14. REGIONAL SUMMARY

14.1 Scientific publications across ASEAN+3

Research efforts on pollution from marine plastics in the states of the ASEAN+3 are varied in methods, focus and scope. A total of 371 scientific research papers have been reviewed (145 in the ASEAN and an additional 226 articles in China, Japan and RO KOREA) for this analytical comparison. See Table 1.2.14.1 below and Appendix II for a full inventory of these articles.

The regional analysis below is primarily based on these publications, completed where needed by government reports and grey literature where they fill a gap left by scientific publications.

Table 1.2.14.1. Number of scientific publications examined across ASEAN+3 in this study.

Country	No. of scientific publications examined
China	129
Korea	67
Indonesia	64
Malaysia	36
Japan	30
Philippines	15
Singapore	9
Thailand	9
Vietnam	4
Cambodia	3
Myanmar	3
Brunei	2

In terms of number of publications, the region can be divided into four tiers. In the first tier, the three leaders are China, RO KOREA and Indonesia. They lead in number of articles published and depth or breadth in scope or both. China leads the region with the greatest number of scientific publications on pollution from marine plastics (n=129), RO KOREA and Indonesia follow with a comparable number of articles. Together, RO KOREA and Indonesia have a comparable number of articles as has been published in China since 2015.

The second tier of states is made of Malaysia and Japan with substantial research in some aspects of pollution from marine plastics. The third tier includes the Philippines, Singapore and Thailand with a small number of publications but meaningful in breadth and depth. Finally, the last tier is at the earliest stage of research on pollution from marine plastics (Vietnam, Cambodia, Myanmar and Brunei).

Whilst the number of articles published is a valuable indicator of research efforts in a country, articles are not all equivalent as they vary greatly in scope, timeframe, depth, technology used, etc.

The next section compares the types of research foci across published papers and provide some understanding of areas that are being researched and those that are not.

14.2 Comparison of research focus

For the purpose of this comparative analysis, the 23 research foci have been grouped in 10 categories (or clusters) as indicated in the colour grouping below:

1. Laws, administrative measures
2. Guidelines and standards
3. Research framework, coordination
4. Upstream research/waste management
5. Methodology for marine plastic clean-up/removal
6. Surveys and monitoring/pollution status
7. Methodology for the monitoring and assessment of marine litter
8. Accumulation zones and hotspots
9. Movement of plastics in water bodies
10. Source differentiation
11. Contribution from rivers
12. Discharge from shipping and offshore installations (including aquaculture)
13. Contribution from fisheries/ALDFG
14. Fragmentation and degradation
15. Ecological and environmental impact:
    - Ingestion of plastic in the wild
    - Branchial uptake of plastic in the wild
    - Entanglement by plastics in the wild
    - Changes in microbial assemblages
    - Experimental studies of physicochemical impacts
    - Trophic transfer of plastics
16. Socio-economic impact:
    - Human health/food safety
    - Economic loss
17. Social perceptions
18. Public outreach/beach clean-up
19. Contaminants associated with marine plastics:
    - Organic and inorganic pollutants from marine plastic debris
    - Adsorption-Desorption of chemicals/pollutants
    - Plastics as transport medium/vector
20. Port reception facilities
21. Fibreglass-reinforced plastic vessels
22. Hull scraping and marine coating

23. Language and cultural barriers/data accessibility

Of note, research foci 20 to 23 are not included in the comparison because no or hardly any research were found on them. A first finding is therefore a lack of research on these four topics of relevance to pollution from marine plastic debris:

- Port reception facilities
- Fibreglass-reinforced plastic vessels
- Hull scraping and marine coating
- Language and cultural barriers/data accessibility

Figure 1.2.14.2 below shows the number of articles that investigate each research cluster in each country. The number of articles relevant to each cluster is further detailed in Table 2 of Appendix III.

