09.079

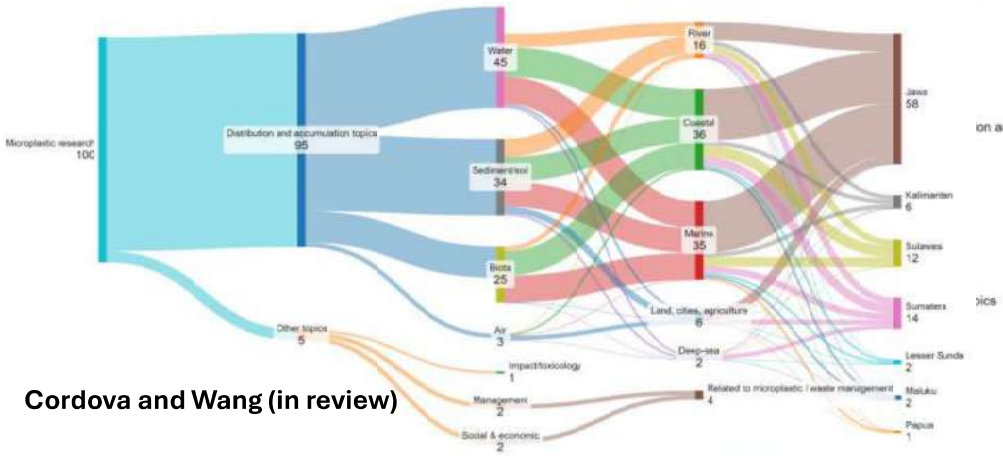


A cascade of consequences: microplastic

ELSEVIER Scopus
Clarivate Web of Science™
Google Scholar

Proportion (%) microplastic research in Indonesia

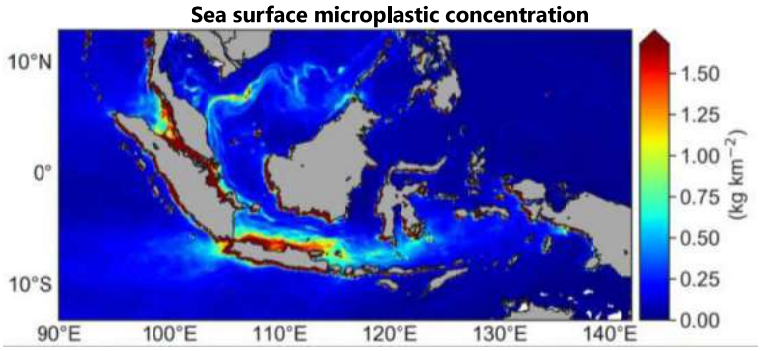


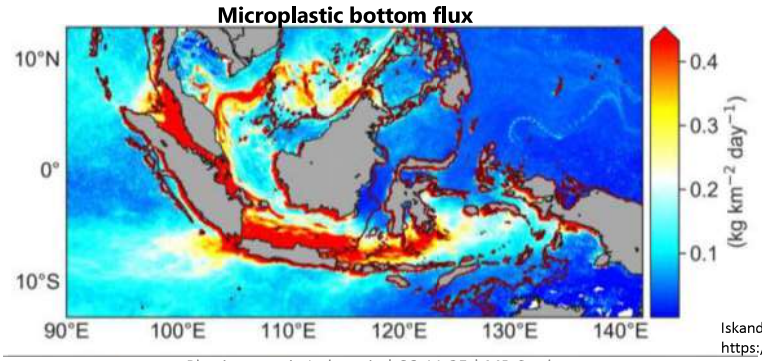


Cordova and Wang (in review)

~200 publication
Microplastic Indonesia
2015- July 2024*

A cascade of consequences: microplastic





Iskandar et al, 2024
https://doi.org/10.1016/j.marpolbul.2024.117047
Marine Pollution Bulletin 117047

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Scientific data to policy

Waste management related regulations in Indonesia

National Law	Act No. 18/2008 on Solid waste management		Act No. 32/2009 on Environmental Protection and Management		
Government Regulation	PP No. 81/2012 Government Regulation on Management of Household and Household-like Waste	PP No. 101/2014 Government Regulation on Hazardous Waste Management	**DRAFT** Government Regulation on Excise on Plastic	**DRAFT** Government Regulation on Specific Waste Management	
Presidential Regulation	Perpres No. 97/2017 Presidential Regulation on National Policy and Management Strategy of Household Waste and Household-like Waste	Perpres No. 83/2018 Presidential Regulation on Marine Debris Management	Perpres No. 18/2015 Presidential Regulation on Income Tax Facilities for Investment in Certain Business Fields and/or in Certain Regions	Perpres No. 15/2018 Presidential Regulation on Acceleration of Damage and Pollution Control on Citarum River Basin	Perpres No. 35/2018 Presidential Regulation on Acceleration of Development of Waste-to-Energy Installation using Environmentally-sound Technology
Presidential Decree	Keppres No. 61/1993 and No. 47/2005 Presidential Decree on Ratification of the Basel Convention on the Control of the Transboundary Movement of Hazardous Waste and Their Disposal				
Ministerial Regulation	Ministry of Trade Regulation No. 31/2016 on Non-Hazardous Waste Import	Ministry of Public Works Regulation No. 3/2013 on Implementation of Solid Waste Infrastructure and Facilities	Ministry of Trade Regulation No. 48/2015 on General Provisions in the Import Sector	Ministry of Trade Regulation No. 70/2015 on Importer Identification Number	Ministry of Industry Regulation No. 48/2015 on Requirements for Income Tax Facilities Implementation
	Ministry of Environment and Forestry Regulation No. P.75/2019 on Roadmap to Waste Reduction by Producers	**DRAFT** Ministerial Regulation (MoEF) on Shopping Plastic Bag Reduction			
Local Regulation	Regional/Local Regulations on Single-use Plastic Bans; 3 provinces and 97 municipalities as of August 2023				

Strategic Goals	Target indicator	
	Baseline (2017)	2025
1. Reducing plastic waste generation, with plastic waste reduction	Amount of Plastic Waste Reduction	
	2.26%	30%
2. Reinforcing the plastic recycling system, with plastic waste reduction	Amount of plastic wastes recycled	
	0.696M (Mt/year) 7%	Not officially decided yet
3. Reducing marine debris emitted into the ocean	Amount of mismanaged plastic waste	
	0.27–0.59 million tonnes (2018)	70% Reduction
4. Consolidating stakeholders' responsibility, with the amount of EPR programme	Number of EPR programme implemented	
	N.A	Not officially decided yet

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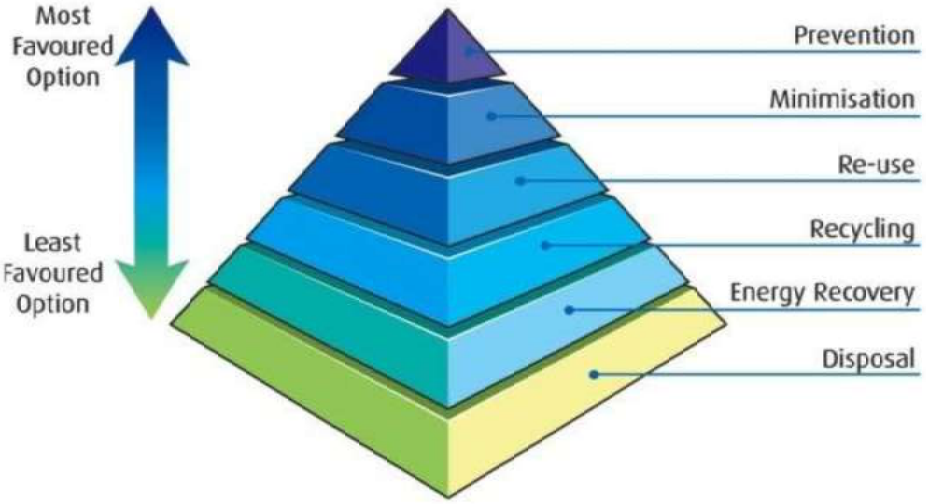
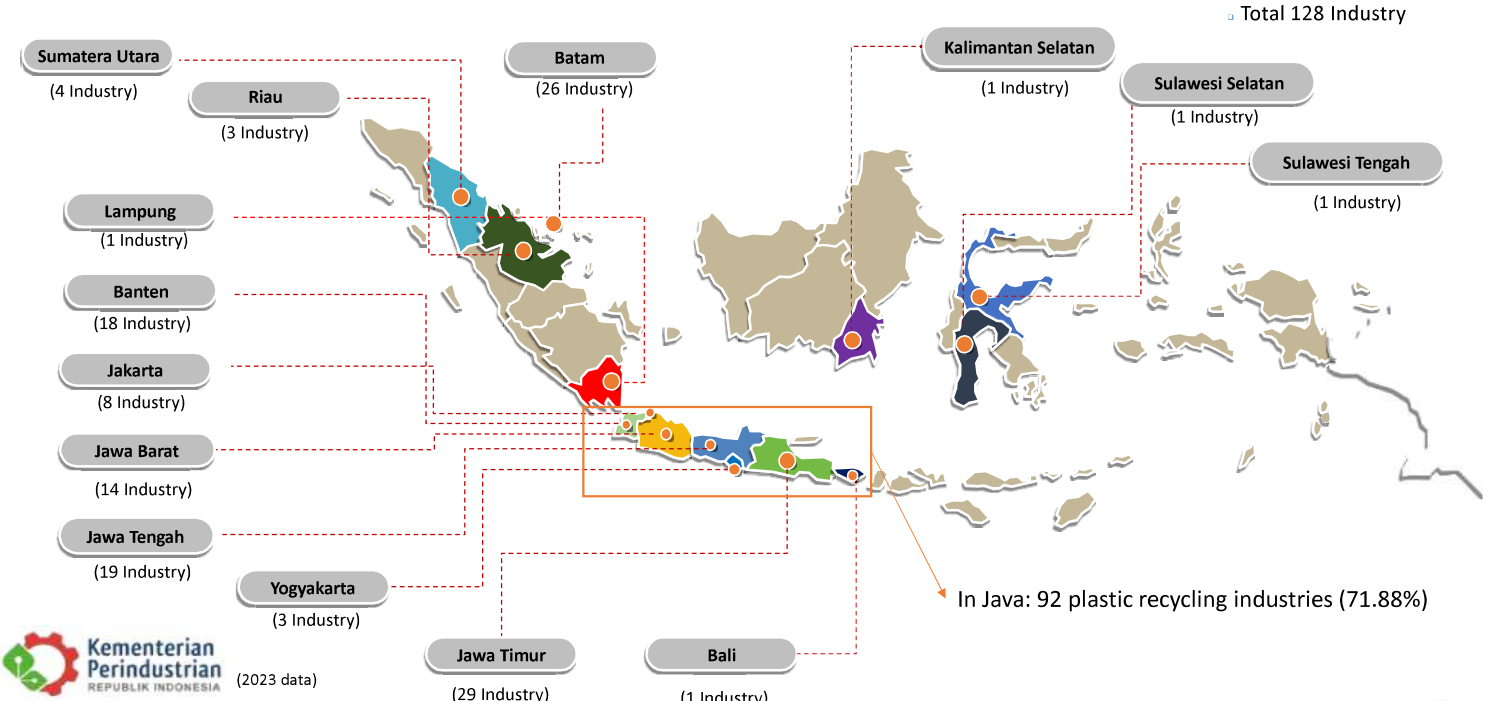
Plastic recycling industry in Indonesia



