A review of research on marine plastics in Southeast Asia:

Who does what?

Youna Lyons, Theresa Linting Su and Mei Lin Neo

May 2019

Acknowledgements

Realisation of this report has been permitted by funding from the UK Department for Business, Energy and Industrial Strategy (BEIS) 'Global Partnerships Fund' and the UK Science and Innovation Network at the British Commission in Singapore, as well as support from the research institutions of the authors and the Advisory Committee on Protection of the Sea (ACOPS).

Authors Mei Lin Neo and Theresa Linting Su also acknowledge the National Research Foundation, Singapore for supporting their work at the St John's Island National Marine Laboratory. We thank Pavarne Shantti for her assistance in putting together the report. Special thanks also to the valuable comments and inputs from Jade Chung, Karen Raubenheimer and Sam Shu Qin.

Any enquiries regarding this publication should be sent to us at:
younalyons@nus.edu.sg.

For bibliographic purposes, this document may be cited as: Y Lyons, Theresa Su and Mei Lin Neo, A review of research on marine plastics in Southeast Asia: Who does what? 2019. Available at https://www.gov.uk/government/publications/a-review-of-research-on-marine-plastics-in-sea-who-does-what.

Contents

Executive Summary

Scope

The scope of this review is marine pollution from marine plastic in Southeast Asia with a focus on the ten ASEAN member states: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam. The aim is to provide a regional overview of marine plastics research in Southeast Asia. This includes a review of the current knowledge on pollution from marine plastic in ASEAN member States, of recent marine scientific plastics research about Southeast Asia and of research interest on this topic by international and regional intergovernmental bodies and initiatives interested in marine plastics. The data and analysis included in the report are the result of several years of work by National University of Singapore (NUS) on marine plastic pollution in Southeast Asia, completed with rigorous consultation of relevant scientific databases, journals and internet research.

Methodology and analysis

The review of scientific research in each ASEAN member state shows an important variation in efforts expended in each, in methods used and in research focus. Indonesia displayed attempts to understand more aspects of the marine plastics problem than all other Southeast Asian countries. It is the only country which, with the assistance of the WorldBank tried to identify hotspots and accumulation zones of marine plastics. The most common research focus across the countries is to survey and monitor the level of plastic pollution in the coastline or in the waters. Results also showed that the examinations of the ecological and environmental impacts of marine plastics are of interest to many countries. The literature search also showed that some research topics are reported more readily in grey literature and less in research publications, such as the quantification of macroplastics in general, compared to the quantification of microplastics. For the sampling of plastics in the marine environment, sediment or substrate sampling is the most common, which may be attributed to coastal (intertidal) sampling. Quantification of the amount of plastics in or on marine organisms appears to be often opportunistic.

The review also analysed research interest by 10 regional and 9 international intergovernmental bodies with a particular focus on pollution by marine plastics as well as 13 governmental and non-governmental organisations, research centres and initiatives with a focus on marine plastics in Southeast Asia. Research interest was assessed with respect to 20 research topics on marine plastics pollution from three categories: (1) discharge or leakages of plastics into the coastal and marine environment, (2) methodologies for and study of their ecological, environmental and socio-economic impacts, and (3) treatment of pollution by education and outreach, law and policy, including action plans, guidelines and standards.

Several main points can be noted from this comparative analysis:

- ASEAN governments are concerned with pollution by marine plastics and are pushing for a better understanding of the issues. Research activity is therefore recent and still at an early stage;
- Among the regional bodies, COBSEA stands out as the regional body with the most developed action plans and documents with respect to marine plastics;
- The topic of highest shared interest overall is upstream research and waste management, including the development of the circular economy;
- Several intergovernmental bodies emphasize the importance of a risk approach;
- Among non-governmental efforts, Ocean Conservancy stands out as one of the organisations with the greatest breadth and involvement in the region;
- NGOs and independent research centres play a particularly important role with respect to public outreach and language and cultural barriers where regional and global research interest is markedly lower;
- Natural science research is lagging behind the interest of international and regional bodies and initiatives in 3 research topics: monitoring and assessment methodologies, accumulation zones and fragmentation; and,
- Interestingly, the interest of natural scientists in microplastics exceeds that of international and regional bodies and initiatives.

Recommendations

A risk approach has been followed in the identification of the following recommendations.

Primary recommendations

- Surveys and monitoring
- Accumulation zones & Hotspots
- Source differentiation
- Ecological and environmental impact
- Contribution of fisheries/Lost and abandoned fishing gear

Secondary recommendations

- Methodology for the monitoring and assessment of marine litter
- Contribution from rivers/river basin management
- Fragmentation and degradation

1 Introduction

1.1 Scope of work

The aim of this report is to provide a regional overview on the current knowledge in marine plastics research, the frameworks and policies guiding marine plastics research, and possibly recommend where research will be most useful. The scope of this work is marine pollution from marine plastic in Southeast Asia with a focus on the ten Association of Southeast Asian Nations (ASEAN) member states: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Viet Nam. This report is both a review of research and a research guide on marine plastics in Southeast Asia for anyone who has an interest in the topic and needs to understand who does what at regional and international levels as well as in academia. It seeks to be as comprehensive as possible within this scope. However, it is not exhaustive as it does not seek to identify all the private actors involved in marine plastics in ASEAN member states. Such an analysis would be a useful complement to this report, especially if it was to be done with comparable analytical frameworks, units and categories of reference.

As acknowledged throughout this report, marine plastics are the subject of numerous research initiatives and political attention in a large number of private and public institutions. The status of knowledge and the state of play are therefore evolving fast so that, to remain current, this report will need updating. This version 1 is based on information available as of 1st May 2019. Stakeholders of these issues and users of the report are welcome to provide feedback and updates to younalyons@nus.edu.sg. The authors would be keen to work on a version 2 of this report so that it can continue to provide a research guide for research in this field in Southeast Asia, if regional players support this.

1.2 Framing of this review within research fields on marine plastics

Research on marine plastics includes a variety of topics. We have set out below an outline of the main research areas on marine plastics. We have used this ‘checklist’ as a guide to determine which of these topics has received research attention in Southeast Asia. However, the ‘checklist’ does not rank issues according to their respective importance or urgency. The review showed that whereas the research reviewed includes all the categories below, it does not include all sub-topics.

Marine plastic from waste

- Composition of plastics in solid waste generated
- Collection and sorting efforts (including port waste reception facilities)
- Recycling and trade in plastic waste
- Source differentiation: land leakage, rivers, coastal, sea-based sources
- Abandoned, lost or otherwise discarded fishing gear (ALDFG)

Distribution, abundance, identification and fate of marine plastic

- Standardising methodologies – constructing internationally accepted categories and analysis approaches

- Survey and monitoring (e.g., distribution, abundance, type) in different environs (e.g., coastal, water surface, water column, seafloor, sediment, biota)
- Optimizing the extraction procedures and identification methods
- Deposition, accumulation, hotspots, transportation and movement (e.g., numerical models)
- Building a marine plastics data platform (e.g., fingerprint repository for microplastics, marine plastic debris abundance and distribution)
- Removal and recyclability of marine plastics
- Degradation and fragmentation (e.g., rates, mechanisms, products)

Impact of marine plastic on the environment

- Uptake, egestion, assimilation, accumulation and transfer of ingested plastics by marine organisms
- Occurrence of plastics across taxa and trophic levels
- Effect on particular taxa, communities and ecosystems (e.g., toxicity, productivity, food chain)
- Effect on marine environment (e.g., physical, chemical, level of absorption)
- Marine plastics as a vector/pathway for pathogens and toxic components (e.g., microbes, additives and Persistent Organic Pollutants [POPs])
- Monitoring of impact on marine ecosystems (e.g., numerical models)

Socio-economic impact of marine plastic

- Economic loss (e.g., plastic in fishing gear, threat on tourism)
- Food security
- Human health
- Plastic as a vector/pathway for pathogens

Upstream production – manufacture and use of plastic

- Development of new polymers
- Ban on specific polymers: manufacture, import or use
- Limitation in use (i.e., specific polymers for specific application, for example include packaging)
- Trade regulations
- Impact on international trade

Governance and regulation of marine plastic at international and regional levels

- Circular Economy is another way to frame research on this topic that overlaps with at least some of the categories listed above.
- Capacity building on any of these topics

1.3 Background facts on marine plastics in Southeast Asia

Marine plastics are defined as the synthetic or semi-synthetic polymers and associated additives that entered the ocean and the surrounding marine habitats. Due to the many forms of plastics, they can be found on the seabeds, in the water column, on the water surface or along the coastlines. The non-biodegradable nature of plastics means that the pollution problem brought about by marine plastics will persist in the environment leading to various repercussions.

The region of Southeast Asia is one of the main contributors to the amount of marine plastics that are found in the environment globally. In a 2010 estimate, six ASEAN member states are listed in the top 20 countries that mismanages their waste, resulting in plastic leakage into the oceans (see Table 1; Jambeck et al., 2015). Together with China, Indonesia, the Philippines, Thailand, and Viet Nam were responsible for more than half of the plastics entering the oceans (Ocean Conservancy, 2015).

Table 1: Six out of the 10 ASEAN member states (in bold text) are ranked in the top 20 among 192 coastal countries that mismanaged plastic waste in 2010. ppd, person per day; MMT, million metric tonnes. (Table adapted from Jambeck et al., 2015).

Rank	Country	Waste generation rate (kg/ppd)	Plastic waste (%)	Mismanaged waste (%)	Plastic marine debris (MMT/year)
1	China	1.1	11	76	1.32–3.53
2	Indonesia	0.52	11	83	0.48–1.29
3	Philippines	0.5	15	83	0.28–0.75
4	Viet Nam	0.79	13	88	0.28–0.73
5	Sri Lanka	5.1	7	84	0.24–0.64
6	Thailand	1.2	12	75	0.15–0.41
7	Egypt	1.37	13	69	0.15–0.39
8	Malaysia	1.52	13	57	0.14–0.37
9	Nigeria	0.79	13	83	0.13–0.34
10	Bangladesh	0.43	8	89	0.12–0.31
11	South Africa	2	12	56	0.09–0.25
12	India	0.34	3	87	0.09–0.24

Rank	Country	Waste generation rate (kg/ppd)	Plastic waste (%)	Mismanaged waste (%)	Plastic marine debris (MMT/year)
13	Algeria	1.2	12	60	0.08–0.21
14	Turkey	1.77	12	18	0.07–0.19
15	Pakistan	0.79	13	88	0.07–0.19
16	Brazil	1.03	16	11	0.07–0.19
17	Myanmar	0.44	17	89	0.07–0.18
18	Morocco	1.46	5	68	0.05–0.12
19	North Korea	0.6	9	90	0.05–0.12
20	United States	2.58	13	2	0.04–0.11

Contribution of rivers to marine plastics is also particularly high in Southeast Asia. Mismanaged plastic waste enters the oceans through the numerous riverine systems in Indonesia, the Philippines, Myanmar, Thailand, Cambodia, Lao PDR and Viet Nam (see Fig. 1; Lebreton et al., 2017). Frequent occurrences of flooding and tropical storms also contribute to large run-offs of land-based waste that includes plastics.