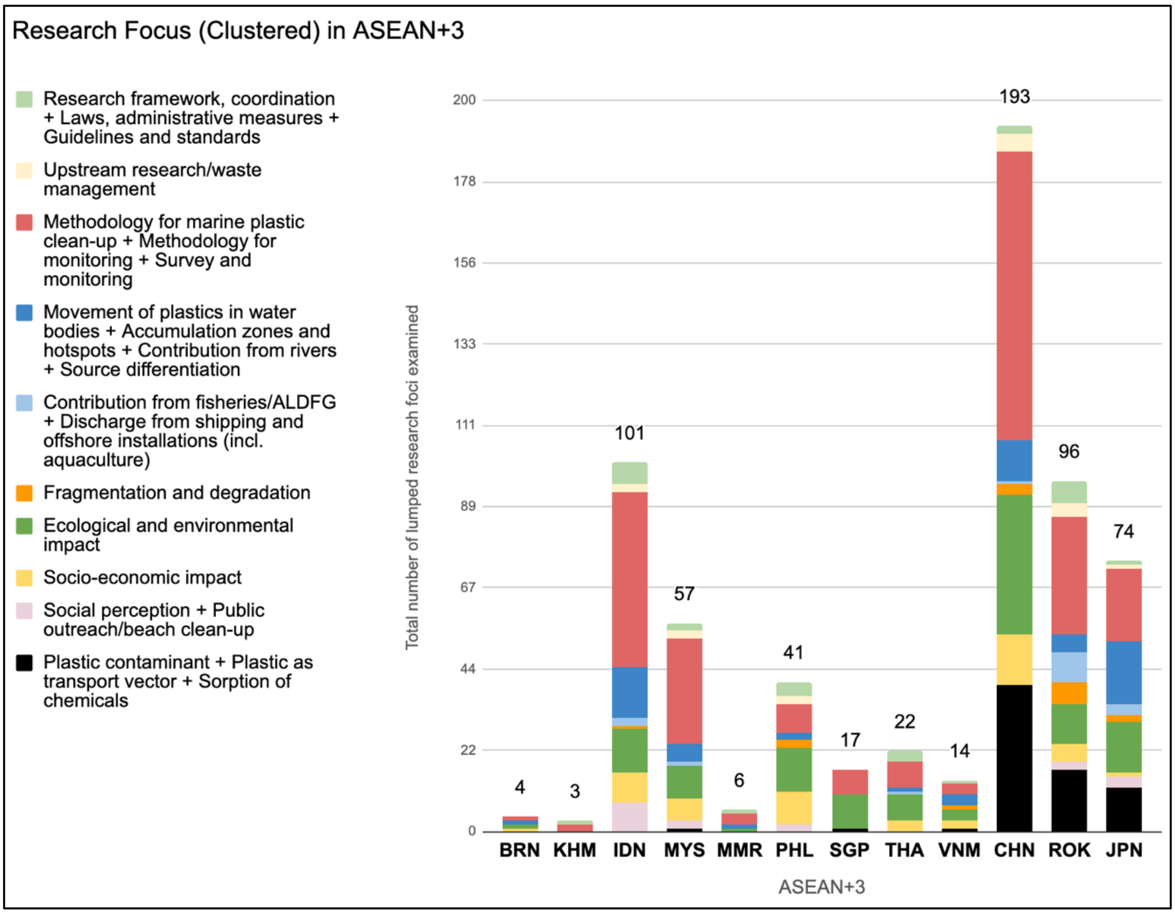

Figure 1.2.14.2. Top 10 clustered research foci in the marine plastics research across ASEAN+3.

This comparative analysis of level of interest in different clusters of research foci is different from comparing the number of publications. Instead of giving a measure of the overall research effort in a country, the former provides information on the breadth of the research topics (although not the depth – this requires a more detailed analysis of the methodology employed, nature of the investigation and findings). The first observation from this comparison is that only RO KOREA and Japan meet them all. Although, as shown in each country analysis, some research foci have not been researched in the same depth, it shows the overall breadth of the research.

The second observation is that China, Indonesia and Malaysia follow closely with nine out of ten research clusters although China has substantially more publications than the other two states. The Philippines, Vietnam and Thailand form the next group of states in number of research clusters covered. The last four states compose the last group in number of research clusters covered. Of note, Singapore is among these states. This may be partly explained by the fact that its publications have a comparatively specific (and therefore narrower) focus, although they are also comparatively deeper than those of the other three states in this group.

Tables 1 and 2 of Appendix III also show the cumulative interest of the region in different research areas, in the following order:

+

- Methodology, monitoring and surveying
- Ecological and environmental impact
- Plastic contaminants
- Accumulation areas, movement and hotspots
- Socio-economic impact
- Research framework, laws, measures, guidelines
- Upstream research and ALDFGs
- Social perception
- Fragmentation and degradation

-

Whilst the top first four research foci are generally recognised as being more important, discrepancies exist between countries with respect to the nature of research efforts and their research depth. It must also be highlighted that the strong research interest in ecological and environmental impacts tends to skew towards only the quantification of marine plastics within marine organisms. The downstream effects of marine plastics, such as organismal ingestion, accumulation, trophic transfer are less studied, and understood, although they can further impact communities, habitats and consequently ecosystem functionality.

This result also shows the gap in research in the other research foci areas, especially fragmentation and degradation, a key element in the understanding of transformation, sinks and fate of macroplastic to microplastic and the extent to which this transformation may occur in the marine environment or before. In this context, the hot and humid conditions of marine plastics in the ASEAN may be of particular relevance.

14.3 Comparison of methodologies used

This comparison has been approached in two ways: first, with a focus on the diversity in use of different methodological approaches in ASEAN+3 employed for research on pollution from marine plastics (Table 1.2.14.3); and second, with a focus on research papers that discuss methodological approaches. (Table 1.2.14.4).

Table 1.2.14.3. Methodologies employed in marine plastics research in ASEAN+3. Legend: Green = methodology employed in marine plastics research; Red = methodology not employed in marine plastics research.

Methodologies	BRN	KHM	IDN	MYS	MMR	PHL	SGP	THA	VNM	CHN	ROK	JPN
Review (literature/social media)	Red	Red	Green	Green	Green	Green	Red	Red	Red	Green	Green	Green
Sampling	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Monitoring	Red	Green	Green	Green	Red	Red	Green	Red	Red	Green	Green	Green
Quantification	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Identification	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green	Green
Laboratory experimental work	Red	Red	Green	Red	Red	Red	Green	Red	Red	Green	Green	Green
Simulation model	Red	Red	Green	Green	Red	Red	Red	Red	Green	Green	Green	Green
Social perception	Red	Red	Green	Green	Red	Red	Red	Red	Green	Green	Green	Red

Methodological approaches for monitoring and assessing marine litter were explored in six countries. These include: Indonesia (n=2), Malaysia (n=3), Vietnam (n=1), China (n=8), ROK (n=8) and Japan (n=8). In Brunei, Cambodia, Myanmar, the Philippines, Singapore and Thailand, there was no published work on such monitoring methodologies.