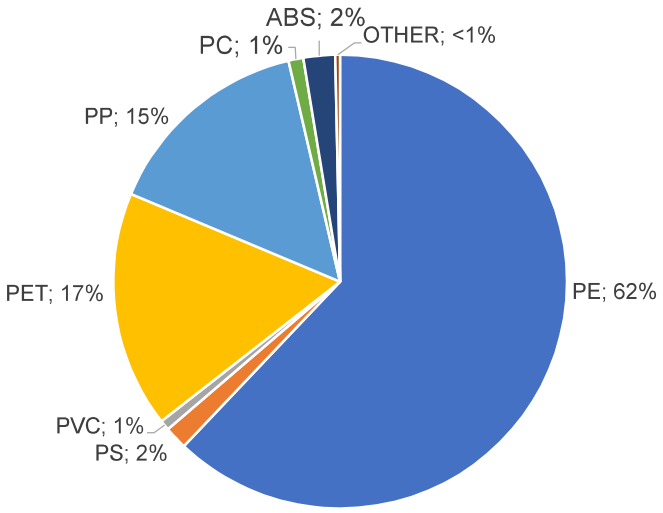
Hierarchy	EC/US
1	Source reduction
2	Recycling/composting
3	Incineration:
	a. With energy recovery b. Without energy recovery
4	Landfilling.

Plastic recycling industry in Indonesia



Kementerian Perindustrian
REPUBLIK INDONESIA (2023 data)

Plastic recycling industry in Indonesia



TYPES OF POLYMERS	NUMBER OF INDUSTRIES	INSTALLED CAPACITY	PRODUCTION CAPACITY	PRODUCTION	EXPORT
PE	62	1.607.330	809.078	434.675	238.293
PP	35	770.071	105.556	105.176	57.870
PET	18	643.638	485.904	118.138	23.536
PS	6	91.010	13.970	11.510	1.044
PVC	2	46.400	30.934	4.934	1.600
PC	5	93.710	12.139	7.379	2.250
ABS	4	59.260	15.791	15.791	236
Other	5	4.200	4.200	2.400	38.520
Plastic recycling industries		3.605.113	1.767.066		

49.57% production capacity

Kementerian Perindustrian REPUBLIK INDONESIA

National Industrial Information System
the Ministry of Industry of the Republic of Indonesia (2023 data)

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Expanding plastic recycling sector

Top-10 stranded macroplastic debris in general and in each location.

Area	Top-10 plastic debris category									
	1	2	3	4	5	6	7	8	9	10
All beaches	Plastic sachet/ multilayer	Thin plastic wrap/bag	Plastic bottles	Straw, cotton buds, pieces	Plastic cup	Styrofoam packaging	Thick plastic wrap, sack	Cigarettes filter butts	Rope, fishing line, fishing rod, plastic rope/small net pieces	Shoes, sandals, gloves
% share Aceh	12.15 Plastic bottles	11.96 Plastic cup	11.42 Cigarettes filter butts	8.05 Plastic sachet/ multilayer	7.64 Styrofoam packaging	6.99 Straw, cotton buds, pieces	6.81 Rope, fishing line, fishing rod, plastic rope/small net pieces	6.47 Diapers, sanitary and period products	4.78 Food boxes, plastic utensil	3.15 Wrap cosmetics, toiletries, etc.
% share Belawan	13.59 Plastic sachet/ multilayer	13.22 Thin plastic wrap/bag	12.30 Plastic bottles	9.87 Styrofoam packaging	8.29 Shoes, sandals, gloves	7.01 Plastic cup	6.15 Straw, cotton buds, pieces	5.86 Rope, fishing line, fishing rod, plastic rope/small net pieces	4.15 Plastic cable, Pipe, hoses, pieces	2.57 Diapers, sanitary and period products
% share Bintan	20.77 Thin plastic wrap/bag	15.02 Plastic sachet/ multilayer	13.09 Plastic bottles	9.26 Thick plastic wrap, sack	5.88 Straw, cotton buds, pieces	5.13 Plastic cup	4.88 Shoes, sandals, gloves	3.88 Diapers, sanitary and period products	3.38 Food boxes, plastic utensil	2.51 Cigarettes filter butts
% share Padang	14.60 Plastic bottles	14.43 Thin plastic wrap/bag	12.68 Plastic sachet/ multilayer	12.43 Cigarettes filter butts	10.63 Plastic cup	9.26 Rope, fishing line, fishing rod, plastic rope/small net pieces	5.74 Thick plastic wrap, sack	3.04 Straw, cotton buds, pieces	2.65 Styrofoam packaging	2.40 Plastic cable, Pipe, hoses, pieces
% share JKT Pari	12.54 Plastic sachet/	12.35 Styrofoam packaging	10.65 Thin plastic wrap/bag	9.87 Plastic cup	7.66 Plastic bottles	7.64 Straw, cotton buds, pieces	7.55 Shoes, sandals, gloves	7.53 Cigarettes filter butts	7.33 Thick plastic wrap, sac	2.25 Rope, fishing line, fishing rod, plastic rope/small net pieces
JKT Pramuka	Styrofoam packaging	Plastic sachet/ multilayer	Thin plastic wrap/bag	Straw, cotton buds, pieces	Plastic cup	Shoes, sandals, gloves	5.46 Thick plastic wrap, sack	3.76 Cigarettes filter butts	3.16 Plastic bottles	2.86 Rope, fishing line, fishing rod, plastic

Cordova et al (2022)
https://www.sciencedirect.com/science/article/pii/S0025326X22007172

Most frequently reported items of litter

1. Plastic sachet/multilayer
2. Thin plastic wrap/bag
3. Plastic bottles
4. Straw, cotton buds, pieces
5. Plastic cup
6. Styrofoam packaging
7. Thick plastic wrap, sack
8. Cigarettes filter butts
9. Rope, fishing line, fishing rod, plastic rope/small net pieces
10. Shoes, sandals, gloves

Single-use plastic but has the potential to be recycled

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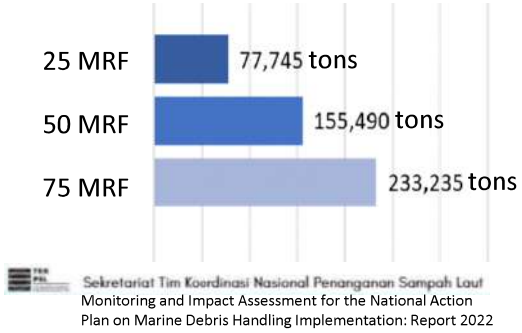
Expanding plastic recycling sector

Scenario for reducing leakage of plastic waste into Indonesian seas



Sekretariat Tim Koordinasi Nasional Penanganan Sampah Laut
Monitoring and Impact Assessment for the National Action Plan on Marine Debris Handling Implementation: Report 2022

The Extended Producer Responsibility Program aims to address plastic waste leakage by implementing **25-75** Material Recovery Facilities (**MRF**) and Integrated Waste Processing Sites (**TPST** / Tempat Pengolahan Sampah Terpadu), potentially **reducing leakage** by at least **233,235 tons/year**.