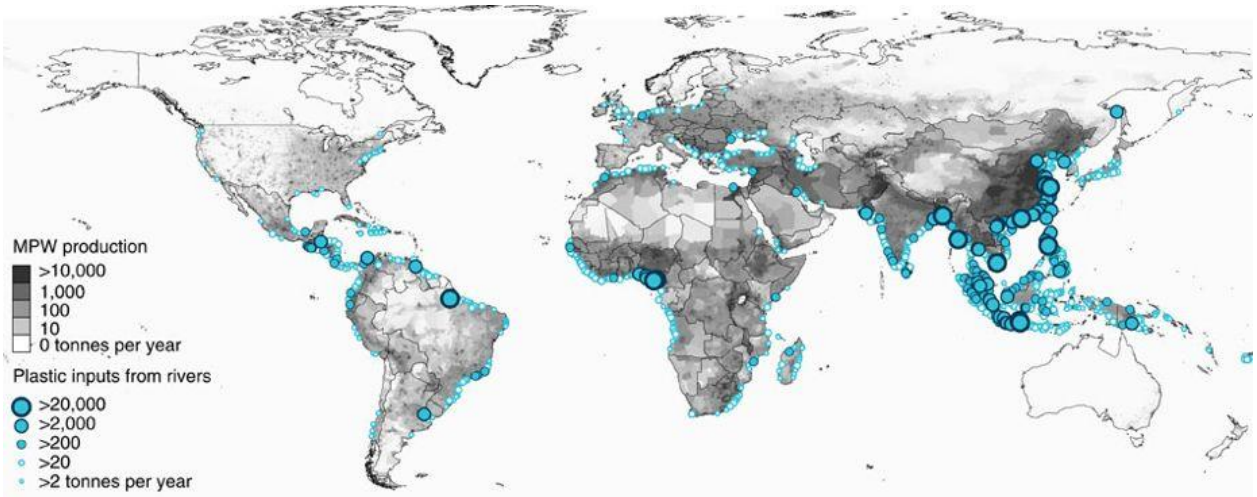

Figure 1: Marine plastic inputs from the riverine systems. MPW: mismanaged plastic waste. Taken from Lebreton et al. (2017).

This data contributes to the narrative widely shared by news and social media that ‘more than half of the plastic that pollutes oceans originates from eight Asian countries.’ However this misleading statement does not reflect:

1. The share of plastics found in Southeast Asia that in fact originates from western countries (including from Europe, America and Australia); or

2. The difference in plastic concentration in the sea bodies of Southeast Asia compared to other parts of the world.

Data on the extent of marine pollution is generally insufficient in Southeast Asia, as well as the understanding of the problem is still rudimentary. The first part of this report examines the status of research on this topic in ten countries of Southeast Asia.

The sudden emergence of marine plastic pollution as a critical issue globally resulted from the view by policy makers and the public that it is a global environmental crisis. This approach has resulted in the launch of numerous initiatives. The trans-sectoral nature of the issues, from source, pathway and impact perspectives, has further expanded the number of institutions concerned and involved in such initiatives, at global and regional levels. This review outlines the most important initiatives at global, regional, governmental and non-governmental levels that are relevant to Southeast Asia. Given ongoing activity in this field of research, current knowledge, as well as initiatives at the global, regional and national levels are constantly evolving.

1.4 Methodology

To gain an understanding of the current research conducted in Southeast Asia on marine plastics, a combination of the following keywords “marine plastic”, “marine plastics”, “plastic”, “plastics”, “research”, “ASEAN”, “<country name>” was entered in major literature databases such as Google Scholar, JSTOR, PubMed, ScienceDirect, AFSA and Web-of-Science. Retrieved information may be in the forms of peer-reviewed publications, proceedings, dissertations, books, manuals, technical reports and reports of intergovernmental meetings and working groups. Earlier work on marine debris (before 2000) were omitted as marine plastics research has since evolved greatly. From here, we contacted relevant scientists in the region and disseminated an online survey to advise on research projects and programmes that may be ongoing or unpublished. Science communicated through fora, symposia, and conferences is also included in the review. Work done on marine plastics by intergovernmental organisations and other international and regional institutions has been reviewed on the basis of the authors’ professional knowledge of these networks and further research on the web of the most recent work completed by these organisations and institutions. This includes political, legal, and grey literature as well as websites. It is important to note that all reviewed material are written in the English language. Additional review of literature published in the language of each ASEAN member state would be necessary to gain a full picture of the research carried out regionally.

The information is presented in four sections: (1) marine plastic research in each ASEAN member state, (2) regional programmes and research undertaken by regional institutions, (3) other intergovernmental policy frameworks, guidelines and initiatives relevant to Southeast Asia, and (4) notable non-institutional research programmes and public-private initiatives involving the region.

This report includes the most visible research projects and programmes developed on this topic. However, the authors are aware of several private initiatives with a lighter internet footprint, which they only knew about by word of mouth. Given the time and budget constraints, algorithm-based internet mining for mapping such activity could not be used. The report does not include a comprehensive review of industry and civil society initiatives.

2 Marine plastic research in each ASEAN member state

The ten member states in the ASEAN are examined individually to identify their efforts made into marine plastics research. A brief profile of solid waste generation, the amount of plastics as a proportion of solid waste and plastic waste management strategies are presented for each country. Each country's contribution to marine plastic research is also analysed.

The areas of research conducted are sorted into the following categories:

Survey and monitoring

Research that surveys and monitors the amount of marine plastics in the environment is the first step to understanding the current situation in the country. This category of projects typically involves the quantification and identification of either macro- and microplastic types. The resolution of these research is varied, as it is dependent on the motivation behind the work, e.g, high resolution of the information gathered from scientific sampling of microplastics on coastal sediment surface, or lower resolution of the amount of marine plastic debris (e.g., number of item type) collected through citizen science beach clean-up programmes. The latter research is also typically reported in grey literature.

Source differentiation

Investigating the sources of marine plastics brings insight to the mismanagement of plastic waste resulting in the leakage into the environment. Some sources of marine plastics include land- or sea-based leakage, through the riverine system, runoffs due to flooding, etc.

Hotspots

Examining hotspots of marine plastics generally involves data mining survey and monitoring programmes of marine plastics and possibly generating a hotspot map through numerical modeling. The resulting information shows areas where marine plastics occur in large amounts and the sources that feed into these accumulation zones.

Ecological and environmental impacts

The impacts of marine plastics can be examined both in the field or through laboratory experiments. Some of these work may be opportunistic, due to events like the beaching of large mammals or marine organisms on the shore, that permits the post-mortem examination of gut contents.

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

Abandoned, lost or otherwise discarded fishing gear (ALDFG) is a source of marine plastics. However, it has a category on its own as the fishing industry in the Southeast Asian region is largely dependent on such gear.

The main players in plastic research are determined based on the available published literature identified for each country. The knowledge gaps pertaining to each country are reported. Lastly, fora, symposia or conferences hosted in the country for the communication of marine plastics research are presented.

2.1 Brunei Darussalam

2.1.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Brunei Darussalam was estimated at 247 tonnes a day, at 0.87 kg per capita per day, and projected to increase to 554 tonnes a day at 1.30 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012). The bulk of the solid waste ends up in the six landfills in Brunei. The landfill at Sungei Paku, in the Tutong District collects 400-500 tonnes of waste everyday (Department of Environment, Parks and Recreation, 2015).

Plastics as a proportion of solid waste

Estimates showed that Brunei will generate more than 4.5 million tonnes of waste by 2024, of which plastic makes up 20% (Progresif, 2018). When poorly managed, these plastics may find their way into the river streams and end up as marine debris.

Plastic waste management

Increasing attention is spent on the reduction and management of solid waste. Zero waste strategies are put forth in Shams et al. (2014) that addresses the upstream problems of marine plastics. For example, the use of polythene bags by retailers are restricted from Fridays to Sundays since 2011, while the use of plastic bags in major supermarkets is targeted to phase out by 2019 (ASEAN Secretariat News, 2018).

2.1.2 Status of understanding of extent of pollution from marine plastic

Currently, there is little information about marine plastic research conducted in Brunei.

Published work/ Research team	Study period	Scope of Work
Qaisrani et al. (2016)	Information unavailable	Quantifying and identifying debris entering the Kedayan River, Brunei

Survey and monitoring

Qaisrani et al. (2016) trapped and extrapolated that approximately 230 kg of plastic debris flows within the Kedayan River annually in dry weather. Under wet conditions, the amount of plastic increases exponentially to approximately 5,600 kg per year due to surface runoff. From April to May 2018, over 20,000 bags comprising plastic bottles and bags were collected from the Brunei River (Progresif, 2018).

Source differentiation

There is no published study on the source differentiation of marine plastics.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

There is no published study on the ecological and environmental impacts of marine plastics.

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

There is no published study on abandoned, lost or otherwise discarded fishing gear.

2.1.3 Main players in marine plastic research

No players were identified.

2.1.4 Gaps

Little is known about the current status of marine plastic pollution in Brunei. It is recommended to survey, monitor and identify sources and hotspots of marine plastics. To permit regional comparisons, it will be critical to standardise the methodologies to that employed in studies conducted thus far in the other ASEAN member states.

2.1.5 Fora/symposia hosted

Brunei Darussalam has not hosted any forum or symposium related to marine plastics research.

2.2 Cambodia

2.2.1 Context

Solid waste generation

The municipal solid waste of Phnom Penh, the capital city of Cambodia is estimated at 0.73 kg per capita per day across a population of 15.39 million people (Provincial Department of Planning, 2015).

Plastics as a proportion of solid waste

Plastics account for the second largest proportion of the waste generated in Phnom Penh, at 20.9% (Seng et al., 2015). The consumption rates of single-use plastic bags in Phnom Penh measures at 10 million pieces daily; individuals in urban areas use more than 2,000 plastic bags annually (Fondazione ACRA, 2016).

Plastic waste management

Fondazione ACRA, a non-governmental organisation based in Italy, launched a campaign to raise awareness on plastic alternatives (from 2014-2017, valued at 1,341,033 €, funded by the European Union), and collaborated with the Cambodia's Ministries of the Environment, Home Affairs, Finance and Tourism to draft a bill for regulatory charges on plastic bags (Fondazione ACRA, 2016). Cambodia was also listed as one of the countries for Fauna & Flora International (FFI)'s work (see Section 5.2.1) on combating marine plastics (Entwistle et al., 2018).

2.2.2 Status of understanding of extent of pollution from marine plastic

Currently, there are no published records of marine plastic research conducted in Cambodia.

Survey and monitoring

Preliminary work in the Koh Rong Archipelago showed that plastic bottles are a major component of the plastic entering Cambodian waters, amongst food packaging, disposable cutlery, straws and fishing gear (FFI, unpublished work).

Source differentiation

There is no published study on the source differentiation of marine plastics.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

There is no published study on the ecological and environmental impacts of marine plastics.

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

There is no published study on abandoned, lost or otherwise discarded fishing gear.

2.2.3 Main players in marine plastic research

The research on marine plastics reported in Cambodia so far is conducted by Fauna & Flora International, an international NGO. The Coastal and Marine Conservation Programme identifies strategies for minimising marine plastic waste, conducts plastic waste research, and stakeholder meetings in Phnom Penh and coastal areas.

2.2.4 Gaps

Little is known about the current status of marine plastic pollution in Cambodia. It is recommended to survey, monitor and identify sources and hotspots of marine plastics. To permit regional comparisons, it will be critical to standardise the methodologies to that employed in studies conducted thus far in the other ASEAN member states.

2.2.5 Fora/symposia hosted

Cambodia has not hosted any forum or symposium related to marine plastics research.

2.3 Indonesia

2.3.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Indonesia was estimated at 61,644 tonnes a day, at 0.52 kg per capita per day, and projected to increase to 151,921 tonnes a day at 0.85 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012).

Plastics as a proportion of solid waste

Plastic composition of solid waste was estimated at 11% to 15% in Indonesia (Hoornweg and Perinaz, 2012; Jambeck et al., 2015; Shukar and Cadman, 2018).

Plastic waste management

Out of the 3.22 million tonnes of mismanaged waste in 2010, an estimate of 0.48 to 1.29 million metric tonnes of plastics leaked into the marine environment annually (Jambeck et al., 2015). The Indonesian government is committed to a goal of 70% reduction in marine plastic by the year 2025 through the Indonesia's Plan of Action on Marine Plastic Debris 2017-2025 (Coordinating Ministry for Maritime Affairs, 2018).

2.3.2 Status of understanding of extent of pollution from marine plastic

Indonesia has the most extensive information on marine plastics research in the region. Following Jambeck et al. (2015)'s estimation of Indonesia as the second biggest contributor of plastics leaking into the oceans, there is increasing attention on this research topic, its upstream effectors, downstream impacts and possible solutions. The priorities for microplastic research can be seen in beach macro-litter monitoring, microplastic monitoring in the environment, co-pollutants, microplastic ingestion by marine organisms and community empowerment. For an overview of "marine microplastic research in Indonesia", refer to Syakti (2017).