In some papers, the comparison of methodologies was the main purpose of the paper. In others, their chosen methodology was discussed in the context of particular field or lab-based experiments. Table 1.2.14.3 also shows a strong emphasis on methodologies for microplastic sampling, and significantly less on methodologies for macroplastic identification, fragmentation, degradation and other processes that drive plastic particle behaviour and transport as well as bacterial assemblages.

In most countries, this type of discussion seems to arise after a number of studies and publications as a sign of progress in this field of research whether prior research is country specific or topic specific. An example of this is researchers from a non-ASEAN country discussing application of different methodologies in the context of an ASEAN country; such publication can happen to be the first publication of this type in the country (e.g. Vietnam).

Table 1.2.14.4. List of papers that analysed the methodologies for monitoring and assessing marine litter.

Country	No.	Relevant papers
IDN	2	• Syakti et al. (2018). Simultaneous grading of microplastic size sampling in the Small Islands of Bintan water, Indonesia. Marine Pollution Bulletin 137: 593-600. • Syakti (2017). Microplastics Monitoring in Marine Environment. Omni-Akuatika 11 (2): 1-6
MYS	3	• Auta et al. (2017a). Screening of Bacillus strains isolated from mangrove systems in Peninsular Malaysia for microplastic degradation. Environmental Pollution 231(2): 1552-1559. • Auta et al. (2017). Screening for Polypropylene Degradation Potential of Bacteria Isolated from Mangrove Ecosystems in Peninsular Malaysia. International Journal of Bioscience, Biochemistry and Bioinformatics 7(4): 245-251. • Karami et al. (2016). A high-performance protocol for extraction of microplastics in fish. Science of The Total Environment 578: 485-494.
VNM	1	• van Emmerik et al. (2018) A methodology to characterize riverine macroplastic emission into the ocean. Frontiers in Marine Science 5: 372.
CHN	8	• Ding et al. (2019) Detection of microplastics in local marine organisms using a multi-technology system. Analytical Methods 11: 78-87 • Fok et al. (2019) A meta-analysis of methodologies adopted by microplastic studies in China. Science of the Total Environment: 135371 • Liu et al. (2019a) A novel method enabling the accurate quantification of microplastics in the water column of deep ocean. Marine Pollution Bulletin 146: 462-465. • Wang et al. (2019) Preliminary study of the source apportionment and diversity of microplastics: Taking floating microplastics in the South China Sea as an example. Environmental Pollution 245: 965-874. • Li et al. (2018) A straightforward method for measuring the range of apparent density of microplastics. Science of the Total Environment 639: 367-373. • Xu et al. (2018). Microplastic risk assessment in surface waters: A case study in the Changjiang Estuary, China. Marine Pollution Bulletin 133: 647-654. • Zhao et al. (2018) Limitations for microplastic quantification in the ocean and recommendations for improvement and standardization. In: Zeng (ed.) Microplastic Contamination in Aquatic Environments: An Emerging Matter of Environmental Urgency, Elsevier, pp. 27-49. • Qiu et al. (2016) Extraction, enumeration and identification methods for monitoring microplastics in the environment. Estuarine, Coastal and Shelf Science 176: 102-109.
ROK	8	• Kim and An (2019) A simple and efficient method for separation of low-density polyethylene films into different micro-sized groups for laboratory investigation. Science of the Total Environment 668: 84-89. • Lee et al. (2019) Rapid assessment of marine debris in coastal areas using a visual scoring indicator. Marine Pollution Bulletin 149: 110552. • Hong et al. (2017) Methods of analysing chemicals associated with microplastics: a review. Analytical Methods 9: 1361 • Shim et al. (2016) Identification and quantification of microplastics using Nile Red staining. Marine Pollution Bulletin 113: 469-476. • Jang et al. (2015) Application of remote monitoring to overcome the temporal and spatial limitations of beach litter survey. Advanced Science and Technology Letters 95: 67-72. • Song et al. (2015) A comparison of microscopic and spectroscopic identification methods for analysis of microplastics in environmental samples. Marine Pollution Bulletin 93: 202-209. • Saido et al. (2014) New analytical method for the determination of styrene oligomers formed from polystyrene decomposition and its application at the coastlines of the North-West Pacific Ocean. Science of the Total Environment 473-474: 490-495.

		• Heo et al. (2013) Distribution of small plastic debris in cross-section and high strandline on Heungnam beach, South Korea. Ocean Science Journal 48(2): 225-233.
JPN	6	• Iwasaki et al. (2017) Fate of microplastics and mesoplastics carried by surface currents and wind waves: A numerical model approach in the Sea of Japan. Marine Pollution Bulletin 121(1-2): 85-96. • Matsuguma et al. (2017) Microplastics in sediment cores from Asia and Africa as indicators of temporal trends in plastic pollution. Archives of Environmental Contamination and Toxicology 73(2): 230-239. • Kataoka and Hinata (2015) Evaluation of beach cleanup effects using linear system analysis. Marine Pollution Bulletin 91(1): 73-81. • Isobe et al. (2014) Selective transport of microplastics and mesoplastics by drifting in coastal waters. Marine Pollution Bulletin 89: 324-330. • Kataoka et al. (2012) A new technique for detecting colored macro plastic debris on beaches using webcam images and CIELUV. Marine Pollution Bulletin 64: 1829-1836. • Kako et al. (2011) Establishment of numerical beach-litter hindcast/forecast models: An application to Goto Islands, Japan. Marine Pollution Bulletin 62(2): 293-302.

In conclusion, these methodological discussions should be taken into account in the context of the development of regional guidelines on monitoring and surveying of pollution from marine plastics, bearing in mind that further methodological discussions are still needed on research aspects that have not been discussed.