It is **necessary** to **increase** the **recycling industry** in **each province** and not only focus on the island of Java

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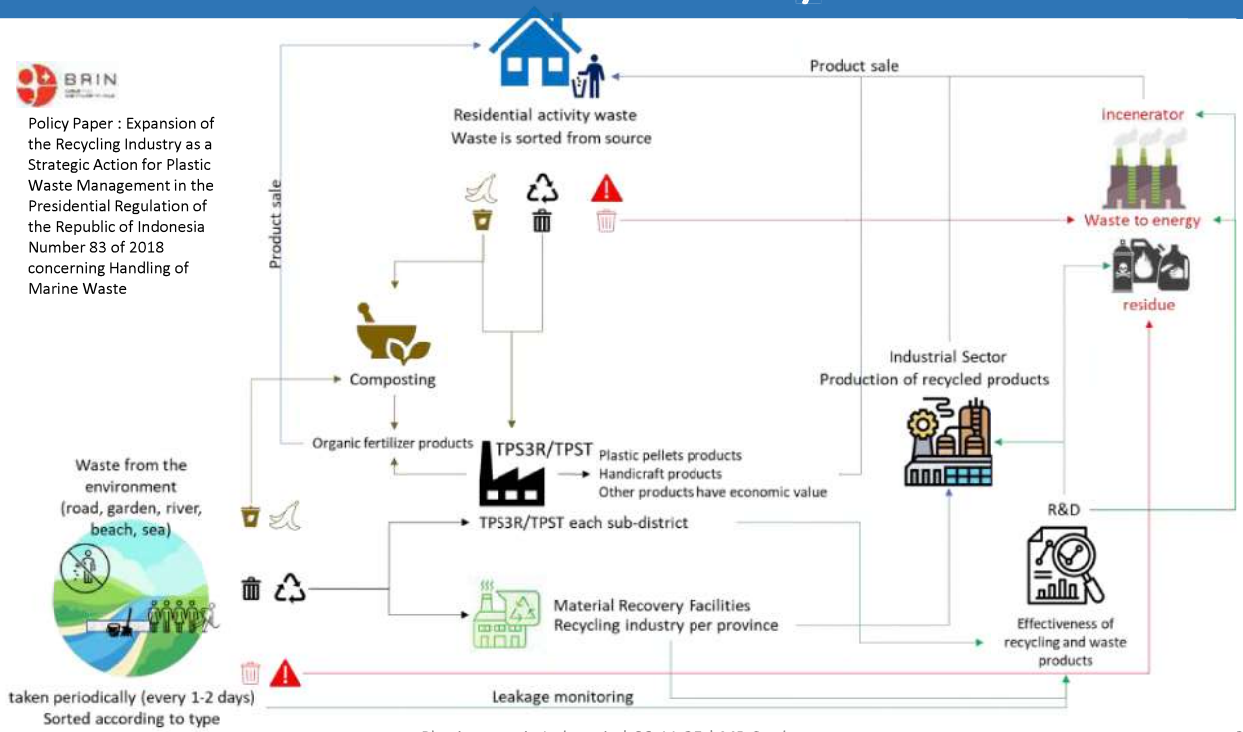
Recommendation : system



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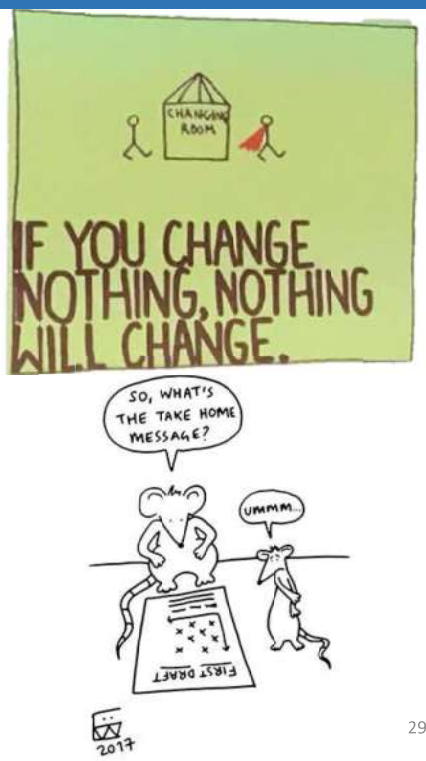
Take home messages

- Plastic dominates anthropogenic debris on Indonesian environment
- Sources of stranded : local areas (not really far from the accumulation areas)
- Tackle from the sources by simple and effective methods
- It's crucial to promote the growth of recycling industry, RDF, MRF, Waste to Energy, and other techs across all provinces, rather than just concentrating on Java Island.



Marine Litter Team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Riyana Subandi


Triyoni Purbonegoro


Rachma Puspitasari


Sofia Yuniar Sani


M. Riza Iskandar

Terima kasih

Thank you

감사 합니다

どうもありがとうございました

Cảm ơn nhiều

ขอบคุณมาก

អរគុណច្រើន

Gracias

شكرا لك

Danke

Grazie

谢谢

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Best Practices and Innovation in Waste Management

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Senior Research Fellow
Economic Research Institute for ASEAN and East Asia (ERIA)
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International Workshop on
"Indonesia-Taiwan Collaboration in Scaling Up Marine Plastic Debris Governance in the Indo-Pacific."
November 6, 2025

Plastic Bag used in Daily Shopping Activities

1 Waste Reduction

Reduce Use of Plastics (1)
Voluntary Initiative

The use of leaves and stem to tie the vegetables in Vietnam, April 2019, photo by M. Kojima.

The use of paper straw and sugarcane stiller in Indonesia, 2019, Photo by M. Kojima.

Wooden spoon and folk for in-flight meal by Singapore Airline, August, 2022, photo by M. Kojima.

Biodegradable plastic bag in Vietnam, April, 2019, Photo by M. Kojima

Reduce Use of Plastics (2)
Refill business

- Refill business
  - Consumer bring the bottles buying only contents without packaging and container.
- Challenge
  - In some country, by the regulation on food safety, refill is not allowed to refill of drinks or foods.

Refill shop in HCMC, Vietnam, Oct. 2022, photo by M. Kojima)

Reduce Use of Plastics (3) Ban and Charge

- China
  - Proposal to Reduce Single Use Plastics (2008)
  - Proposal to Ban Single Use Plastics (2020)
    - Ban on plastic bag with less than 0.025mm thickness, vinyl for agriculture with less than 0.01mm thickness. microbeads in daily necessities
- India
  - State governments issue ban on plastic shopping bag.
- Thailand "Action Plan on Plastic Waste Management Phase I (2020-2022) "
  - Ban on Plastic bag less than 36 μm thickness, Plastic cup less that 100 μm thickness, Styrofoam container for food, plastic straw
- Indonesia: Regulation of the Minister of Environment and Forestry regarding Road Map to Waste Reduction by Producers
  - Producer and retailer should have a plan to reduce packaging and container and submit the report to the government.

Biodegradable Plastics

- There are limited production capacity of biodegradable plastics.
- Priority to use biodegradable plastics should be usage of plastics in outer space, such as usage of plastic in agriculture.
  - Capsule for slow-release fertilizer
  - Sheet to protect fruits, such as banana, and palm.
  - In highland, black plastic sheets are used to keep moisture and soil temperature.

Photo by Michikazu Kojima, in the Philippines, 2002.

Garbage bins for waste segregation

2

Waste Management

Japan's Waste Management in 1960s to 1970s

- In early 1960s, waste collection services were limited.
- JICA "Technical Expertise of Japan in Solid Waste Management" https://www.youtube.com/watch?v=10FhkNBjgpY
  - Video recorded littering in central Tokyo, and dump waste to river or open splace
  - Population getting waste collection services were limited.
  - In 1961, less than 50% of population in Japan got waste collection services.

Waste Management in ASEAN

- Reason behind larger leakage of plastics to the ocean from developing countries is the improper waste management: not enough waste collection and proper disposal

Waste dumped along roadside, in Sihanoukville, Cambodia. (July 2022年 Photo by M. Kojima)

Waste disposed in open space in Semarang Indonesia, September 2016, photo by M. Kojima

Waste Management (2)
The fate of Indonesia's plastic waste

	Mega Cities	Medium & Small Cites	Rural	Remote	Total
Total Generation	1.6Mt	1.8Mt	2.5Mt	0.9Mt	6.8Mt
Leakage into Sea, Lakes and Rivers	4%	8%	12%	15%	10%
Dumping on Land	1%	3%	8%	8%	5%
Open Burning	21%	45%	61%	64%	48%
Official dumpsites	3%	3%	14%	15%	9%
Managed Disposal	51%	29%	0%	0%	20%
Recycling	20%	12%	5 %	0%	9%

Among mismanaged waste, 15.9% is leaked into sea, lakes and rivers.

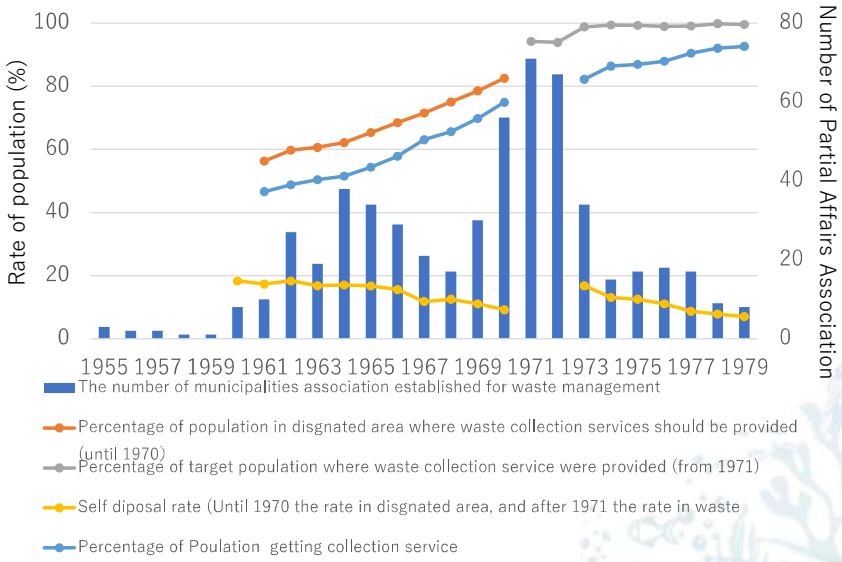
Looking at the amount of runoff into the sea, rivers, and lakes, rural areas accounted for the largest amount of runoff, accounting for 46.7% of the total amount of runoff. Rural areas and small and medium-sized cities together account for 69% of the total outflow. Facilities such as sanitary landfill and waste to energy plant have economies of scale. The construction cost for landfill and waste-to-energy plant can be saved by inter-municipal cooperation.