Published work/ Research team	**Study period**	**Scope of Work**
Akhir and Wisz *	Information unavailable	Literature review of marine plastic litter in tourism destinations with technological interventions
Alam et al. (2019)	2017	Quantifying microplastic from the surface water and sediment samples at slum and industrial area of Ciwalengke River, Majalaya district, Indonesia
Cordova and Riani *	2015-2018	Quantifying and identifying microplastics in Green mussel, Perna viridis
Cordova and Wahyudi (2016)	2015	Quantifying microplastics in deep-sea sediments (depths of 66.8 to 2182 m)
Cordova et al. *	2015-2017	Quantifying microplastics in waters and sediments nationwide in Indonesia
Handyman et al. (2019)	2015	Modelling to identify the microplastic transport of North Indramayu, Java Sea
Ismail et al. (2018)	2017	Quantifying microplastic debris in gut contents of fishes caught by fishermen
IU–IOC Westpac 2017 Summary Report	2016, 2017	Quantifying microplastics in water, sediment, biota, and beaches
IU–IOC Westpac 2017 Summary Report	Information unavailable	Quantifying marine debris
Manalu et al. (2017)	2015, 2016	Quantifying and identifying microplastics in coastal sediment samples
Manullang (2017)	2017	Assessment of marine pollution research in the Banda Sea
Nordén and Karlsson (2018)	2018	Modelling the placement of booms to clear marine plastics using Jakarta Bay as a pilot study
Purba and Pranowo *	2012- 2018	Review of marine debris in Indonesia

Published work/ Research team	Study period	Scope of Work
Purba et al. (2017)	2013, 2014	Quantifying and identifying marine debris using the global International Coastal Cleanup (ICC) Network
Purba et al. (2018a)	2018	Quantifying and identifying macro debris in Savu Sea Marine National Park
Purba et al. (2018b)	2016-2017	Quantifying and identifying macro plastics at Pangandaran Beach, Indonesia
Ramos et al. (2018)	2016	Modelling microplastic movement patterns of Pacific Garbage Patch into the north of Indonesia Seas
Richardson et al. (2018)	Information unavailable	Identifying reasons for loss and abandonment of fishing gear from interviews with Australian and Indonesian fishermen
Rochman et al. (2015)	2014	Quantifying microplastics from fishes and shellfish from Makassar, Sulawesi, Indonesia and Half Moon Bay, California, USA
Syakti (2017)	Information unavailable	Reviewing methods for microplastics extraction, quantification, and identification
Syakti et al. (2017)	2013-2015	Quantifying plastic debris from beach litter and floating microplastics; identifying microplastics using Fourier transform infrared (FTIR) spectroscopy
Syakti et al. (2018)	Information unavailable	Quantifying and identifying microplastics in Bintan Regency, Riau Island Province, Indonesia
Syakti et al. *	Information unavailable	Impact of microplastics on hard coral Acropora formosa

* unpublished work.

Survey and monitoring

There are a number of published research which aims to quantify the amount of plastics in the marine environment, along the coast (Syakti et al., 2017; Purba et al., 2018a, 2018b), on the sediment surface (Willoughby et al., 1997; Manalu et al., 2017; Alam et al., 2019), on the water surface (Syakti et al., 2018; Alam et al., 2019) and even in the deep sea environment (Cordova and Wahyudi, 2016).

Source differentiation

In addition to sources like leakage from land and abandoned fishing gear, the potential of plastics from the open waters to enter Indonesian waters was examined. A model by Ramos et al. (2018) stated that plastics from the Pacific Garbage Patch is unable to enter Indonesian waters. In contrast, Handyman et al. (2019) showed that microplastics currently in the Java Sea may be brought in from the South China Sea and Pacific Oceans through hydrodynamic modeling.

Hotspots

According to the Marine Debris Hotspot Rapid Assessment, city waterways have an average plastics composition of 20% to 38% (Shukar and Cadman, 2018), with the potential to leak out to the seas. Nordén and Karlsson (2018) developed a model to identify hotspots where booms should be placed to trap plastics in waterways, and their pilot study was to simulate capture rates in Jakarta Bay. Handyman et al. (2019) indicated that the Java Seas have a high probability to host the largest patch of microplastics in Indonesia.

Ecological and environmental impacts

The impact of marine plastics were examined through the quantification in or on marine organisms like green mussel (Cordova and Riani, unpublished work), fishes (Ismail et al., 2018; Rochman et al., 2015), shellfish (Rochman et al., 2015) and coral (Syakti et al., unpublished work).

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

Richardson et al. (2018) conducted interviews with fishermen to understand the circumstances that gave rise to loss and abandonment of fishing gear which becomes a source of marine plastics.

2.3.3 Main players in marine plastic research

The governmental authority for research and science, the Indonesian Institute of Sciences, also known as Lembaga Ilmu Pengetahuan Indonesia (LIPI), is very active in the research of marine plastics. Research teams like that of Cordova, Syakti and Purba from various Indonesian universities are equally involved in marine plastics work.

2.3.4 Gaps

Despite the amount of work conducted in Indonesia to understand marine plastics, there is a lack of standardised protocols for detection, sampling and extraction of plastics. Thus, further analyses, comparisons and syntheses may not be possible.

2.3.5 Fora/symposia hosted

International Conference on Marine Plastic Pollution Prevention and Management (2018)

This conference brought together academics, researchers and scholars to share about marine plastic pollution.

2.4 Lao PDR

2.4.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Lao PDR was estimated at 1,342 tonnes a day, at 0.70 kg per capita per day, and projected to increase to 4,154 tonnes a day at 1.10 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012).

Plastics as a proportion of solid waste

Of the 500 tonnes of solid waste generated in Vientiane each day, 6.1% is accounted for by plastics (Climate and Clean Air Coalition, 2015).

Plastic waste management

There is little information on marine plastic in Lao PDR and plastic waste is typically discussed with solid waste management. As a landlocked nation, the country may not be proximately exposed to the effects of marine plastics. However, the waterways of Mekong River are important pathways from which plastic materials enter the South China Sea.

2.4.2 Status of understanding of extent of pollution from marine plastic

Currently, there are no published records of marine plastic research conducted in Lao PDR.

Survey and monitoring

There is no published study on survey and monitoring of marine plastics.

Source differentiation

There is no published study on the source differentiation of marine plastics.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

There is no published study on the ecological and environmental impacts of marine plastics.

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

There is no published study on abandoned, lost or otherwise discarded fishing gear.

2.4.3 Main players in marine plastic research

No players were identified.

2.4.4 Gaps

Little is known about the current status of marine plastic pollution in Lao PDR. It is recommended to survey, monitor and identify sources and hotspots of marine plastics. To permit regional comparisons, it will be critical to standardise the methodologies to that employed in studies conducted thus far in the other ASEAN member states.

2.4.5 Fora/symposia hosted

Lao PDR has not hosted any forum or symposium related to marine plastics research.

2.5 Malaysia

2.5.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Malaysia was estimated at 21,918 tonnes a day, at 1.52 kg per capita per day, and projected to increase to 51,655 tonnes a day at 1.90 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012).

Plastics as a proportion of solid waste

In Kuala Lumpur, plastics rank second by composition for solid waste generated, at 11.45% after organic waste in 2000 (Saeed et al., 2009).

Plastic waste management

Through the 2005 National Strategic Plan for Solid Waste Management, the Malaysian Government aims to set overall waste reduction and recovery at 17% and the recycling target for plastic at 20% by 2020.

2.5.2 Status of understanding of extent of pollution from marine plastic

There are some published work on marine plastics research conducted in Malaysia, however, it remains the interest of a subset of the scientific community.

Published work/ Research team	**Study period**	**Scope of Work**
Anuar et al. *	Information unavailable	Quantifying and identifying microplastic ingestion by cage-farmed and wild caught Holothuria scabra
Barasarathi et al. (2014)	2014	Quantifying microplastics in a mangrove forests with emphasis on those isolated from anthropogenic activities
Fauziah et al. (2015)	Information unavailable	Quantifying plastic debris buried in sand at selected beaches
Horcajo-Berná et al. *	2017	Quantifying plastics from digestive tract during turtle necropsy and marine plastic collection at Tioman Island
Ibrahim et al. (2016)	2014	Quantifying microplastics found in bivalve (Scapharca cornea) from Setiu Wetlands
Ibrahim et al. (2017)	2016	Quantifying microplastics in wild and cage-cultured Asian sea bass (Lates calcarifer) from Setiu Wetlands
Karami et al. (2017a)	Information unavailable	Quantifying microplastics in commercial salts
Karami et al. (2017b)	Information unavailable	Quantifying microplastics in edible fish tissues
Karami et al. (2018)	Information unavailable	Quantifying microplastics in processed seafood for human consumption
Khalik et al. (2018)	2015	Quantifying microplastics in water samples from Kuala Nerus and Kuantan port
Noik and Tuah (2015)	2013, 2014	Quantifying microplastics on sandy beach
Prakash et al. *	2018	Quantifying and identifying marine plastic debris in Johor Marine Park

* unpublished work.

Survey and monitoring

The quantification of marine plastics are conducted in mangrove forests (Barasarathi et al., 2014), sandy beaches (Fauziah et al., 2015; Noik and Tuah, 2015), in the water of ports

(Khalik et al., 2018), and marine parks (Prakash et al., unpublished work). Comparisons were also made to understand the effect of anthropogenic activities on the amount of plastics sampled (Barasarathi et al., 2014).

Source differentiation

There is no published study on the source differentiation of marine plastics.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

Research efforts were concentrated on the impact of plastics in marine organisms like the sea turtle (Horcajo-Berná et al., unpublished work) and marine derived food products e.g., sea cucumber (Anuar et al. unpublished work), ark shell (Ibrahim et al., 2016), sea bass (Ibrahim et al., 2017), other seafood (Karami et al., 2017b, 2018) and even commercial salt (Karami et al., 2017a). There are a few studies looking at the amounts of microplastics in wild caught and farmed marine organisms (Anuar et al., unpublished work; Ibrahim et al., 2017), which may be reflective of the plastics in the open waters versus that in the coastal waters.

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

There is no published study on abandoned, lost or otherwise discarded fishing gear.

2.5.3 Main players in marine plastic research

The main players in microplastic research are researchers in the Microplastic Research Interest Group from Universiti Malaysia Terengganu (Khalik WMAWM, Ibrahim YS, Anuar ST, Govindasamy S, Baharuddin NF).

2.5.4 Gaps

Like other countries in the region, despite the amount of work conducted in Malaysia to understand marine plastics, there is a lack of standardised protocols for detection, sampling and extraction of plastics. Thus, the information collected may not be comparable across studies within the country or the region due to these variations.

2.5.5 Fora/symposia hosted

Malaysia has not hosted any forum or symposium related to marine plastics research.

2.6 Myanmar

2.6.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Myanmar was estimated at 5,616 tonnes a day, at 0.44 kg per capita per day, and projected to increase to 21,012 tonnes a day at 0.85 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012).

Plastics as a proportion of solid waste

The composition of plastic in solid waste for Myanmar was estimated at 16% (Hoornweg and Perinaz, 2012).

Plastic waste management

There is not much information with respect to plastic waste in Myanmar. The reduction of plastic use is fronted by Thant Myanmar, a grassroots movement formed in 2018, through campaigns.

2.6.2 Status of understanding of extent of pollution from marine plastic

Currently, there is no published record of marine plastic research conducted in Myanmar.

Survey and monitoring

There is no published study on survey and monitoring of marine plastics.

Source differentiation

There is no published study on the source differentiation of marine plastics.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

There is no published study on the ecological and environmental impacts of marine plastics.

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

There is no published study on abandoned, lost or otherwise discarded fishing gear.

2.6.3 Main players in marine plastic research

No players were identified.

2.6.4 Gaps

Little is known about the current status of marine plastic pollution in Myanmar. It is recommended to survey, monitor and identify sources and hotspots of marine plastics. To permit regional comparisons, it will be critical to standardise the methodologies to that employed in studies conducted thus far in the other ASEAN member states.