14.4 Comparison of types of plastics research

Macroplastics and microplastics

There is a very dominant interest in microplastics from the scientific literature examined (Figure 1.2.14.5). Although quantification of marine plastic debris or macroplastics is also reported in grey literature, it is often without the same rigour and level of details. There is also a clear lack of research on examining both macro- and micro-plastics or primary and secondary plastic particles in general to understand the process of transformation from the former to the latter.

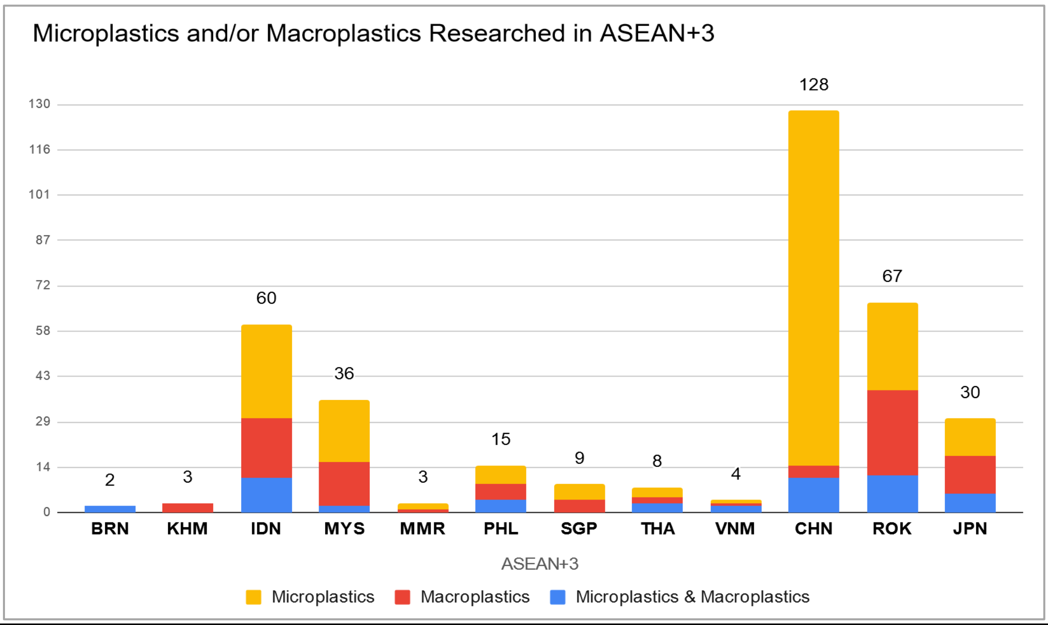

Figure 1.2.14.5. Research efforts on micro-/macro- plastics in the ASEAN+3.

Polymer types

Table 1.2.14.6 below provides a compilation of all polymers identified or studied in ASEAN+3, with a selection of the top five types of plastic polymers in each country in terms of research effort (i.e. number of publications). Overall, this shows that the most commonly studied polymers are PP, PE and PS across ASEAN+3.

When looking at the regional research effort as a whole (i.e. lumping all publications together, irrespective of the country of interest) the same top three plastic polymer is obtained. However, a substantial research effort can also be noted for another 14 types of plastic polymer, including PET, PVC, PA, EPS, SAN, LPDE, nylon and cellophane (Table 1.2.14.7).

Table 1.2.14.6. List of plastic polymer types identified and the top 5 in the research reviewed.
* In some countries with too few articles that mention polymer types, the top 5 polymers could not be deduced

	All plastic polymer types identified	Top 5 plastic polymer types*
BRN	PET, PE, PVC	(only 1 study)
KHM	-	-
IDN	PP, PS, PE, PET, LDPE, polyester, synthetic cellulose, PVC, PU, PC, PBD, PA, nylon, HDPE, EDPM, dipar, CP	PP, PS, PE, PET, LDPE
MYS	PP, PE, PET, PS, PVC, PA, nylon, LDPE PVA, polyisoprene/polystyrene, PEP, PAN, PAK, HDPE, EPS, CP	PP, PE, PET, PS, PVC
MMR	-	-
PHL	GPPS, PE, PET, PA, PP, PVC, LDPE, PETE, rayon, phenoxyresin, acrylic	PE, PVC
SGP	PE, PP, PVC, PVA, nylon, acrylonitrile butadiene styrene	PE, PP, nylon
THA	PS, PET, PA	(only 1 study)
VNM	PE, PP, PET, PP-vistalon, polyester, rayon, viscose, acrylic, resin	(only 1 mention in 2 studies)
CHN	PE, PP, PS, PET, PVC, PA, CP, LDPE, polyester, nylon, rayon, PC, HDPE, EPS PU, PES, PE/PP, PTFE, acrylic, POM, alkyd, SAN, PVA, PP/EPR, PMMA, PBT, wax, urethane alkyd, synthetic cellulose, resin, PVDC, PVAC, PV, PP/EPDM, PSUL, polyphenylene, polyethylene/ethylacrylate copolymer, PAN, poly(1-octene), PEVA, PCL, PBAT, PB, PARA, PAE, MDPE, EVA, epoxy, cellulose, ASA, AN, alkyd, ABS	PE, PP, PS, PET, PVC
ROK	EPS, PE, PP, PS, acrylic, vinyl, PVC, PU, PET, nylon, alkyd, styrene oligomers, polyester, polyacrylate/styrene, PEVA or EVA, LDPE, teflon, styrene/acrylonitrile, silicone, PTFE, PVA, polystyrene ethylene butylene styrene, PPS, polyethylacrylate styrene, polyepoxides PC, PBT, PMMA, PCB, PBMA, paraffin, PA HDPE, XPS, ABS	EPS, PE, PP, PS, acrylic
JPN	PS, PE, PP, PVC, resin, PA, PET, PCL, PAK, EVA, PVA, PMMA, PEPD, PEP, PC/ABS, nylon, FPS	PS, PE, PP, PVC, resin

Table 1.2.14.7. List of plastic polymers studied in the research reviewed.