Source: World Economic Forum (2020)

Waste Management (3): Associations

- In 1961, percentage of population getting collection was less than 50%.
- To invest in waste reception facilities such as landfill, incineration plant, waste to energy plant, central government subsidize local government.
- Economies of Scale works in construction of landfill, waste to energy plant, incineration plant.
- To utilize the economies of scale, many municipalities in Japan have formulated the **associations on waste managemen**t with neighboring municipalities since 1960s.

Number of Establishment of Partial Affairs Association concerning Waste Management in Japan



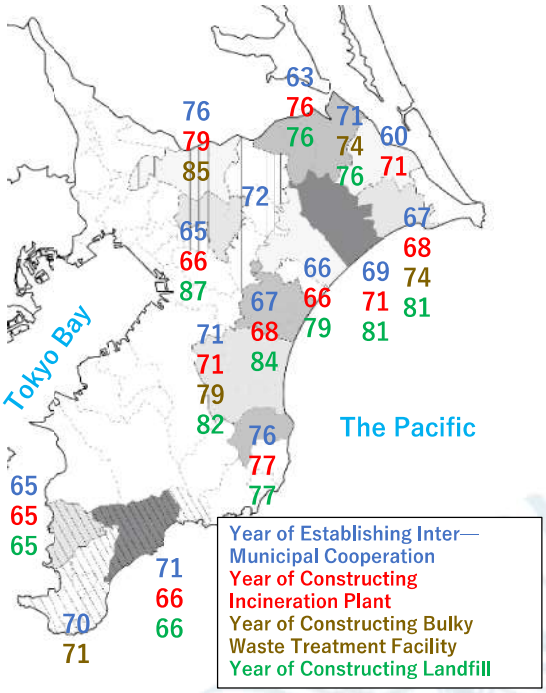
Waste Management (4): Case in Chiba Prefecture

- Until 1964, there were no waste treatment facility serving to multiple municipalities in Chiba.
- Municipalities have formulated associations for managing waste in 1960s and 1970s, because economy of scale works in waste incineration plant and landfill site.

Number of local government associations with waste management

	1960-64	1965-69	1970-74	1975-79
No. of Association	0	6	5	3

Source：Compiled by M. Kojima from documents of Chiba prefecture.



Collection points for bottle recycling by PlasticPay

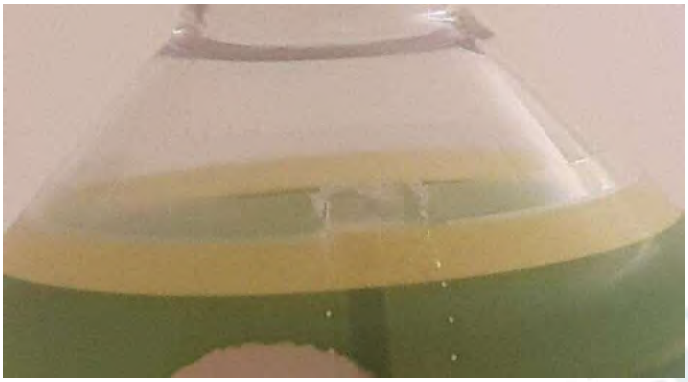
3 Promoting Recycling

Plastic Recycling (1): Applying EPR

- In the 1990s, Japan and South Korea applied **extended producer responsibility** to packaging and containers, and home appliances, which require producers to implement physical responsibility for recycling (collection rate, recycling rate, etc.) and/or economic responsibility (bearing cost of recycling, etc.).
- Around 2010, countries such as Vietnam, Thailand, and Malaysia attempted to apply extended producer responsibility, but it was not implemented.
- But in recent years, many Asian countries tries to introduce EPR.
  - Indonesia (previous page)
  - Vietnam: Environmental Protection Laws revised in 2021.
  - Philippines: Extended Producer Responsibility Act (2022)
  - Singapore: mandatory reporting on volume of packaging and container, for preparation to apply EPR.
  - India: Plastic Waste Management Rule (Amendment) (2022)

Plastic Recycling (2): Design for Recycling

- A best practice on design for recycling is the voluntary guideline for the design of PET bottles developed by Japan's Council for PET Bottle Recycling. The first version was developed in 1992. The guideline has been revised several times.
  - PE or PP which gravity are less than 1 should be used for caps, in order to sort caps from PET.
  - Prohibit the coloring of PET, because waste PET with color has limited demand of recycling.
  - It is also recommended to have perforation on the labeling.
- You can access English version of voluntary standard here:
  - https://www.petbottle-rec.gr.jp/english/design.html
- In 2020, Japan's collection rate is 96.7%. Bottle to bottle recycling rate is about 32% of total recycling volume.
- PET bottle to bottle chemical recycling was approved by the Food Safety Committee in 2004.
- Bottle to bottle mechanical recycling of PET was also approved in 2012.



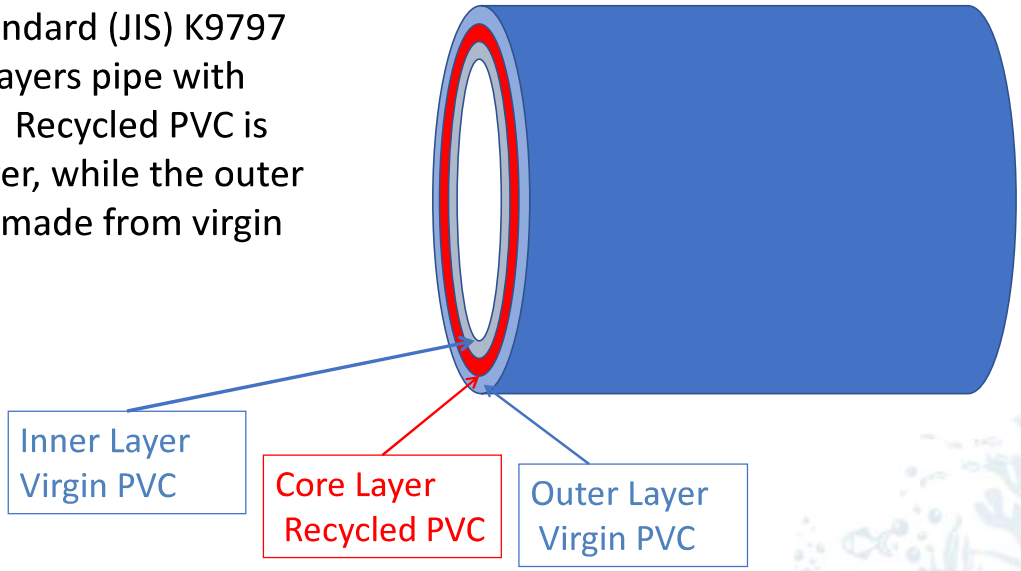
Perforation on the labeling of PET bottle.

Industrial Standard for Recycled Goods

- Indonesia
  - SNI 7199:2016:
    - Ecolabelling Criteria for the Categories of Compostable Products, Product Packaging and Bioplastic Containers.
  - SNI 8424:2017:
    - Certification for Recycled PET
- Malaysia
  - SIRIM ECO 001:2018
    - Eco-labelling criteria – Biodegradable and compostable plastic and bioplastic
  - SIRIM ECO 018:2024
    - Eco-labelling criteria – Recycled plastic products
- India
  - IS 14534 : 2023: Plastics-Recovery and Recycling of Plastics Waste-Guidelines
  - IS 14535: 1998: Designation of recycled plastics use in manufacturing
  - IS 17899T: 2021: Assessment of the biodegradability of plastics in different conditions.
  - IS 16591 (Part 1): 2016/ISO 18263-1: 2015: Designation system and basis for specifications for mixtures of polypropylene (PP) and polyethylene (PE) recyclate

Example of Japan Industrial Standard

Japan Industrial Standard (JIS) K9797 defines PVC three-layers pipe with recycled solid core. Recycled PVC is used in the core layer, while the outer and inner layer are made from virgin PVC.



Plastic Recycling (3): Styrofoam

- Technology to reduce the volume is crucial to transport bulky expanded polystyrene (EPS) or Styrofoam waste efficiently to recycling factories.
  - Compressing machines: EPS to reduce the volume to one- fiftieth of the original size.
  - The first machine was installed in 1977 in Tsukiji Fish Market.

Video in English
https://youtu.be/Rjcp7fK8i2o

↑ Machines compressing EPS Fish Boxes at Tsukiji Fish Market in 2004.