2.6.5 Fora/symposia hosted

Myanmar has not hosted any forum or symposium related to marine plastics research.

2.7 Philippines

2.7.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Philippines was estimated at 29,315 tonnes a day, at 0.50 kg per capita per day, and projected to increase to 77,776 tonnes a day at 0.90 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012).

Plastics as a proportion of solid waste

The 2012 World Bank estimate of plastic composition in solid waste for Philippines was estimated at 14% (Hoornweg and Perinaz, 2012). In addition to the usual single-use plastics like shopping bags and food packaging, large amounts of plastic waste is attributed to sachet consumption. Approximately 164 million pieces of sachets are used daily, equivalent to 59.7 billion sachet waste generated annually in the Philippines (Global Alliance for Incinerator Alternatives, 2019).

Plastic waste management

According to reports form WWF-Philippines, the National Solid Waste Management Commission, and the World Bank, 74% of plastic leakage into the waters comes from collected waste. This resulted in the Department of Environment and Natural Resources- Biodiversity Management Bureau (DENR-BMB) ranking marine litter a top priority in coastal and marine projects.

2.7.2 Status of understanding of extent of pollution from marine plastic

There is scant research published on marine plastics in the Philippines. It appears that there is no government funding opportunity with limited research interests. There is a call for more work to be done as the country is dependent on the ecosystem services provided by the marine environment (Abreo, 2018).

Published work/ Research team	**Study period**	**Scope of Work**
Abreo et al. (2015)	Information unavailable	Literature review on the effects of nutrient enrichment, sedimentation, heavy metals and plastic pollution in the marine environment and its implications on marine biodiversity.
Abreo et al. (2016a)	2012	Quantifying marine litter found in the beaked whale, Mesoplodon hotaula, GI tract
Abreo et al. (2016b)	2015	Quantifying marine litter found in green sea turtle, Chelonia mydas, carcasses
Abreo et al. (2018)	2016	Quantification, characterization, and distribution of anthropogenic marine debris in a shallow subtidal area in Mati City, Philippines
Abreo et al. (2019a)	2018	Quantifying marine litter in a whale shark carcasses
Abreo et al. (2019b)	2011-2018	Reviewing social media (FaceBook) for the impact of marine litter on megafauna in the Philippines
Kalnasa et al. (2018)	2018	Quantifying microplastic and beach litter on surface sediments

Published work/ Research team	Study period	Scope of Work
Palermo *	2014-2016	Quantification of microplastics in guts of Bali Sardines

* unpublished work.

Survey and monitoring

Quantification of marine plastics was carried out along the coastline (Abreo et al., 2018) and the first microplastic research was conducted on beach surface sediments in 2018 (Kalnasa et al., 2018).

Source differentiation

There is no published study on the source differentiation of marine plastics.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

The ecological and environmental impacts were assessed through quantifying the amounts of marine plastics ingested by the beaked whale (Abreo et al., 2016), green sea turtle (Abreo et al., 2016), whale sharks (Abreo et al., 2019a) and Bali Sardines (Palermo, unpublished work). A review of photographs on social media showing effects of marine plastics on megafauna was also published (Abreo et al., 2019b)

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

There is no published study on abandoned, lost or otherwise discarded fishing gear.

2.7.3 Main players in marine plastic research

Although marine plastics research is limited in the Philippines, Abreo NAS from Davao Oriental State College of Science and Technology is actively working on the state of marine plastics.

2.7.4 Gaps

Little is known about the current status of marine plastic pollution in the Philippines. It is recommended to quantify, monitor and identify hotspots of marine plastics. To permit regional comparisons, it will be critical to utilise the same units of measures as studies conducted in the other countries thus far.

2.7.5 Fora/symposia hosted

The Philippines has not hosted any forum or symposium related to marine plastics research.

2.8 Singapore

2.8.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Singapore was estimated at 7,205 tonnes a day, at 1.49 kg per capita per day, and projected to increase to 9,187 tonnes a day at 1.80 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012).

Plastics as a proportion of solid waste

The 2012 World Bank estimate of plastic composition in solid waste for Singapore was estimated at 12% (Hoornweg and Perinaz, 2012). It is estimated that people in Singapore use 467 million PET bottles, 820 million supermarket plastic bags and 473 million polypropylene plastics each year (Singapore Environment Council, 2018).

Plastic waste management

In 2017, 7,704,300 tonnes of solid waste were generated. Of which, 815,200 tonnes were plastic and only 6% was recycled (National Environment Agency, 2019). As part of the National Recycling Programme in 2014, dual rubbish chutes designed for refuse and recyclables will be installed in homes while recycling corners are encouraged in schools.

2.8.2 Status of understanding of extent of pollution from marine plastic

There is a basic awareness of marine plastics among the scientific community, but it is not a main research thrust of any marine laboratory currently. Initial work was carried out to understand baseline occurrence of microplastics in Singapore and since 2016, there have been efforts (Symposium, Workshop and Conference) to being local and regional scientists together to discuss the issues of marine plastics and microplastics.

Published work/ Research team	**Study period**	**Scope of Work**
Bhargava et al. (2018)	2016-2019	Assessing the impacts of synthetic nanoplastics on acorn barnacles
Chua et al. (2019)	2015	Assessing the diet and mitochondrial DNA haplotype of a sperm whale (Physeter macrocephalus) found dead off Jurong Island, Singapore
Curren and Leong (2019)	2018	Quantifying microplastics, and profiling communities of bacteria on the surfaces of microplastic particles in Singapore
Leong et al. *	Information unavailable	Quantifying and identifying microplastics in freshwater reservoirs in Singapore
Mohamed Nor and Obbard (2014)	2012	Quantifying the prevalence and concentration of microplastics in Singapore mangroves
Ng and Obbard (2006)	2004	Documenting the presence and quantifying microplastics in Singapore's coastal environment
Ong et al. (2015)	2015	Blacktip reef sharks caught in trammel nets
Ryan (2018)	2014-2018	Literature review quantifying entanglement of birds by marine plastic - Singapore accounted for 2% of entanglement records
Seng et al. *	2018	Quantifying microplastics on seagrasses

Published work/ Research team	Study period	Scope of Work
Sivasothi et al. *	2017-2019	Quantifying microplastics on Singapore shores through citizen science programme
Soto et al. *	Information unavailable	Reviewing the framework of ecosystem services and disservices brought about by marine plastics
Summers et al. *	Information unavailable	Examining how nanoplastics affect bacterial community in marine snow
Toh et al. *	2014-2018	Quantifying and identifying marine plastics through underwater clean ups

* unpublished work.

Survey and monitoring

Currently, there is only one published study on survey and monitoring of marine plastics from Ng and Obbard (2006). However, Singapore has contributed to two large international surveys: International Coastal Cleanup (ICC) and PADI's Project AWARE Dive Against Debris.

The International Coastal Cleanup Singapore is coordinated by Toddycats, volunteers of the Lee Kong Chian Natural History Museum, National University of Singapore (NUS). Using the protocol from Ocean Conservancy, 14,566 kg of trash (195,706 items) was collected across 62 km of coastline. Of which, marine plastic were enumerated: 20,355 cigarette butts, 9,379 food wrappers, 18,238 plastic beverage bottles, 6,564 plastic bottle caps, 4,604 plastic grocery bags, 7,986 other plastic bags, 14,227 straws and stirrers, 3,020 plastic take out/away containers, 1,838 plastic lids, 2,454, foam take out/away containers (Ocean Conservancy, 2018).

As of April 2019, Singapore has collected 9,881 pieces of underwater marine debris under the PADI's Project AWARE Dive Against Debris (Project AWARE, 2019).

Source differentiation

There is no published study on the source differentiation of marine plastics.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

In 2015, an autopsy conducted on a female sperm whale (Physeter macrocephalus) with a fatal caudal wound revealed marine plastic wastes in her gut (Chua et al., 2019).

Acute exposure to nanoplastics showed ingestion, egestion, translocation, assimilation and consequently persistence in developing Acorn barnacles (Amphibalanus amphitrite). In comparison, chronic exposure at low concentrations of nanoplastics demonstrates bioaccumulation in the barnacle nauplii (Bhargava et al., 2018).

A diversity of bacteria was found on the surface of microplastics collected from three beaches in Singapore. The assemblage reported include bacteria that are commonly associated with coral bleaching, have harmful effects on humans (e.g., gastroenteritis and wound infection),

capable of degrading plastic or those that have been used to clean up oil spill (Curren and Leong, 2018).

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

Derelict fishing gear were reported to have impacts on organisms like sharks (Ong et al., 2015), water birds (Ryan, 2018). Other anecdotal reports document the trapping and killing of wildlife like the blue-spotted fantail ray (Taeniura lymma), the black-tipped reef sharks (Carcharhinus melanopterus), the Indo-Pacific hump-backed dolphin (Sousa chinensis) and even terrestrial long-tailed macaque (Macaca fascicularis).

2.8.3 Main players in marine plastic research

The main players in marine plastic research are researchers from the Department of Chemistry, Department of Biological Sciences and Tropical Marine Science Institute (TMSI) of the National University of Singapore (NUS), and the Singapore Centre for Environmental Life Sciences Engineering (SCELSE) from the Nanyang Technological University (NTU). The governmental agency, National Parks Board, has been organising marine plastic outreach, campaigns and educational programmes. Most of these initiatives are co-organised by local universities, interest groups and non-government organisations.

2.8.4 Gaps

Anecdotal report of marine plastics is not peer-reviewed and published. There is lack of standardisation in protocols for detection, sampling and extraction of marine plastics. While the knowledge gap for the effects of microplastics on human health is narrowing, further work is needed to establish the effects of it on our health. There is no nationwide research to understand the impact of marine plastics in the environment, identify hotpots and sources of these plastics. Research funding is lacking.

2.8.5 Fora/symposia hosted

Symposium on Marine Pollution in Singapore and Southeast Asia (2016)

Organised by Lee Kuan Yew School of Public Policy (LKYSPP), NUS, with the goal of presenting the fields of expertise of young scientists in different institutions in Singapore and the region, with a particular focus on plastic waste.

Towards A Plastic-Free Ocean: What Role For Policy Makers, Civil Society And Business (2017)

Co-organised by European Union Delegation to Singapore and the Embassy of the Netherlands in Singapore, this conference facilitated discussions between business, policy makers, non-governmental organisations and civil society on the issue of marine plastics.

Workshop on Plastic Oceans (2017)

Organised by TMSI, NUS, the workshop aims to increase awareness on plastic contamination in Singapore’s marine environment, and the talks cover an introduction to plastics and their effects, and their occurrence in our coastal waters.

International Conference on Plastics in the Marine Environment (2018)

Organised by NUS, SCELSE-NTU, National Parks Board and the UK's Centre for Environment, Fisheries and Aquaculture Science (Cefas), the conference seeks to address the issue of plastic debris in the marine environment, with a special focus on microplastics and the environmental issues facing tropical Southeast Asia.

2.9 Thailand

2.9.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Thailand was estimated at 39,452 tonnes a day, at 1.76 kg per capita per day, and projected to increase to 56,673 tonnes a day at 1.95 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012).

Plastics as a proportion of solid waste

Thailand is one of the main manufacturers and exporters of plastic in Asia with a production capacity of more than 6 million tonnes in 2015 (Wichai-utcha and Chavalparit, 2019). In 2016, the total amount of mismanaged solid waste from coastal provinces was approximately 2.83 million tonnes, of which 12% was plastic. An estimated 15% mismanaged plastic waste (ca. 51,000 tonnes) passes through the Thai waters into the oceans each year.

Plastic waste management

To properly manage solid waste and plastic debris, Thailand established the five-year programme "National Waste Management Master Plan" from 2016 to 2021 and a four-year "Plastic Debris Management Plan" from 2017 to 2021.

2.9.2 Status of understanding of extent of pollution from marine plastic

The current understanding of marine plastics in Thailand from published research appears limited.