Polymers	No. of papers
Polyethylene (PE)	126
Polypropylene (PP)	107
Polystyrene (PS)	95
Polyethylene terephthalate (PET or PETE or PETP or PET-P)	64
Polyvinyl chloride (PVC)	56
Polyamide (PA)	39
Expanded polystyrene (EPS)	31

Styrene-acrylonitrile (SAN)	23
Low-density polyethylene (LDPE)	19
Nylon	19
Cellophane (CP)	15
Polyester	15
Polyurethane (PU or PUR)	12
Acrylic	11
Polycarbonate (PC)	10
High-density polyethylene (HDPE)	10
Rayon	10

Regulations on plastic polymers under examination

While the top four most researched plastic polymers are the subject of some regulation under international law, it is interesting to note that the following polymers, which are also the subject of substantial research effort, are not the subject of specific international law provisions (Table 1.2.14.8). These include, in particular:

- PVC
- EPS
- SAN
- LDPE
- Nylon
- Cellophane

Conversely, some plastic polymers which are regulated for their potential toxicity and are found in the marine environment do not appear to be the subject of much research effort. These include PA, PU, acrylic polymers and PB.

Further research would be useful. First, to ensure in-depth study of the most prevalent and toxic polymers in the marine environment. Second, to investigate consistency between research outcomes and regulations as well as across international regulations (see Part 1, Section 3.7 on toxic contaminants regulation for further discussion on this).

Table 1.2.14.8. Number of publications on organic contaminants (plastic polymer types) in ASEAN+3.
Legend: Red = not regulated under any of the three conventions (London Convention/London Protocol, Basel Convention and the Stockholm Convention); Green = under the regulation of at least 1 of the mentioned conventions. [A complete table of all researched polymers can be found in Appendix IV.]

Organic contaminants (plastic polymer types)				
Regulated	No. of papers		Unregulated	No. of papers
Polyethylene (PE)	126		Polyvinyl chloride (PVC)	56
Polypropylene (PP)	107		Styrene-acrylonitrile (SAN)	23
Polystyrene (PS)	95		Low-density polyethylene (LDPE)	19

Polyethylene terephthalate (PET or PETE or PETP or PET-P)	64		Nylon	19
Polyamides (PA)	39		Cellophane (CP)	15
Expanded polystyrene (EPS)	31		Polyester	15
Polyurethane (PU or PUR)	12		Rayon/viscose	11
Acrylic polymers	11		High-density polyethylene (HDPE)	10
Polycarbonate (PC)	10			

14.5 Comparison of organic and inorganic contaminants

Organic contaminants (associated additives or sorbed chemicals)

The comparison of research efforts and applicable regulations on plastic-associated organic contaminants provides a picture that is similar to the one with plastic polymers. The research efforts and applicable regulations are presented in Table 1.2.14.9 below.

This table also suggests that further research would be useful. First, to ensure in-depth study of the most prevalent and toxic plastic-associated organic contaminants. Second, to investigate consistency between research outcomes and regulations as well as across international regulations (see Part 1, Section 3.7 for further discussion on this).

It is interesting to note that there is a greater research effort on some unregulated plastic-associated organic contaminants.

Table 1.2.14.9. Number of publications on organic contaminants (plastic-associated) in ASEAN+3.
Legend: Red = not regulated under any of the three conventions (London Convention/Protocol, Basel Convention and the Stockholm Convention); Green = under the regulation of at least 1 of these conventions. [A complete table can be found in Appendix IV.]

Organic contaminants (plastic-associated)				
Regulated	No. of papers		Unregulated	No. of papers
HBCDD	9		PAHs	10
PCB	9		Gamma-HCH	6
Alpha-HCH	6		HCB	5
Beta-HCH	6		Delta-HCH	5
DDTs	4		UV326/Tinuvin 326	4
PBDE	4		BPA and its analogues	3
PeCB	3		Irgafos168 and its 2 degradation products	3
Organophosphorus compounds	2		UV327	3
Aldrin	1		DDE	2
Chlordane	1		Irganox 1076	2
Dieldrin	1		NPs and its antioxidants, plasticisers, and degradation products	2
Endrin	1		UV320	2

Heptachlor	1		UV328	2
PFSO, its salts and PFSOF	1		BP-3	1
			BHT	1
			HEHA	1
			Irganox 1010	1
			Nonachlor	1
			PFOSA	1
			PAEs	1
			PHCs	1
			TBC	1
			UvinualMC80	1
			UV531/BP-12	1
			4-MBC	1
		Pharmaceutical drugs	TC	4
			SMX	3
			CP	2
			SMT	2
			AMX	1
			CEP	1
			PRP	1
			SER	1
			SDZ	1
			TMP	1
			TYL	1
		Antimicrobial agents	TCS	2
		PPCPs	SMs	1
		Others	Lubrication oil	1
			E2	1

Inorganic contaminants

The comparison of research efforts and applicable regulations on plastic-associated inorganic contaminants provides a different picture than that of plastic polymers and plastic-associated organic contaminants.