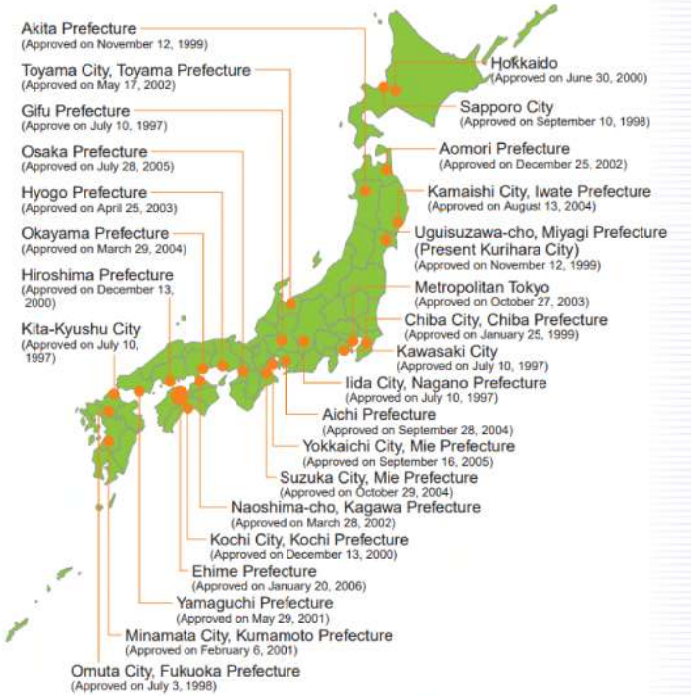
Compressed EPS from the machine.→

Recycled PET Bottles

4

Recycling Industrial Park

Eco-town Project



- 26 Eco-Town (recycling industrial park) had developed from 1997 to 2005.
- Eco-Town projects have been supported by Central government, especially Ministry of Environment and Ministry of Economy, Trade and Investment.

https://www.meti.go.jp/policy/recycle/main/3r_policy/policy/pdf/ecotown/ecotown_casebook/english.pdf

Kitakyushu Eco-town

Regional Knowledge Centre for Marine Plastic Debris

ERIA

Kitakyushu city in Fukuoka Prefecture has Kitakyushu Eco-Town, which hosts various recycling industries.

- PET bottle
- OA Equipment (x2)
- Automobile
- Home appliance
- Fluorescent light
- Construction waste
- Non-ferrous metal, small EEE, and rechargeable battery
- Cooking oil
- Refining used organic solvants
- Waste paper
- Can (x2)
- Automobile
- Pachinko Machine
- Waste wood, Waste Plastic
- Sludge, metal others
- Cement carbide
- Mobile phone
- Glass
- Food waste
- Waste paper, waste sludges
- Urban mining
- Used clothes
- Solar Panel

Tokyo Eco-town

Regional Knowledge Centre for Marine Plastic Debris

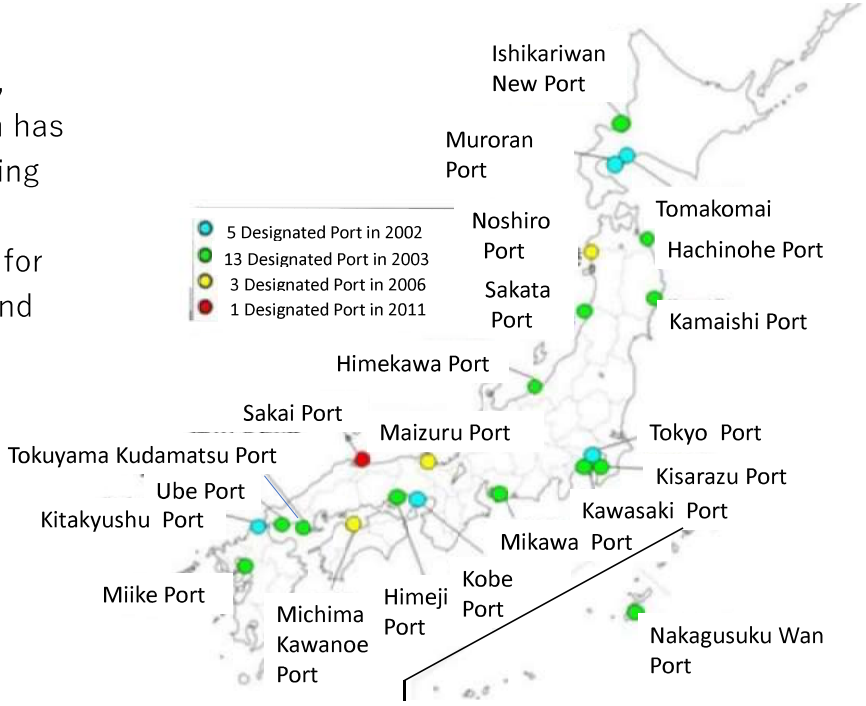
ERIA

- Tokyo Eco-town is located close to landfill site in Tokyo bay.
- In Tokyo Eco-town, 12 facilities are located.
  - Construction waste recycling × 5
  - Melting furnace with Generation of Electricity from infectious wastes and plastic wastes
  - Tokyo Recycle Power (Generation of electricity using waste plastic and infectious waste)
  - Waste information equipment × 2
  - Food waste recycling × 3

Source: https://www.ecotown-tokyo.jp/

Recycling Port

- Ministry of Land, Infrastructure, Transport and Tourism in Japan has designated 22 ports for “Recycling Port”, where recyclers invest in recycling facilities, and the hub for transporting recyclable waste and recycled materials.
- Web page of “Recycle Ports Promotion Council” in Japan https://www.rppc.jp/port.



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Indonesia
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Indonesia-Taiwan Collaboration in Scaling Up Marine Plastic Debris Governance in the Indo-Pacific

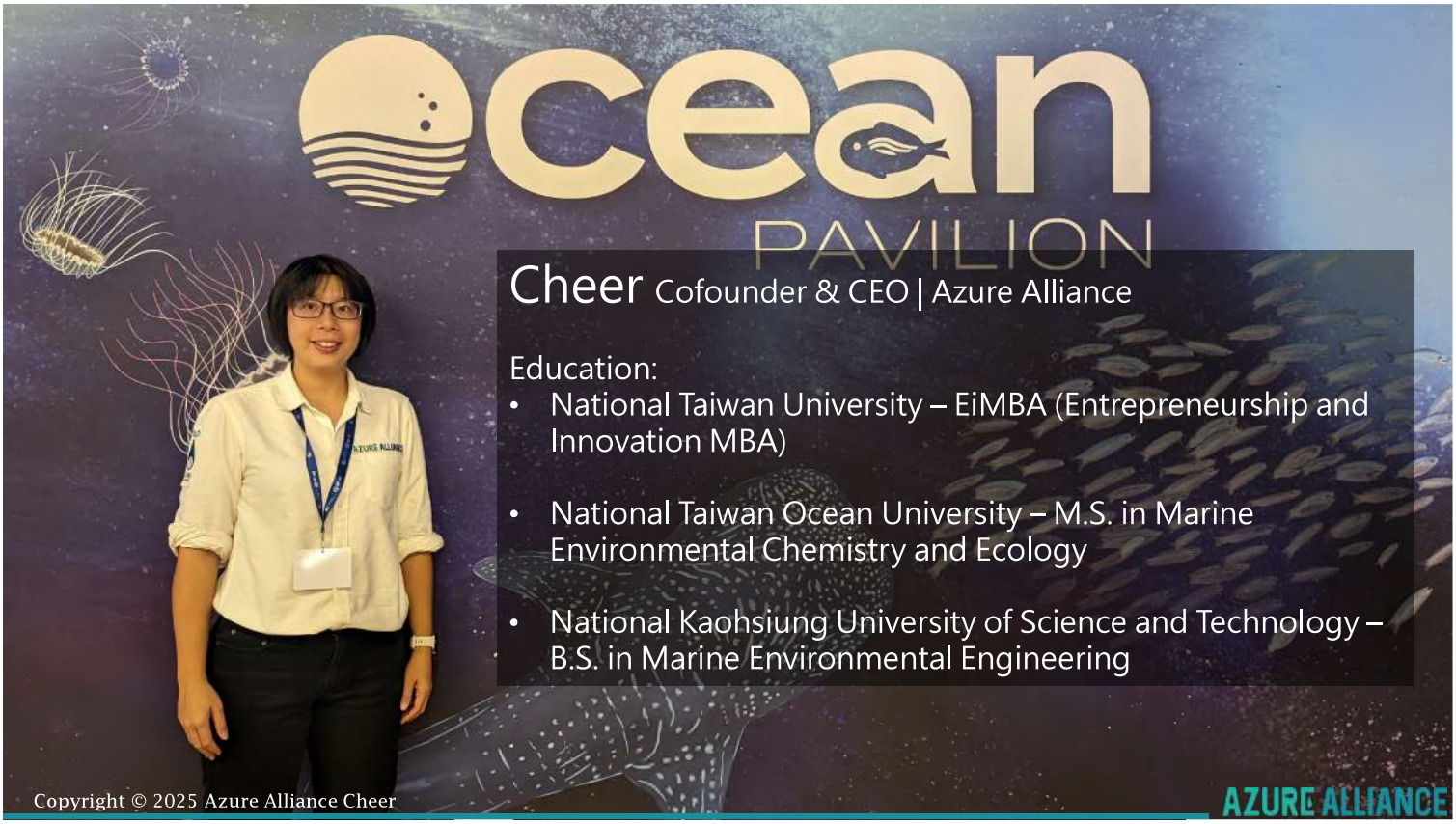
SESSION 3

Technology-based innovations in mitigating marine plastic debris in Indo-Pacific

Szu-Ying Chen 1、Yu Ting Tseng 2

1. Co-founder & CEO of Azure Alliance, Taiwan
2. Co-founder & Secretary-General of Azure Alliance, Taiwan

2025.11.06



AZURE ALLIANCE

Mission

Creating a clean future through technology — “Smart” for a cleaner ocean.

Vision

Deploy appropriate solutions for waters affected by plastic pollution.

Agenda

01 **Pain Point**

02 **Challenge**

03 **AZURE Project**

Technology-Based
Marine Debris Removal Program

04 **Conclusion**

01 Pain Point

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01 Pain Point：The Hidden Governance Crisis

Marine debris is one of the most challenging global issues, faced by nations around the world.