Published work/ Research team	**Study period**	**Scope of Work**
Department of Marine and Coastal Resources, Thailand *	2016-2017	Quantifying and identifying the microplastics in beach sediments
Tharamon et al. (2016)	2014	Quantifying and identifying the microplastics in two bivalve species: Danax sp. and Paphia sp.
Thushari et al. (2017)	2015	Quantifying and identifying the microplastics in rock oyster (Saccostrea forskalii), striped barnacle (Balanus amphitrite) and periwinkle (Littoraria sp.)

* unpublished work.

Survey and monitoring

The Department of Marine and Coastal Resources (DMCR), under the Ministry of Natural Resources and Environment, have conducted marine plastics research work along the Thai coastline since 2015. International Coastal Cleanups led by DMCR between 2009 and 2015 documented plastic disposables as the top marine debris.The work expanded to the sampling

and quantification of microplastics, with the establishment of a long term monitoring plan by 2019. However, these information may not be accessible as publication or reports and may possibly be written in the Thai language.

Source differentiation

There is no published study on the source differentiation of marine plastics.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

The impact of microplastics on marine organisms have been studied on sessile marine organisms like bivalves, barnacles and a periwinkle (Tharamon et al., 2016; Thushari et al., 2017). The type of plastic was examined and the accumulation rate in the organism reported.

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

There is no published study on abandoned, lost or otherwise discarded fishing gear.

2.9.3 Main players in marine plastic research

The Department of Marine and Coastal Resources (DCMR) is a key player in the research of marine plastics in Thailand.

2.9.4 Gaps

Despite the amount of work conducted on both macro- and microplastics, the employed methods and gathered results may not be accessible to other researchers. This may lead to a lack of standardisation in protocols for detection, sampling and extraction of microplastics, or even double efforts.

2.9.5 Fora/symposia hosted

WESTPAC Training Workshop on Distribution, Source, Fate and Impacts of Marine Microplastics in Asia and the Pacific (2017)

Organised by IOC Sub-Commission for the Western Pacific (WESTPAC), the workshop serves as a platform for networking, sharing, developing regional capacity, identifying challenges and gaps, and exploring the possibility of joint monitoring for marine microplastics.

ASEAN Conference on Reducing Marine Debris in ASEAN Region (2017)

Organised by the Ministry of Natural Resources and Environment of Thailand in coordination with the ASEAN Secretariat, the conference seeks to bring together relevant stakeholders to for critical information exchange on the issue of marine debris pollution.

2.10 Viet Nam

2.10.1 Context

Solid waste generation

In the 2012 World Bank report, the Municipal Solid Waste for Viet Nam was estimated at 35,068 tonnes a day, at 1.46 kg per capita per day, and projected to increase to 72,909 tonnes a day at 1.80 kg per capita per day by 2025 (Hoornweg and Perinaz, 2012).

Plastics as a proportion of solid waste

The composition of plastic in solid waste was estimated at 16% for Viet Nam (Hoornweg and Perinaz, 2012).

Plastic waste management

Viet Nam was ranked fourth on Jambeck et al.'s (2015) paper in contributing to the increasing amount of ocean plastics through solid waste mismanagement.

2.10.2 Status of understanding of extent of pollution from marine plastic

Currently, there are limited studies on marine plastics in Viet Nam and it does not appear to be the priority.

Published work/ Research team	**Study period**	**Scope of Work**
Lahens et al. (2018)	2015 , 2016	Quantifying macroplastic and microplastic in Saigon River
van Emmerik et al. (2018)	2018	Quantifying and identifying plastic emission from the Saigon River to the ocean and cross checking with estimation models

Survey and monitoring

Both studies by Lahens et al. (2018) and van Emmerik et al. (2018) examined the amount of plastics in the water surface of the Saigon River. The latter study suggests that river emissions of plastics are up to four times higher than that estimated by Lebreton et al. (2017).

Source differentiation

Plastics were sorted into types in Lahens et al. (2008) with high concentrations of fibers and fragments sampled in various colours and shapes.

Hotspots

There is no published study on the hotspots of marine plastics.

Ecological and environmental impacts

There is no published study on the ecological and environmental impacts of marine plastics.

Abandoned, lost or otherwise discarded fishing gear (ALDFG)

There is no published study on abandoned, lost or otherwise discarded fishing gear.

2.10.3 Main players in marine plastic research

No players were identified.

2.10.4 Gaps

There is a lack of awareness on marine plastic issues in Viet Nam. Little is known about the current status of marine plastic pollution in Viet Nam. It is recommended to quantify, monitor and identify hotspots of marine plastics. To permit regional comparisons, it will be critical to utilise the same units of measures as studies conducted in the other countries thus far.

2.10.5 Fora/symposia hosted

Viet Nam has not hosted any forum or symposium related to marine plastics research.

2.11 Regional summary

2.11.1 Comparison of research focus

The efforts expended by the ten member states of ASEAN on marine plastics research are varied in methods and research focus. Coalescing the information gathered, the total literature reviewed in this report is 63, and notable countries with more extensive research are Indonesia, Malaysia and Singapore. Indonesia displayed attempts to understand more aspects of the marine plastics problem than all other Southeast Asian countries (Fig. 2). It is the only country with efforts in trying to identify hotspots and accumulation zones of marine plastics. The most common research focus across the countries is the surveying and monitoring of marine plastics in the coastline or in the waters (Fig. 2). This is logical, since quantifying the plastics is often seen as the first step towards understanding the pollution. Results also showed that the examinations of the ecological and environmental impacts of marine plastics are of interest to many countries (Fig. 2). However, research on impacts tend to skew towards the quantifying of marine plastics within marine organisms. The downstream effects of marine plastics, such as organismal ingestion, accumulation, trophic transfer are less studied, and can further impact communities, habitats and consequently ecosystem functionality.

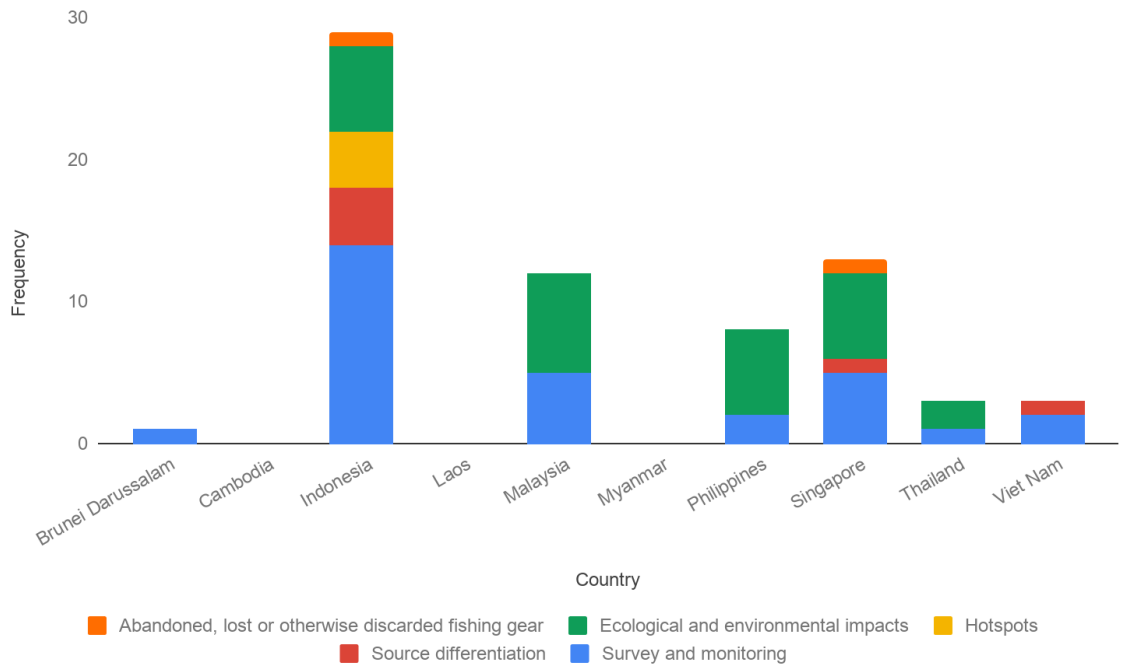

Figure 2: Marine plastics research focus in the ten ASEAN member states (n=63). Some research accounted for more than one category of research focus.

2.11.2 Comparison of methodologies used

To investigate the state of marine plastics in their waters, again Indonesia incorporated the greatest diversity of methods to examine the downstream effects, sources, and hotspots (see Table 2). Sampling and quantifying what is out there are seen as the first steps to make sense of the state of plastic pollution, which explains why they are the most common methods across the ten ASEAN states (Table 2). Plastics identification and monitoring are next in line. Ex situ laboratory experiments and the writing of numerical models for predictions are less common and may be suggestive of more specialised later-stage studies.

Table 2: Methodologies employed in marine plastics research in Southeast Asia

	BRN	KHM	IDN	LAO	MYS	MMR	PHL	SGP	THA	VNM
Review (literature/ social media)										
Sampling										
Monitoring										
Quantification										
Identification										
Laboratory experimental work										
Simulation model										

Legend
Method employed in marine plastics research
Method not employed in marine plastics research

2.11.3 Comparison of macro and micro-plastic research

From the literature search, it appears that quantification of marine plastic debris or macroplastics are reported more readily in grey literature and less in research publications. Nevertheless, there is an equal representation of both macro- and microplastics work in this report (see Fig. 3).

Figure 3: Research efforts on macro- and microplastics in the ten ASEAN member states (n=63). Some research accounted for more than one category of plastic type.

2.11.4 Comparison of plastic sampling

For the sampling of plastics in different parts of the marine environment, sediment or substrate sampling is the most numerous (Fig. 4) which may be attributed to the number of coastline research (focused on the intertidal). The investigation of plastics on the water surface or in the water column is less prominent. Quantifying the amount of plastics in or on marine organisms may be opportunistic, depending on beached marine organisms' carcases. However, it may

gain momentum if the research focus centers on bio-accumulation or toxicity of plastics in marine organisms with potential to impact human health.

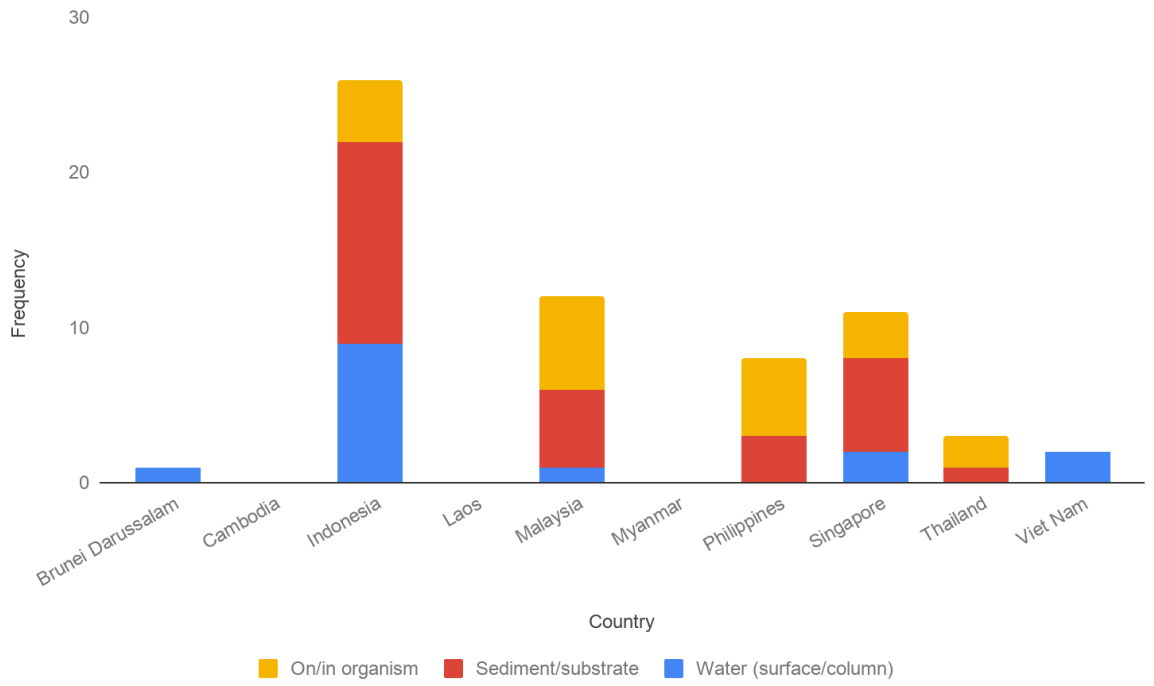

Figure 4 : Marine environs sampled for marine plastics research in the ten ASEAN member states (n=63). Some research sampled in more than one marine environ.