In particular, there are more publications on regulated contaminants than those that are not. However, not all regulated contaminants appear to have been studied in the context of marine plastics, despite them being considered as potential plastic-associated contaminants. A number of non-regulated contaminants have been studied and others have not.

This points to the need for further examination of the reasons for this and consideration of whether additional research and or regulation of potential contaminants is needed.

Table 1.2.14.10. Number of publications on inorganic contaminants (heavy metals and/or its compounds) in ASEAN+3. Legend: Red = not regulated under any of the three conventions (London Convention/Protocol, Basel Convention and the Stockholm Convention); Green = under the regulation of at least 1 of these conventions. [A complete table can be found in Appendix IV.]

Inorganic contaminants (heavy metals and/or its compounds)				
Regulated	No. of papers		Unregulated	No. of papers
Lead (Pb) and lead compounds	6		Manganese (Mn)	1
Cadmium (Cd) and cadmium compounds	5		Strontium (Sr)	1
Copper (Cu)	5		Tin (Sn)	1
Zinc (Zn)	3			
Arsenic (As)	2			
Chromium (Cr) and Hexavalent chromium compounds	2			
Nickel (Ni)	2			
Antimony (Sb); antimony compounds	1			
Mercury (Hg) and mercury compounds	1			

14.6 Comparison of sampling efforts across marine environs

With regard to the sampling of plastics in different parts of the marine environment, shoreline sampling is the most common and the only environ that has been covered in every country (Figure 1.2.14.11). Investigations on marine plastics typically start off with beach sampling and later develop with the sampling of other environs.

The next most common sampling environ is marine biota. Quantifying the amount of plastics in or on marine organisms may be opportunistic, depending on beached marine organisms' carcasses. However, it may gain momentum if the research focus centres on bioaccumulation or toxicity of plastics in marine organisms with its potential to impact human health.

Sampling efforts of plastics in the water column and on or in the seabed are the least common. In the ASEAN, Indonesia and Malaysia are the only states to have some published articles on such studies. This clearly denotes a gap in understanding.

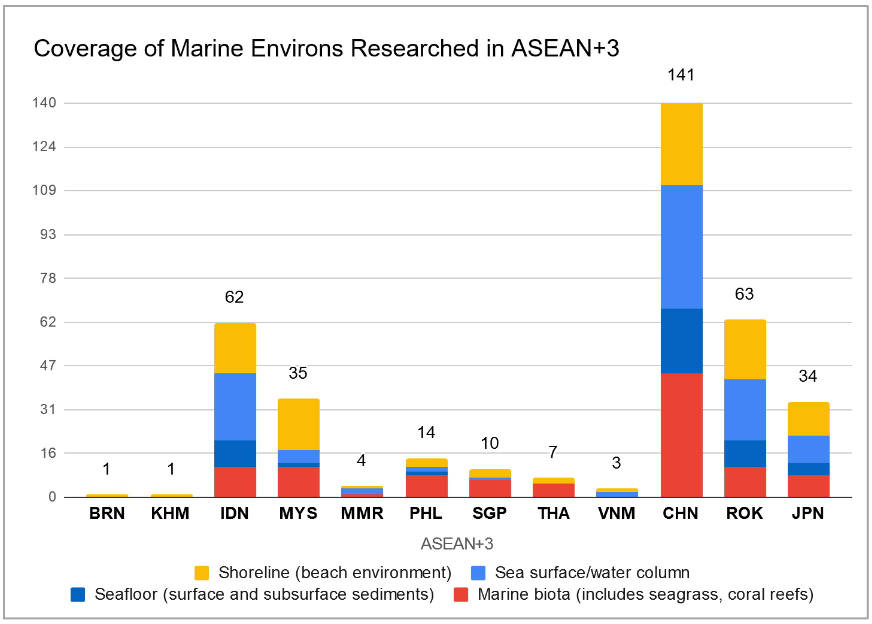

Figure 1.2.14.11. Sampling efforts in four major marine environs in ASEAN+3.

14.7 Comparison of ecological and environmental impacts

Research on the ecological and environmental impacts from marine plastics in the region as a whole can be divided into the following focus areas:

- Direct ingestion and accumulation that limit food intake and sometimes survival or result in the release of toxic plastic-associated contaminants leachates (e.g. DDT or PCB);
- Direct physical impact on marine biota, such as entanglement and laceration, sometimes leading to the death of marine organisms;
- Uptake and accumulation through the respiratory/branchial system and subsequent blockage;
- Uptake and transfer through the food chain; and
- Changes in microbial assemblages.

Another category of research occurs in a laboratory setting, with experimental studies of physiochemical impacts of polymers (i.e. size, shape, type, concentration, etc.) on living organisms.

Table 1.2.14.12 below shows how different countries tend to focus on different types of impacts, with none of the countries having published in all six research areas. Two research areas are particularly understudied:

- Changes in microbial assemblages; and
- Trophic transfer (through the food chain).

Two other areas are the subject of very few studies:

- Branchial uptake of plastic; and
- Plastic entanglement of marine life.

Table 1.2.14.12. Ecological and environmental impacts researched in the ASEAN+3.
Legend: Red = 0 articles; Yellow = 1-9 articles; Light-green = 10-20 articles; Green = >20 articles.