Slow government response	Unclear responsibility	Resource competition:
➢ Lack of clear regulations ➢ Cumbersome public procurement procedures	➢ Ambiguity in accountability for coastal and marine waste management ➢ Shifts in political support.	➢ Imbalanced priorities between economic development and environmental protection.

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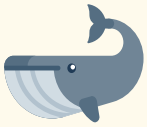
01 Pain Point

Food Contamination

Climate Change

Ocean System Disorder：
Reduced carbon sequestration capacity



Disease Spread

Biodiversity Decline & Economic Impacts

Polarized Commercial Development
(M-shaped economy)

Loss of Terrestrial Functions：
Coastal habitat destruction

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01 Pain Point

"Less than 25 years left" until 2050

2015 | 2025 | 2030 | 2050

150 million tons currently in the ocean

Change Point

300 million tons

2X

By 2050, the total mass of plastic in the ocean will exceed that of fish

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01 Pain Point

The Gray Rhino

A clear, highly probable, yet neglected threat requiring proactive action

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02 Challenge

Why Cleanup Alone Is Not Enough

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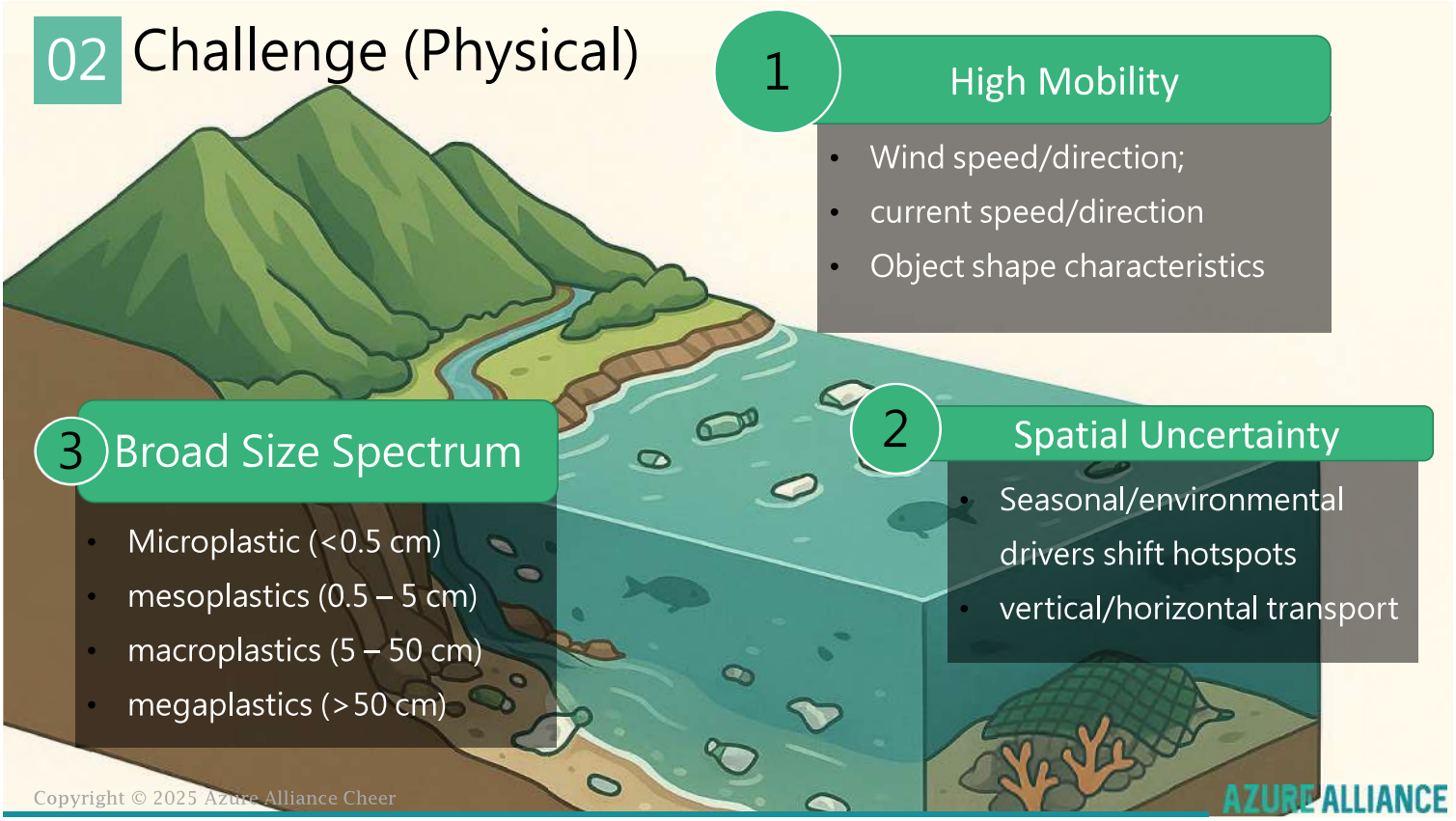
02 Challenge (Physical)



1 High Mobility

- Wind speed/direction;
- current speed/direction
- Object shape characteristics

2 Spatial Uncertainty

- Seasonal/environmental drivers shift hotspots
- vertical/horizontal transport

3 Broad Size Spectrum

- Microplastic (<0.5 cm)
- mesoplastics (0.5 – 5 cm)
- macroplastics (5 – 50 cm)
- megaplastics (>50 cm)

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02 Challenges (Regulatory)

Resource Constraints	Uncertainty & Variability	Public Expectation & Visible Outcomes
Limited staffing and budgets	Debris volumes spike seasonally or during disasters; hard to scale response	"What you see" often lags behind actual cleanup effort

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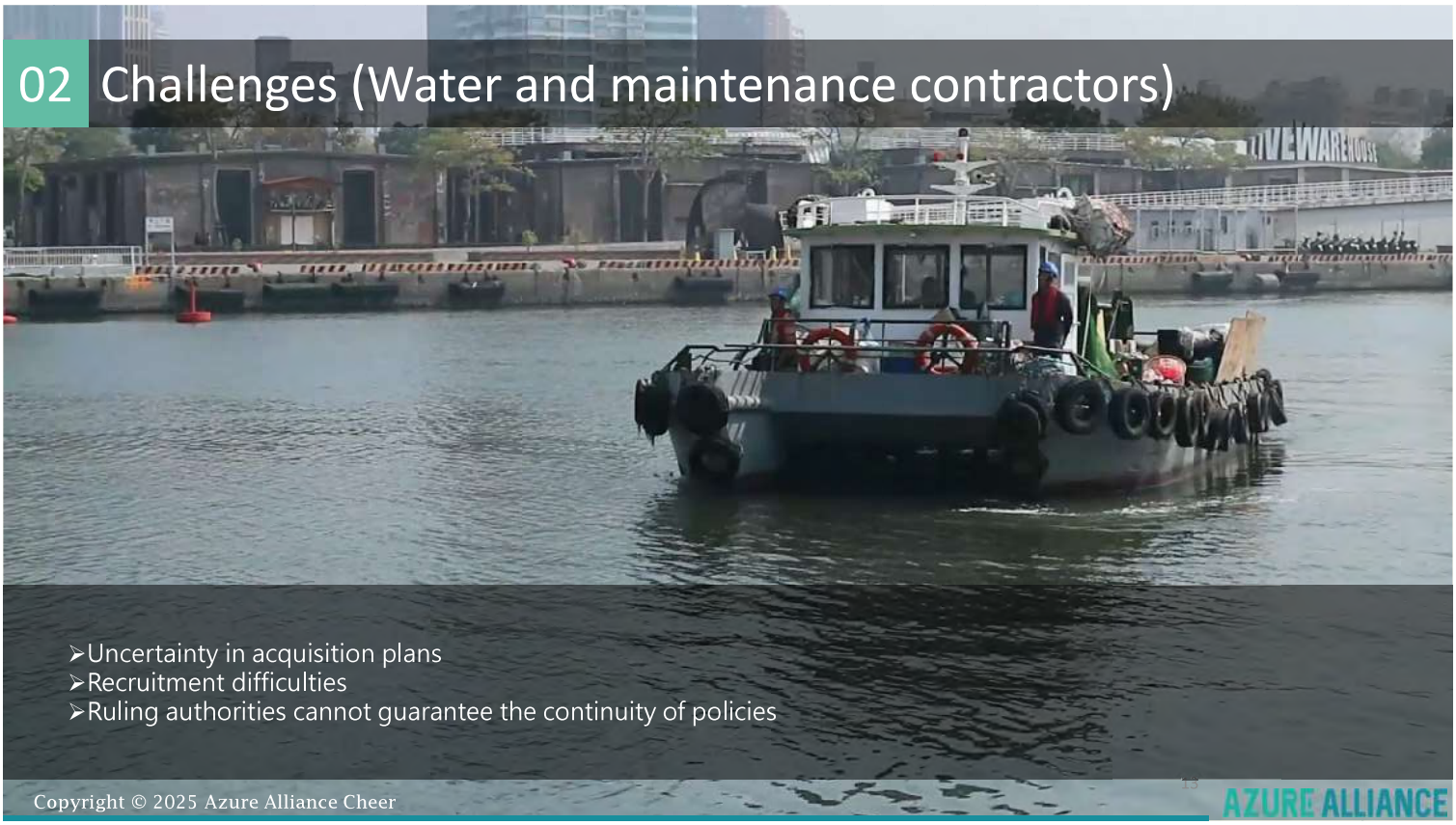
02 Challenges (Water and maintenance contractors)



- Uncertainty in acquisition plans
- Recruitment difficulties
- Ruling authorities cannot guarantee the continuity of policies