2.11.5 Comparison of research funding

From the literature reviewed, research funding came from either the government (25.8%) or the university (16.1%) from which the work was conducted (see Fig. 5). Only 9.7% and 9.7% of the funding came from private or non-ASEAN sources, respectively (e.g., Japan, Sweden).

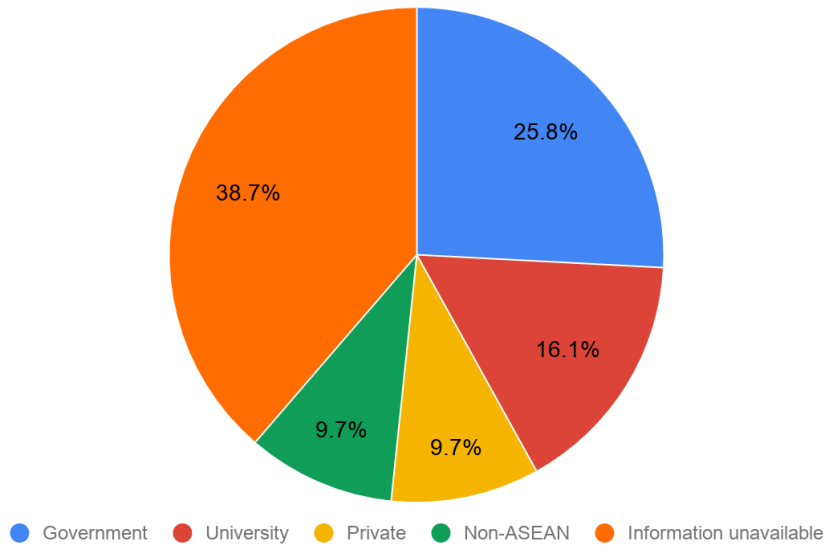

Figure 5 : Research funding sources of the literature reviewed (n=63).

2.11.6 Overall summary

In general, marine plastics research in the ASEAN region is still at an early stage compared to the international scene. The common research thrust of the Southeast Asian countries is to survey and monitor the state of marine plastic pollution. There is also great potential for research on ecological and environmental impacts to expand beyond enumerating plastics within organisms. Processes leading to plastics in the waters like sources of plastic leakage, accumulation zones and hotspots received less attention comparatively. Despite this, it is recommended to examine sources of plastic leakages, paying close attention to contribution from rivers in Southeast Asia. Lastly, efforts are observed within countries but there is no report of regional collaborative work.

3 Regional programmes and research on marine plastic under the auspices of regional institutions and funding agencies

3.1 Chart showing intergovernmental bodies dealing with marine plastics

Chart 2 below

3.2 Programmes, reports and events within the ASEAN

3.2.1 ASEAN Mandate

The Association of Southeast Asian Nations (ASEAN) is a regional cooperative intergovernmental organization. It currently has ten member states: Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Viet Nam. It was established in 1967 and has had its current make-up since 1999. It has a comprehensive institutional structure organised around three pillars:

1. The ASEAN Socio-Cultural Community (ASCC),
2. The ASEAN Economic Community (AEC), and
3. The ASEAN Political-Security Community.

Each pillar is headed by a Council Meeting and divided into several levels of seniority with reporting flowing up from the working groups and technical subject-matter centres. All three Councils report to the ASEAN Coordinating Council and to the ASEAN Summit, the highest level. All three pillars have several bodies involved in issues related to marine environmental protection.

ASEAN member states also have institutional relationships with a number of partner countries and international organisations. The ASEAN + China, the East Asian Summit (EAS), composed of ASEAN + 8 countries and the ASEAN Regional Forum are of particular relevance to the protection of the marine environment including marine plastics.(See Chart 1)

3.2.2 ASEAN Meetings of decision makers and developing initiatives

There is no regional action plan yet. The ASEAN Blueprint 2025 or the upcoming ASEAN Strategic Plan on the Environment are expected to include action on marine litter prevention, especially plastic pollution.

However, there seems to be a Framework of Action on Marine Debris which comprises four (4) priority areas:

(i) Policy Support and Planning;

(ii) Research, Innovation, and Capacity Building;

(iii) Public Awareness, Education, and Outreach; and

(iv) Private Sector Engagement.

It is referred to in the Joint Statement issued at the March 2019 Special ASEAN Ministerial Meeting on Marine Debris organised by Thailand (in Bangkok) to provide ASEAN with a platform to explore and pursue concrete actions on combating marine debris and strengthen collaboration between ASEAN and supportive partners to address marine debris issues in the region effectively. The Joint Media Statement summarises the approach of the meeting and indicates that the Bangkok Declaration on Combating Marine Debris in ASEAN Region will be put forward for consideration and adoption by the ASEAN Leaders at the 34th ASEAN Summit in Bangkok, Thailand scheduled for 20-23 June 2019. (https://asean.org/storage/2019/03/3.-Joint-Media-Statement-SAMM-5-March-2019-Thai-Logo.pdf)