	BRN	KHM	IDN	MYS	MMR	PHL	SGP	THA	VNM	CHN	ROK	JPN	Total
Ingestion of plastic in the wild	0	0	10	9	0	8	0	4	0	26	5	8	70
Branchial uptake of plastic in the wild	0	0	1	1	0	0	0	0	0	2	0	0	4
Entanglement of plastics in the wild	0	0	0	0	0	2	4	0	0	0	1	0	7
Changes in microbial assemblages	0	0	0	0	0	0	1	0	0	0	0	0	1
Experimental studies of physicochemical impacts	0	0	1	0	0	0	1	0	0	12	6	0	20
Trophic transfer of plastic	0	0	0	0	0	0	1	0	0	1	0	0	2

Further study of the large body of publications on ingestion of plastic by marine organisms shows a clear preference for commercially exploited species such as fish and bivalves, and a rare interest in the impact on endangered migratory species despite the important coverage of these species in social media (Table 1.2.14.13). This may be partly explained by the fact that most of such studies require dissecting or washing the guts out of the animals, which is costlier and more time-consuming for larger mammals. However, further research may remedy this imbalance.

Table 1.2.14.13. Biota examined for plastic ingestion.
Legend (for total): Yellow = 1-9 articles; Light-green = 10-20 articles; Green = >20 articles.

	IDN	MYS	PHL	THA	CHN	ROK	JPN	Total
Bony Fish	6	4	2	1	14	0	1	28
Bivalves	3	1	2	2	8	1	0	17
Birds	0	0	0	0	1	1	4	6
Echinoderms	1	1	0	0	2	0	0	4
Zooplankton	0	1	0	0	2	1	0	4
Crabs, Shrimps, and Amphipods	0	0	0	0	2	0	1	3
Cetaceans	0	0	1	0	2	0	0	3
Gastropods	1	0	0	1	0	0	0	2
Sharks and Rays	1	0	0	1	0	0	0	2
Turtles	0	1	1	0	0	0	0	2
Corals	0	0	0	0	1	0	0	1
Polychaetes	0	0	0	0	0	1	0	1
Barnacles	0	0	0	1	0	0	0	1

14.8 Comparison of ALDFG

Despite a general recognition of the importance of ALDFGs in the region and their high expected contribution to marine plastics, their physical impacts on coral reefs and on marine life, as well as their contribution to marine plastics pollution, are understudied. Table 1.2.14.14 below provides a summary of the few publications found on this topic as a baseline for further study.

Table 1.2.14.14. List of publications on ALDFGs in ASEAN+3 (including aquaculture).

	No.	Research aim of study
IDN	2	Examining presence of ALDFG (plastic net) and as a substrate for coral reef
		Examining possible causes of ALDFG from Australian and Indonesian fisherman
SGP	4	Documenting the impacts of trammel nets on marine life in Singapore
		Documenting the presence of coral cat-shark, reporting impacts of fish traps on marine life in Singapore
		Documenting the presence of blackspot shark, reporting impacts of gill nets on marine life in Singapore
		Documenting the presence of black-tipped reef shark, reporting impacts of gill nets on marine life in Singapore
THA	1	Understanding the impact of lost fishing gear (nets, ropes, cages, lines) on six stony coral growth forms; Inventorising lost fishing gear on reefs, and identify and quantify damaged caused to stony corals based on growth forms
CHN	1	Quantifying microplastics in the surface waters, intertidal sediments, and benthic sediments of Xiangshan Bay, Zhejiang, with a focus on potential mariculture origin
ROK	8	Observing ingestion and fragmentation of EPS debris (derived from styrofoam fishing buoys) in marine polychaetes, in the field and in laboratory conditions
		Quantifying entanglement records of ALDFG on ships of Korea's navy
		Measuring HBCD levels in mussels adhering to polystyrene buoys
		Identifying the spatial distribution and source of HBCDs in Jinhae and Masan Bay
		Evaluating the cost-effectiveness of three derelict fishing gear programmes (cleanup with ships, buy back, floating reception barge) in South Korea using an emergy accounting method
		Quantifying marine debris on 13 beaches in Tongyeong City
		Quantifying mesoplastic on Heungnam beach, Geoje Island, and comparing differences in result when measuring along the cross-sectional line or the high strandline
		Reviewing the impact of marine debris in South Korea and the practices, policies, and challenges for managing marine debris, with a focus on ALDFG
JPN	3	Conducting comparative surveys of microplastics in three zones of coastal seas of Japan; Examine the abundance and size of microplastics, as well as their polymer types in a coastal sea; Compare across the bottom sediment, beach sediment, and surface water; Deduce sinking and fragmentation process of foamed polystyrene (FPS) plastics
		Developing database to capture deep-sea debris information; Examine archives of photographs from dives by deep-sea submersibles and remotely operated vehicles; Assess the quantity, debris types, and impacts on deep-sea ecosystem
		Assessing the abundance and composition of anthropogenic marine debris on the basis of six bottom trawl surveys on the continental slope off Iwate Prefecture between pre- and post-earthquake period

14.9 Comparison of social perception

Social perception studies were found for three countries only (Indonesia, n=8; Malaysia, n=2; and ROK, n=1). Generally, these studies involved interviews with locals, either through individual or household interviews (Table 1.2.14.15).

Further social science studies would be very useful to support the development of successful management and decrease of use of plastic waste, as well as a sustainable approach to a circular economy.

Table 1.2.14.15. List of publications on 'social perception' in ASEAN+3.