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03 AZURE Project

A Technology-Based
Marine Debris Removal Program

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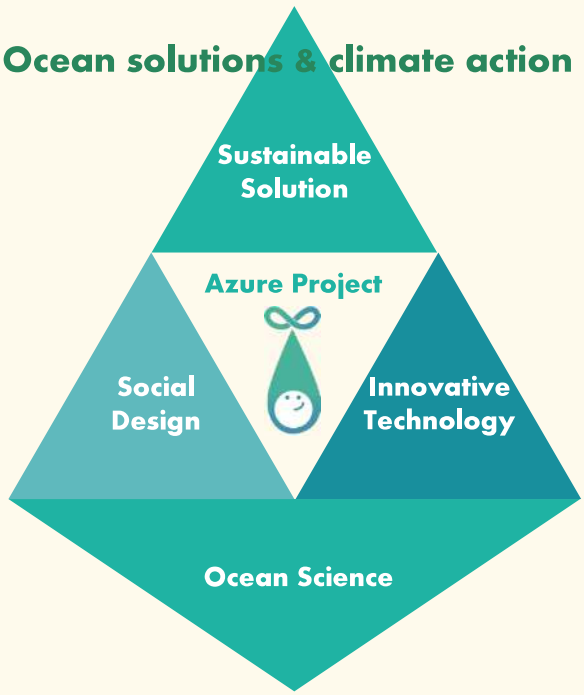
AZURE Project - Technology-Based Marine Debris Removal Program



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milestone

2020

Taiwan’ s first civilian-initiated floating marine debris removal program

2021

Taiwan’ s first all-electric, remote-controlled cleanup boat launched

2022

Taiwan’ s first demonstration harbor using unmanned boats for debris removal

2024

Pioneered gamified, interactive learning using unmanned boats;

2025

Selected as a partner organization in the Indo-Pacific Marine Debris Governance Framework

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Social Design ：Technology alone cannot clean the ocean; people can.

O	F	P	C
Observation	Focus	Program	Collaboration
Pain points Lack of government resource Manpower shortage	**Solution** Concatenate external resources Compensating manpower with technology	**Empower** Marine debris knowledge Beach Cleaning and Harbor Cleaning Safety Instructions	**Awareness** Project introduction Community Involvement

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Cooperation among stakeholders

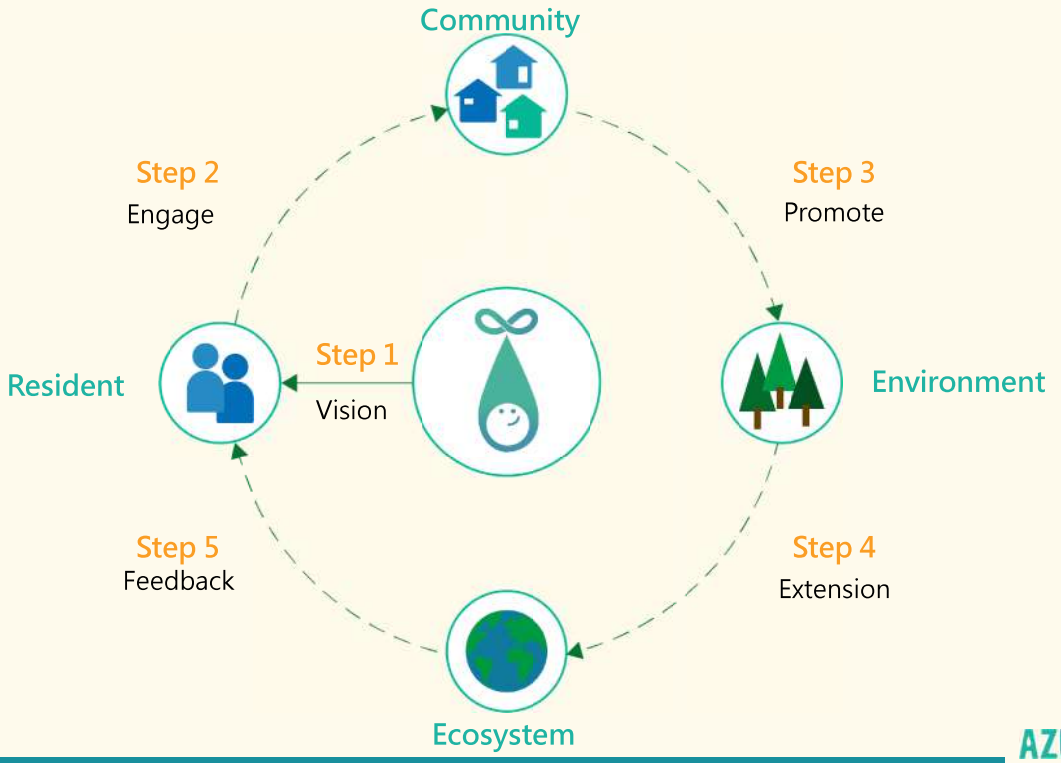
森崴能源 SHINFOX ENERGY　YANG MING 陽明海運　ASE　acer　Google.org　avpn

【Enterprise】

海洋委員會 Ocean Affairs Council　新北市政府 New Taipei City Government

INTERNATIONAL TRASH TRAP NETWORK Ocean Conservancy University of Toronto Trash Team

Social Design Operational concept



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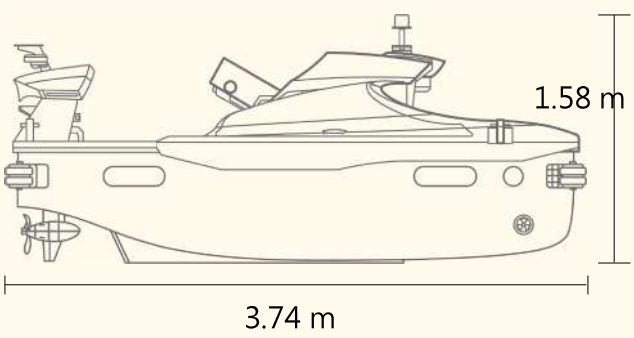
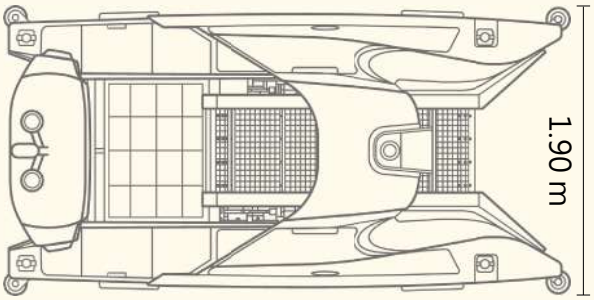
AZURE FIGHTER V1— Basic Specifications





Key Features

Communication	Wi-Fi / 4G LTE / 5G
Software	AZURE-OOS O'PRUEBA
Capacity	200kg pay load per trip
GNSS	Real-Time Kinematic DGPS

Propulsion System

Propulsion	2 x Electric Thrusters
Speed	4 knots
Battery	280 Ah NCA Lithium battery
Charger	48V 33A

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RELIABLE

SAFETY

3 Modes

1.Admin Mode
2.Engineer Mode
3.Viewer Mode

INTELLIGENT

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Safety

Use remote control boats, Improvement of the staff and user's working conditions

Clean

All-electric vessel, producing no polluting emissions, and requiring no oil changes.

Eco-friendly

Charging with renewable energy is environmentally friendly.

Creating a clean future through technology — “Smart” for a cleaner ocean.

Intelligence

Utilizing technology to accelerate the removal of marine debris.

Electrification

Enhancing energy efficiency to achieve environmental sustainability.

digitalization

Leveraging spatial information to inform and advance environmental policies.

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04

Conclusion

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Our Goal : Bringing Back Trash-Free Oceans

1

Clean up marine debris

Protect biodiversity

2

Analyze debris composition

Establish environmental baselines

3

Scientific publications

Respond to the UN Sustainable Development Goals (SDGs)