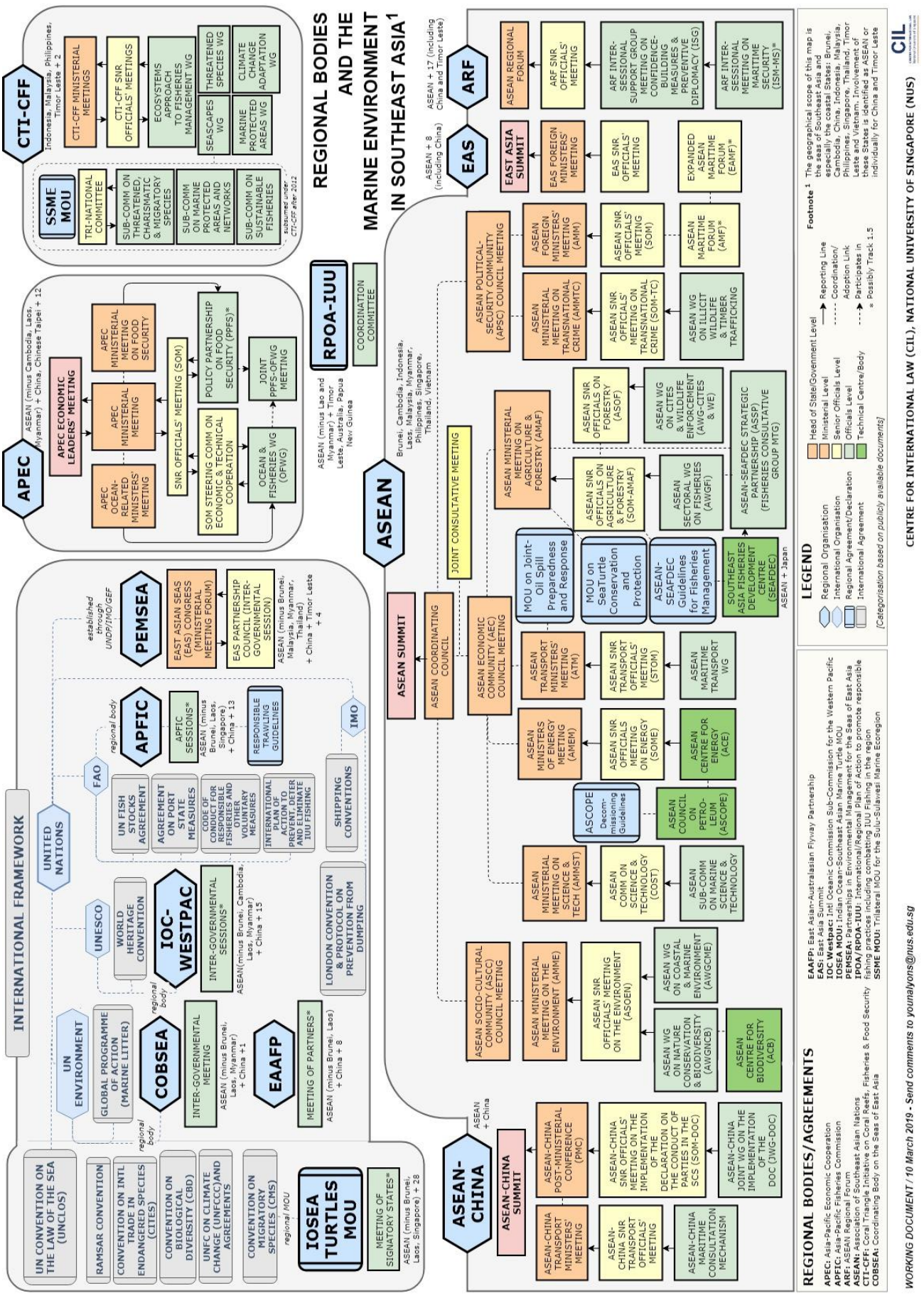
REGIONAL BODIES AND THE MARINE ENVIRONMENT IN SOUTHEAST ASIA[1]
INTERNATIONAL FRAMEWORK
UN CONVENTION ON THE LAW OF THE SEA (UNCLOS)
RAMSAR CONVENTION
CONVENTION ON INTL TRADE IN ENDANGERED SPECIES (CITES)
CONVENTION ON BIOLOGICAL DIVERSITY (CBD)
UNFC ON CLIMATE CHANGE (UNFCCC)AND AGREEMENTS
CONVENTION ON MIGRATORY SPECIES (CMS)
IOSEA TURTLES MOU
MEETING OF SIGNATORY STATES*
ASEAN (minus Brunei, Laos, Singapore) + 28
UN ENVIRONMENT
GLOBAL PROGRAMME OF ACTION (MARINE LITTER)
COBSEA
INTER-GOVERNMENTAL MEETING
ASEAN (minus Brunei, Laos, Myanmar) + China +1
EAAFP
MEETING OF PARTNERS*
ASEAN (minus Brunei, Laos) + China + 8
UNITED NATIONS
UNESCO
WORLD HERITAGE CONVENTION
IOC-WESTPAC
INTER-GOVERNMENTAL SESSIONS*
ASEAN(minus Brunei, Cambodia, Laos, Myanmar) + China + 15
LONDON CONVENTION & PROTOCOL ON PREVENTION FROM DUMPING
FAO
UN FISH STOCKS AGREEMENT
AGREEMENT ON PORT STATE MEASURES
CODE OF CONDUCT FOR RESPONSIBLE FISHERIES AND OTHER VOLUNTARY MEASURES
INTERNATIONAL PLAN OF ACTION TO PREVENT, DETER AND ELIMINATE IUU FISHING
regional body
APFIC
APFIC SESSIONS*
ASEAN (minus Brunei, Laos, Singapore) + China + 13
RESPONSIBLE TRAWLING GUIDELINES
established through UNDP/IMO/GEF
PEMSEA
EAST ASIAN SEAS (EAS) CONGRESS (MINISTERIAL MEETING FORUM)
EAS PARTNERSHIP COUNCIL (INTER-GOVERNMENTAL SESSION)
ASEAN (minus Brunei, Malaysia, Myanmar, Thailand) + China + Timor Leste + 4
IMO
SHIPPING CONVENTIONS
APEC
ASEAN (minus Cambodia, Laos, Myanmar) + China, Chinese Taipei + 12
APEC ECONOMIC LEADERS' MEETING
APEC OCEAN-RELATED MINISTERS' MEETING
APEC MINISTERIAL MEETING
APEC MINISTERIAL MEETING ON FOOD SECURITY
SNR. OFFICIALS' MEETING (SOM)
SOM STEERING COMM ON ECONOMIC & TECHNICAL COOPERATION
POLICY PARTNERSHIP ON FOOD SECURITY (PPFS)*
OCEAN & FISHERIES WG (OFWG)
JOINT PPFS-OFWG MEETING
ASEAN (minus Lao and Myanmar) + Timor Leste, Australia, Papua New Guinea
RPOA-IUU
COORDINATION COMMITTEE
CTI-CFF
Indonesia, Malaysia, Philippines, Timor Leste + 2
CTI-CFF MINISTERIAL MEETINGS
CTI-CFF SNR OFFICIALS' MEETINGS
ECOSYSTEMS APPROACH TO FISHERIES MANAGEMENT WG
SEASCAPES WG
THREATENED SPECIES WG
MARINE PROTECTED AREAS WG
CLIMATE CHANGE ADAPTATION WG
SSME MOU
TRI-NATIONAL COMMITTEE
SUB-COMM ON THREATENED, CHARISMATIC & MIGRATORY SPECIES
SUB-COMM ON MARINE PROTECTED AREAS AND NETWORKS
SUB-COMM ON SUSTAINABLE FISHERIES
subsumed under CTI-CFF after 2012
ASEAN
Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam
ASEAN SUMMIT
ASEAN COORDINATING COUNCIL
ASEAN ECONOMIC COMMUNITY (AEC) COUNCIL MEETING
JOINT CONSULTATIVE MEETING
ASEAN POLITICAL-SECURITY COMMUNITY (APSC) COUNCIL MEETING
ASEAN MINISTERIAL MEETING ON TRANSNATIONAL CRIME (AMMTC)
ASEAN SNR OFFICIALS' MEETING ON TRANSNATIONAL CRIME (SOM-TC)
ASEAN WG ON ILLICIT WILDLIFE & TIMBER TRAFFICKING
ASEAN FOREIGN MINISTERS' MEETING (AMM)
ASEAN SNR OFFICIALS' MEETING (SOM)
ASEAN MARITIME FORUM (AMF)*
ASEAN MINISTERIAL MEETING ON AGRICULTURE & FORESTRY (AMAF)
ASEAN SNR OFFICIALS ON AGRICULTURE & FORESTRY (SOM-AMAF)
ASEAN SNR OFFICIALS ON FORESTRY (ASOF)
ASEAN WG ON CITES & WILDLIFE ENFORCEMENT (AWG-CITES & WE)
ASEAN SECTORAL WG ON FISHERIES (AWGFI)
ASEAN-SEAFDEC STRATEGIC PARTNERSHIP (ASSP) (FISHERIES CONSULTATIVE GROUP MTG)
MOU on Joint-Oil Spill Preparedness and Response
MOU on SeaTurtle Conservation and Protection
ASEAN-SEAFDEC Guidelines for Fisheries Management
SOUTHEAST ASIA FISHERIES DEVELOPMENT CENTRE (SEAFDEC)
ASEAN + Japan
ASEAN + 8 (including China)
EAS
EAST ASIA SUMMIT
EAS FOREIGN MINISTERS' MEETING
EAS SNR. OFFICIALS' MEETING
EXPANDED ASEAN MARITIME FORUM (EAMF)*
ASEAN + 17 (including China and Timor Leste)
ARF
ASEAN REGIONAL FORUM
ARF SNR. OFFICIALS' MEETING
ARF INTER-SESSIONAL SUPPORT GROUP MEETING ON CONFIDENCE-BUILDING MEASURES & PREVENTIVE DIPLOMACY (ISG)
ARF INTER-SESSIONAL MEETING ON MARITIME SECURITY (ISM-MS)*
ASEAN-CHINA
ASEAN + China
ASEAN-CHINA SUMMIT
ASEAN-CHINA TRANSPORT MINISTERS' MEETING
ASEAN-CHINA POST-MINISTERIAL CONFERENCE (PMC)
ASEAN-CHINA SNR OFFICIALS' MEETING ON THE IMPLEMENTATION OF THE DECLARATION ON THE CONDUCT OF PARTIES IN THE SCS (SOM-DOC)
ASEAN-CHINA JOINT WG ON THE IMPLEMENTATION OF THE DOC (JWG-DOC)
ASEAN-CHINA TRANSPORT OFFICIALS' MEETING
ASEAN-CHINA MARITIME CONSULTATION MECHANISM
ASEAN SOCIO-CULTURAL COMMUNITY (ASCC) COUNCIL MEETING
ASEAN MINISTERIAL MEETING ON THE ENVIRONMENT (AMME)
ASEAN SNR OFFICIALS' MEETING ON THE ENVIRONMENT (ASOEN)
ASEAN WG ON NATURE CONSERVATION & BIODIVERSITY (AWGNCB)
ASEAN CENTRE FOR BIODIVERSITY (ACB)
ASEAN WG ON COASTAL & MARINE ENVIRONMENT (AWGCME)
ASEAN MINISTERIAL MEETING ON SCIENCE & TECH (AMMST)
ASEAN COMM ON SCIENCE & TECHNOLOGY (COST)
ASEAN SUB-COMM ON MARINE SCIENCE & TECHNOLOGY
ASCOPE
Decom-missioning Guidelines
ASEAN COUNCIL ON PETRO-LEUM (ASCOPE)
ASEAN MINISTERS OF ENERGY MEETING (AMEM)
ASEAN SNR OFFICIALS MEETING ON ENERGY (SOME)
ASEAN CENTRE FOR ENERGY (ACE)
ASEAN TRANSPORT MINISTERS' MEETING (ATM)
ASEAN SNR TRANSPORT OFFICIALS' MEETING (STOM)
ASEAN MARITIME TRANSPORT WG
LEGEND
Regional Organisation
International Organisation
Regional Agreement/Declaration
International Agreement
Head of State/Government Level
Ministerial Level
Senior Officials Level
Officials Level
Technical Centre/Body
Reporting Line
Coordination/ Adoption Link
Participates in
* Possibly Track 1.5
[Categorisation based on publicly available documents]
Footnote [1]
The geographical scope of this map is the seas of Southeast Asia and especially the coastal States: Brunei, Cambodia, China, Indonesia, Malaysia, Philippines, Singapore, Thailand, Timor Leste and Vietnam. Involvement of these States is identified as ASEAN or individually for China and Timor Leste
REGIONAL BODIES/AGREEMENTS
APEC: Asia-Pacific Economic Cooperation
APFIC: Asia-Pacific Fisheries Commission
ARF: ASEAN Regional Forum
ASEAN: Association of Southeast Asian Nations
CTI-CFF: Coral Triangle Initiative on Coral Reefs, Fisheries & Food Security
COBSEA: Coordinating Body on the Seas of East Asia
EAAFP: East Asian-Australasian Flyway Partnership
EAS: East Asia Summit
IOC-WESTPAC: Intergovernmental Oceanographic Commission Sub-Commission for the Western Pacific
IOSEA MOU: Indian Ocean-Southeast Asian Marine Turtle MOU
PEMSEA: Partnerships in Environmental Management for the Seas of East Asia
IPOA/RPOA-IUU: International/Regional Plan of Action to promote responsible fishing practices including combatting IUU Fishing in the region
SSME MOU: Trilateral MOU for the Sulu-Sulawesi Marine Ecoregion
WORKING DOCUMENT / 10 March 2019 - Send comments to younalyons@nus.edu.sg
CENTRE FOR INTERNATIONAL LAW (CIL), NATIONAL UNIVERSITY OF SINGAPORE (NUS)
CIL

Chart 1

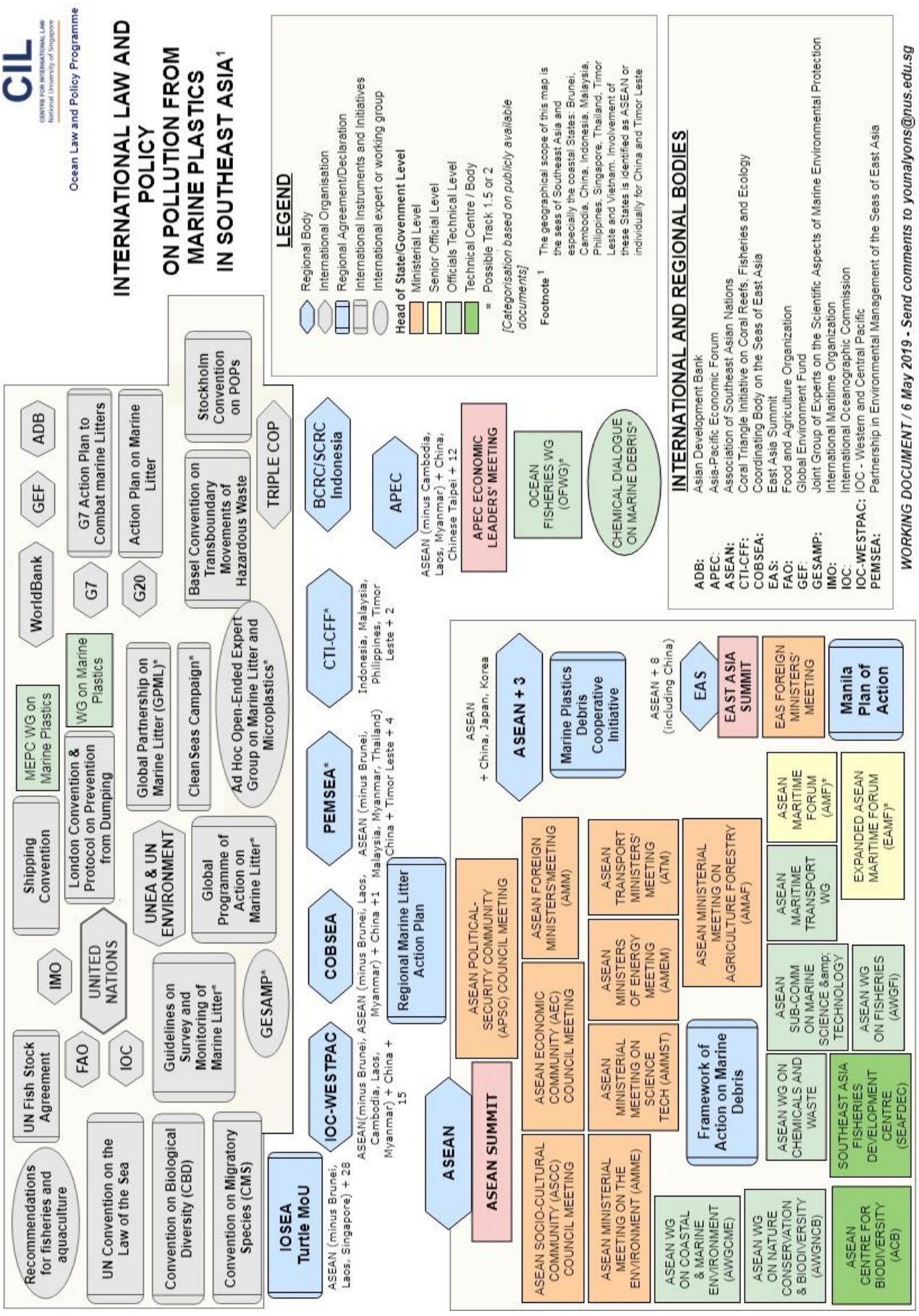
CIL
Ocean Law and Policy Programme
INTERNATIONAL LAW AND POLICY ON POLLUTION FROM MARINE PLASTICS IN SOUTHEAST ASIA[1]
LEGEND
Regional Body
International Organisation
Regional Agreement/Declaration
International Instruments and Initiatives
International expert or working group
Head of State/Government Level
Ministerial Level
Senior Official Level
Officials Technical Level
Technical Centre / Body
Possible Track 1.5 or 2
[Categorisation based on publicly available documents]
Footnote [1] The geographical scope of this map is the seas of Southeast Asia and especially the coastal States: Brunei, Cambodia, China, Indonesia, Malaysia, Philippines, Singapore, Thailand, Timor Leste and Vietnam. Involvement of these States is identified as ASEAN or individually for China and Timor Leste
INTERNATIONAL AND REGIONAL BODIES
ADB: Asian Development Bank
APEC: Asia-Pacific Economic Forum
ASEAN: Association of Southeast Asian Nations
CTI-CFF: Coral Triangle Initiative on Coral Reefs, Fisheries and Ecology
COBSEA: Coordinating Body on the Seas of East Asia
EAS: East Asia Summit
FAO: Food and Agriculture Organization
GEF: Global Environment Fund
GESAMP: Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
IMO: International Maritime Organization
IOC: International Oceanographic Commission
IOC-WESTPAC: IOC - Western and Central Pacific
PEMSEA: Partnership in Environmental Management of the Seas of East Asia
WORKING DOCUMENT / 6 May 2019 - Send comments to younalyons@nus.edu.sg
Recommendations for fisheries and aquaculture
UN Fish Stock Agreement
FAO
IOC
IMO
UNITED NATIONS
Shipping Convention
London Convention & Protocol on Prevention from Dumping
MEPC WG on Marine Plastics
WG on Marine Plastics
UNEA & UN ENVIRONMENT
Guidelines on Survey and Monitoring of Marine Litter*
Global Programme of Action on Marine Litter*
Global Partnership on Marine Litter (GPML)*
CleanSeas Campaign*
Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics*
GESAMP*
WorldBank
GEF
ADB
G7
G20
G7 Action Plan to Combat marine Litters
Action Plan on Marine Litter
Basel Convention on Transboundary Movements of Hazardous Waste
Stockholm Convention on POPs
TRIPLE COP
UN Convention on the Law of the Sea
Convention on Biological Diversity (CBD)
Convention on Migratory Species (CMS)
IOSEA Turtle MoU
ASEAN (minus Brunei, Laos, Singapore) + 28
IOC-WESTPAC
ASEAN(minus Brunei, Cambodia, Laos, Myanmar) + China + 15
COBSEA
ASEAN (minus Brunei, Laos, Myanmar) + China +1
PEMSEA*
ASEAN (minus Brunei, Malaysia, Myanmar, Thailand) + China + Timor Leste + 4
CTI-CFF*
Indonesia, Malaysia, Philippines, Timor Leste + 2
BCRC/SCRC Indonesia
APEC
ASEAN (minus Cambodia, Laos, Myanmar) + China, Chinese Taipei + 12
APEC ECONOMIC LEADERS' MEETING
OCEAN FISHERIES WG (OFWG)*
CHEMICAL DIALOGUE ON MARINE DEBRIS*
Regional Marine Litter Action Plan
ASEAN
ASEAN SUMMIT
ASEAN + China, Japan, Korea
ASEAN + 3
Marine Plastics Debris Cooperative Initiative
ASEAN + 8 (including China)
EAS
EAST ASIA SUMMIT
EAS FOREIGN MINISTERS' MEETING
Manila Plan of Action
ASEAN POLITICAL-SECURITY COMMUNITY (APSC) COUNCIL MEETING
ASEAN FOREIGN MINISTERS' MEETING (AMM)
ASEAN SOCIO-CULTURAL COMMUNITY (ASCC) COUNCIL MEETING
ASEAN ECONOMIC COMMUNITY (AEC) COUNCIL MEETING
ASEAN TRANSPORT MINISTERS' MEETING (ATM)
ASEAN MINISTERIAL MEETING ON THE ENVIRONMENT (AMME)
ASEAN MINISTERIAL MEETING ON SCIENCE TECH (AMMST)
ASEAN MINISTERS OF ENERGY MEETING (AMEM)
ASEAN MINISTERIAL MEETING ON AGRICULTURE FORESTRY (AMAF)
ASEAN MARITIME FORUM (AMF)*
Framework of Action on Marine Debris
ASEAN WG ON COASTAL & MARINE ENVIRONMENT (AWGCME)
ASEAN WG ON CHEMICALS AND WASTE
ASEAN SUB-COMM ON MARINE SCIENCE & TECHNOLOGY
ASEAN MARITIME TRANSPORT WG
EXPANDED ASEAN MARITIME FORUM (EAMF)*
ASEAN WG ON NATURE CONSERVATION & BIODIVERSITY (AWGNCB)
SOUTHEAST ASIA FISHERIES DEVELOPMENT CENTRE (SEAFDEC)
ASEAN WG ON FISHERIES (AWGFI)
ASEAN CENTRE FOR BIODIVERSITY (ACB)