	No.	Research aim of study
IDN	8	Examining millennial perception towards marine litter and the influence of environmental education towards youth perceptions in West Aceh, Indonesia
		Examining the people's perception towards marine litter responsibility in Aceh Jaya Regency, Indonesia
		Literature review of marine plastic problem in Bali, Indonesia
		Analysing land-based leakage of solid waste, particularly plastics, to the marine environment
		Examining the effectiveness of an educational outreach program in raising awareness of the impacts and scale of marine debris to children in Barrang Lompo, Makassar City, South Sulawesi, Indonesia
		Quantifying, identifying, characterising and comparing coastline, seabed and floating macroplastic on Kuta Beach, Bali, during different seasons; Examining possible sources of macroplastic; Assessing local's awareness and perspective of marine pollution responsibility
		Quantifying, identifying and characterising coastal debris into different types, including plastic, in Kuta beach, Bali
		Quantifying, identifying and characterising land and marine debris into different types, including marine plastic, in Barrang Lompo Island
MYS	2	Quantifying, identifying and characterising coastal debris into different types, including plastic, on 4 beaches of Malaysia; Assessing local's awareness and perspective of marine pollution responsibility
		Quantifying, identifying and characterising coastline macroplastics on beaches in Sarawak, Malaysia; Assessing local's awareness and perspective of marine pollution responsibility
ROK	1	Estimating willingness to pay for removing microplastics from the ocean based on public perceptions in Seoul

14.10 Main players

The most active researchers and their institutions are included in Table 1.2.14.16 below, based on the number of publications or reports.

Table 1.2.14.16. Visible institutions and/or authors in marine plastics research in ASEAN+3.
[A complete table of authors with a clear investment in marine plastic research can be found in Appendix I.]

	(Research) Institution	Researchers	Visible Research Interests
BRN	Universiti Teknologi Brunei (UTB)	Zahid Naeem Qaisrani	Marine debris on coastal beaches

KHM	Marine Conservation Cambodia	-	Marine research and marine conservation, clean-up initiatives on Kep Mainland beaches
IDN	Indonesian Institute of Sciences/Lembaga Ilmu Pengetahuan Indonesia (LIPI)	Muhammad Reza Cordova	Microplastics, marine pollution, aquatic toxicology, heavy metals
	Padjadjaran University	Noir Primadona Purba	Marine debris monitoring, ocean current and circulation, modelling and movement of particles
		Dannisa Ixora Wanadwiva Handyman	Ocean current and circulation, modelling and movement of particles
		Mochamad Rudyansyah Ismail	Marine ecology, fish behaviour, microplastic ingestion
	Jenderal Soedirman University	Agung Dhamar Syakti	Marine debris monitoring, marine pollution, environmental chemistry
MYS	University of Malaya	Shahul Hamid Fauziah Agamuthu Periathamby Helen Shnada Auta Chijioke Emenike	Largely working together on marine debris, microplastics, marine pollution, leachate, environmental bioremediation, waste treatment and management
	University of Sarawak	Julyus Melvin Mobilik	Marine debris, marine pollution
	Universiti Malaysia Terengganu (Microplastic Research Interest Group)	Wan Mohd Afiq Wan Mohd Khalik Yusof Shuaib Ibrahim Sabiqah Tuan Anuar	Largely marine debris, microplastics, monitoring, marine pollution, environmental analysis, microplastic ingestion
PHL	Davao Oriental State College of Science and Technology	Neil Angelo Abreo	Marine plastic, monitoring, marine pollution, microplastic ingestion
SGP	National University of Singapore	-	Marine pollution, ALDFG, microplastics, surface attachment to biota, plastic toxicity impacts
THA	Chulalongkorn University	-	Marine plastic debris, marine plastic ingestion
	Burapha University Chanthaburi Campus	-	Microplastic ingestion
	Prince of Songkla University	-	Marine plastic debris, marine plastic ingestion
	Mahidol University	-	Marine plastic pollution
	Ministry of Natural Resources and Environment - Department of Marine and Coastal Resources (DCMR)	-	Marine plastic ingestion
VNM	Ho Chi Minh City University of Technology	-	Marine plastic debris in riverine systems
CHN	Education University of Hong Kong	Lincoln Fok	Plastic pollution, waste treatment and management, public education in Hong Kong

	East China Normal University	Huahong Shi	Microplastics, aquatic toxicology, plastic pollution (associated chemicals), plastic ingestion
ROK	Korea Institute of Ocean Science and Technology (KIOST) - Oil and POPs Research Group	Won Joon Shim Sang Hee Hong	Microplastics, marine debris, monitoring, plastic pollution (associated chemicals), plastic ingestion
	Korea University of Science and Technology and Our Sea of East Asia Network (OSEAN)	Jongmyong Lee Sunwook Hong	Marine debris, microplastics, monitoring, marine pollution
	Korea University	Jung Hwan Kwon	Desorption modelling of chemicals from plastics
	Pukyong University	-	Marine debris, monitoring, marine pollution, modelling and tracking
	Korea Maritime Institute	-	Marine debris, impact, management, fishing gears, ALDFG
	Konkuk University	-	Microplastics, polymer-specific toxicity impact,
	Incheon University	-	Microplastics quantification
JPN	Tokyo University of Agriculture and Technology	Hideshige Takada	Marine plastic pollution (associated chemicals)
	Kyushu University	Atsuhiko Isobe	Forecasting the quantity and movement of plastic debris around Japan water
	Ehime University	Hirofumi Hinata	Accumulation zones and hotspots, movement of plastics in water bodies
	National Institute for Land and Infrastructure Management	Tomoya Kataoka	
International	Fauna & Flora International (FFI)	-	Marine and Coastal Conservation Programme (Cambodia)
		-	Project in Cambodia 'Tackling plastic pollution for communities and coral reefs in coastal Cambodia'
	United Nations Development Programme (UNDP)	-	Project in Cambodia: 'Combating Plastic Pollution in Cambodia'