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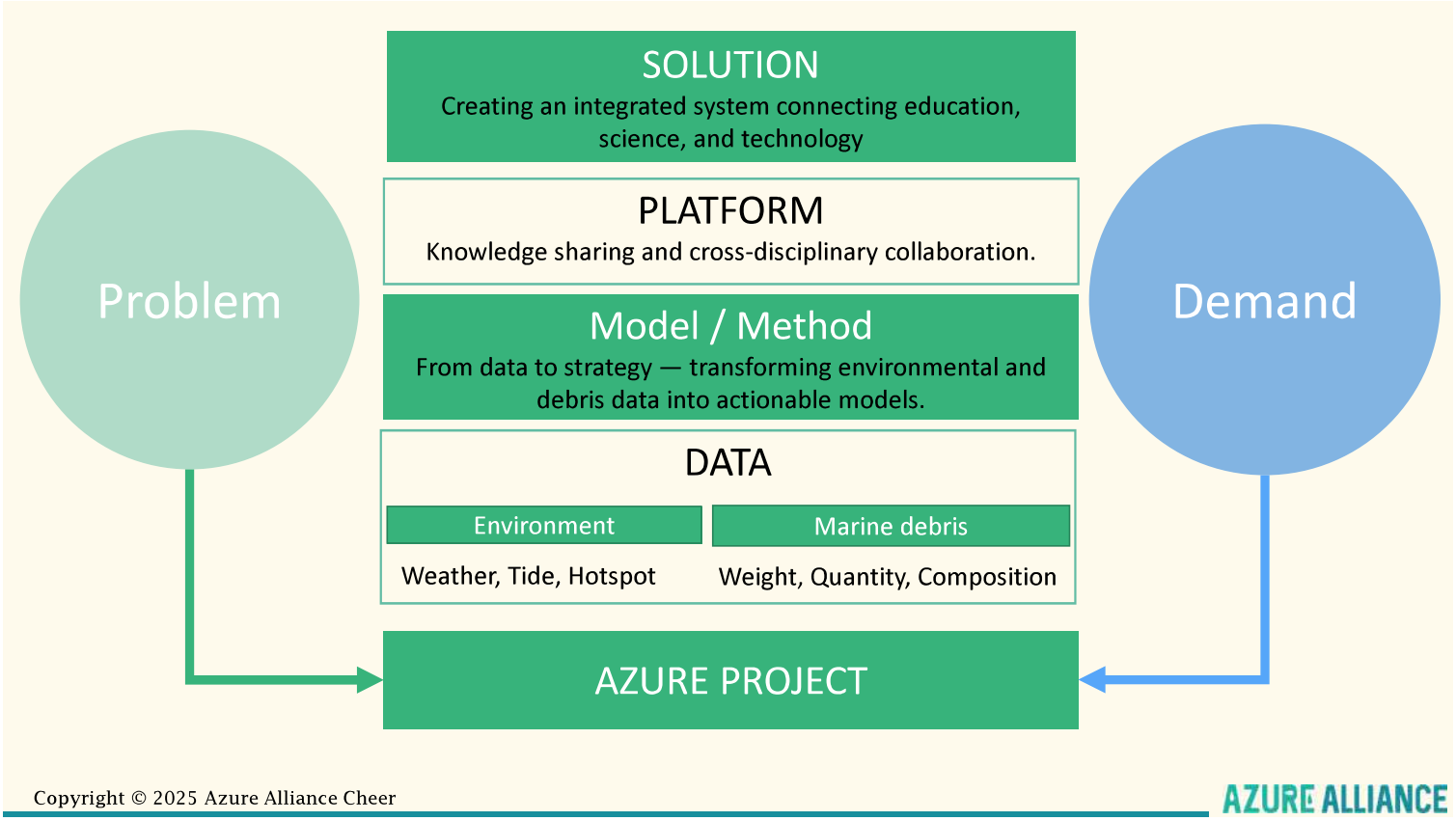

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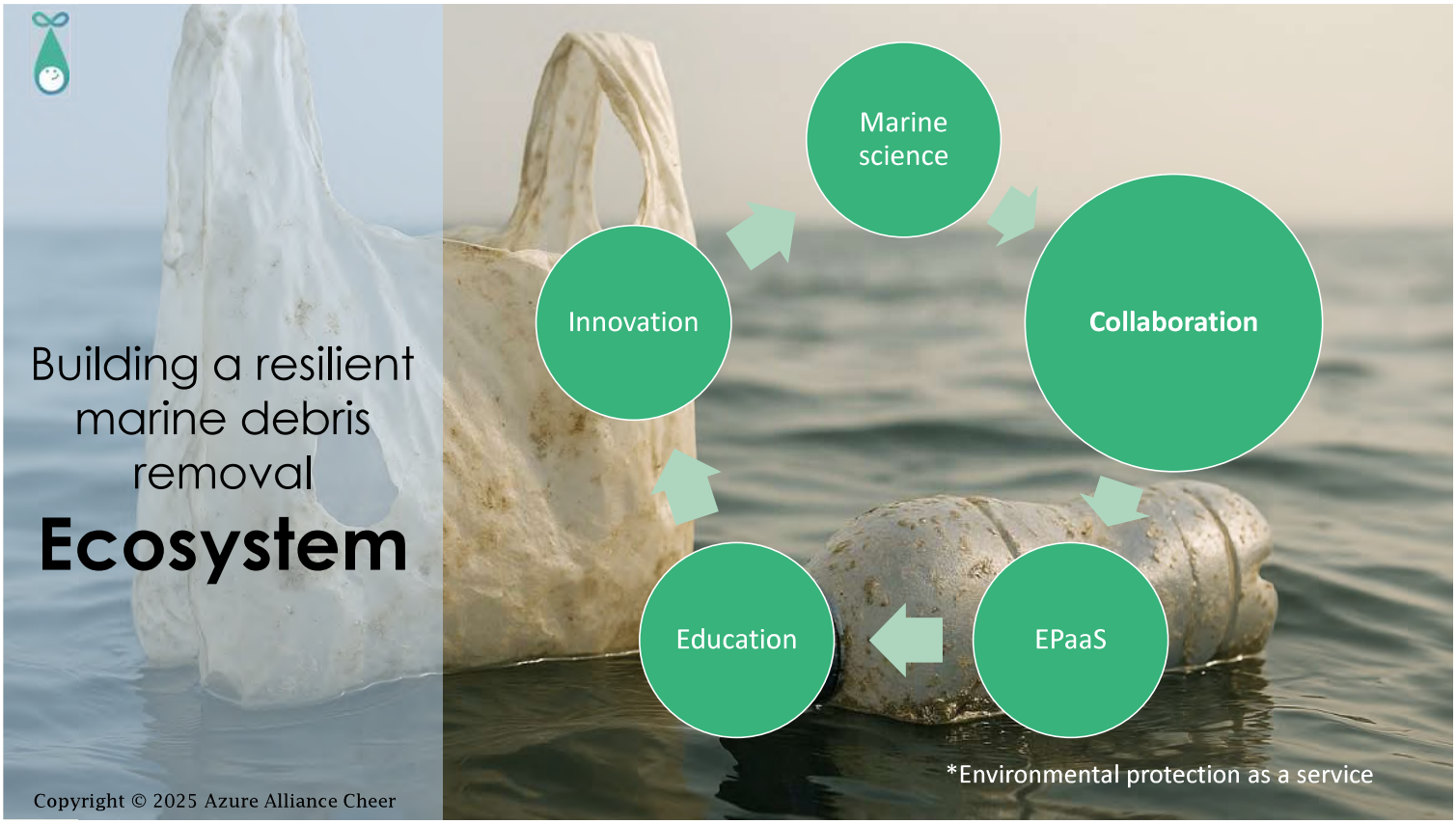

Why we need Technology-based solution

1 faster — Azure Fighter provide efficient and automated water-cleaning solutions.

2 Cheaper — Using Azure Fighter enhances cleaning capabilities and reduces time and operational costs.

3 Easier — By deploying the Azure Fighter, corporations and cities can improve their ESG performance and foster public participation in marine conservation through cross-sector collaboration.

4 Sustainable — Smart ocean-cleaning technology not only addresses marine pollution but also drives sustainable urban transformation, playing a key role in global ocean governance.

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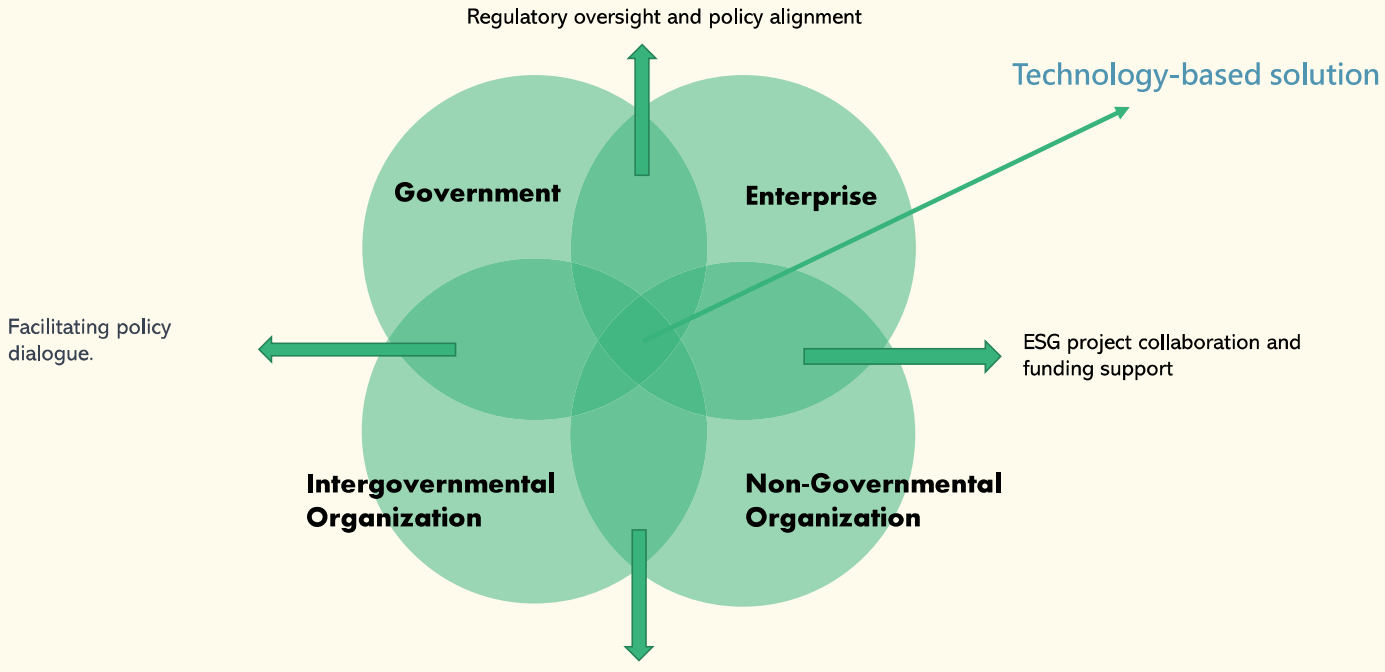
How can we mitigate marine plastic debris in the Indo-Pacific?



AZURE ALLIANCE

臺灣湛藍海洋聯盟
AZURE ALLIANCE

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