Chart 2

November 2018 - ASEAN+3 Marine Plastics Debris Cooperative Action Initiative (ASEAN + China, Japan and South Korea), in Singapore.

This initiative is intended to develop capacity for monitoring plastic waste in the ocean, cooperate in preliminary research and share best practices in each country. It also includes the following specific steps: https://www.mofa.go.jp/files/000419527.pdf

- Deliver ASEAN's initiatives and actions to the G20 process spearheaded by Japan
- Hold a Special ASEAN Ministerial Meeting on Marine Debris in March 2019
- Seek the possibility of establishing a regional knowledge hub on marine plastic debris

2018 EAS Leaders' Statement on Combating Marine Plastic Debris, in Singapore, 15 November 2018 (it recalls 2017 UNGA Resolution on Oceans and Law of the Sea, 2015 EAS Statement on Enhancing Regional Maritime Cooperation, IMO and FAO' commitments to developing an action plan to address marine plastic litter from ships and a global strategy to address abandoned, lost or otherwise discarded fishing gear (ALDFG), respectively. It also emphasises that regional cooperation is necessary to encourage prevention and management of marine plastic debris, including buoys for aquaculture and ghost nets. This meeting has been preceded and prepared by the August 2018 EAS Foreign Ministers' Meeting which highlighted the importance of marine plastics pollution for Southeast Asia. http://www.indonesianwaste.org/6-7-september-2017-east-asia-summit-conference-on-combating-marine-plastic-debris/https://cil.nus.edu.sg/wp-content/uploads/2019/02/2018-EAS-Stm-Marine-Plastic-Debris.pdf

December 2017 Manila Plan of Action to Advance the 2012 Phnom Penh Declaration on the East Asia Summit Development Initiative (2018-2022). It promotes 'cooperation on combating marine plastic pollution to effectively establish and implement a coherent and coordinated regional approach, focused on prevention and management of waste and litter and promotion of investments in waste management infrastructure also through cooperation with the private sector'. https://cil.nus.edu.sg/wp-content/uploads/2019/02/2018-Manila-POA-to-Advance-PP-Decl-1.pdf

September 2017 EAS Conference on Combating Marine Plastic Debris in Bali, Indonesia http://www.indonesianwaste.org/6-7-september-2017-east-asia-summit-conference-on-combating-marine-plastic-debris/

3.2.3 Relevant ASEAN working groups and centres

According to the institutional organisation of the ASEAN, the numerous ASEAN technical working groups and Activity Centres work on issues pertaining to a sector of activity within their mandate and make recommendations to higher bodies in the governmental hierarchy, within their pillar. There are at least 6 working groups and 2 activity centres which deal with marine and maritime issues,including issues of marine plastics. (See Chart 2).

Participation in these meetings is not open to public and meeting agenda as well as meeting reports are often not published. However some of their work is made public. These are highlighted below.

ASEAN Working Group on Coastal and Marine Environment (AWGCME)

20th Meeting of AWGCME, 29-30 January 2019 - Phuket, Thailand focused on marine debris. Projects discussed included:

- E-READI project on Circular Economy
- ASEAN-Norway Proposal on Regional Capacity Building of Reducing Plastic Pollution
- ASEAN CSR Network Proposal on Multistakeholder Partnership to Tackle Marine Plastic
- Japan's Support to Combat Marine Debris
- NOAA's Potential Collaboration with ASEAN on Marine Debris
- ADF's (Dc Fatiha Association) Potential collaboration on Marine Debris; ADF is an active organisation on marine debris in the Mediterranean region. http://www.pcd.go.th/file/17-01-62-01.pdf

19th Meeting of the AWGCME, Oct 2018, Bali, reviewed the current state of packaging value chains and packaging waste management in Southeast Asia, including their contribution to marine pollution in the region.

ASEAN Working Group on Chemicals and Waste (AWGCW)

This body was established to serve as a consultative platform among ASEAN member states to further strengthen regional coordination and cooperation in addressing chemicals-related issues under relevant multilateral environmental agreements such as Basel Convention, Rotterdam Convention, Stockholm Convention, and Minamata Convention. Whilst little information is available online on the work of this body, a relevant report from 2017 is available https://www.kemi.se/en/files/96b822bbbfe745deb349438afa289238/progress-report-2017.pdf

Furthermore, given the push from UN Environment and the ongoing discussions at global level on regulation of plastic and microplastic through the Basel Convention on the transboundary movement of hazardous wastes and their disposal and the Stockholm Convention on persistent organic pollutants (POPs) (http://www.basel.int/Implementation/MarinePlasticLitterandMicroplastics/Overview/tabid/6068/Default.aspx and UNEP-CHW-LEAFLET-PUB-Brochure-MarineLitter-2018). ASEAN projects and discussions on marine plastic are likely to extend more substantially to the AWGCW if it is not already the case. Of note, some polymers are already listed under the Basel Convention and some plastic additives are listed under the Stockholm Convention. Furthermore, all ASEAN States are a party to these conventions.

ASEAN Centre for Biodiversity (ACB)

ACB is in the right position to be a driver of/ or repository of research on the impact of marine plastics on marine biodiversity. ACB's Director is vocal on the topic.

However, the only visible project devoted to the issue (partly) under their responsibility is a joint project on marine litter with PEMSEA in the context of the September 2018 Letter of Cooperation between the two bodies. (http://www.pemsea.org/news/pemsea-and-acb-sign-letter-cooperation)

3.2.4 Events

2018 ASEAN Meeting on the Management of plastic and packaging waste in Bali, Indonesia (31 oct-6 Nov) on packaging design and responsible production, packaging in retail and consumption, packaging waste collection, packaging waste sorting and recycling, the

integration of the informal economy as well as source-to-sea management for preventing marine pollution http://environment.asean.org/asean-pushes-forward-on-marine-litter-prevention/

2017 ASEAN Conference on Reducing Marine Debris in ASEAN Region in Phuket, Thailand (22-23 Nov). Organised by the Department of Marine and Coastal Resources and the Ministry of Natural Resources and Environment (MONRE) of Thailand, in coordination with the ASEAN Secretariat and IUCN. The conference reviewed the current status of marine debris pollution at local, regional, and global scales, and provided an opportunity for participants to exchange knowledge on the most effective methods for addressing marine debris. Attendees: 250 pax (attendees from ASEAN Member States, international conservation groups, government partners, researchers and local community members) https://www.iucn.org/news/thailand/201712/iucn-co-hosted-asean-conference-reducing-marine-debris

3.2.5 Comparison of research focus by different ASEAN fora

Table 3 below summarises the extent to which ASEAN bodies are involved in the 20 research topics which have been reviewed for this report in the context of marine plastic pollution in Southeast Asia.

Table 3: Comparison of research focus of different ASEAN fora with respect to marine plastics

Research Topic	ASEAN Leaders and initiatives*	ASEAN WG on CME	ACB	AWGCW	ASEAN Events
Policy, laws, administrative measures					
Action Plan, guidelines and standards					
Public outreach / Beach clean-up					
Language and cultural barriers/data accessibility					
Upstream research / Circular economy/ Waste management					
Research framework, coordination					
Surveys and monitoring / pollution status					
Methodology for the monitoring and assessment of marine litter					
Source differentiation					
Port reception facilities					
Fiber reinforced plastic vessels					
Hull scraping and marine coating					
Discharge from offshore infrastructures (incl. aquaculture)					
Contribution of fisheries/Lost and abandoned fishing gear					

Research Topic	ASEAN Leaders and initiatives*	ASEAN WG on CME	ACB	AWGCW	ASEAN Events
Contribution from rivers/river basin management					
Accumulation zones & Hotspots					
Fragmentation and degradation					
Microplastics					
Ecological and environmental impact					
Socio-economic impact					

Legend		Active or proposed research
		Expressed or inferred interest
		No research, no interest expressed
	*	Includes ASEAN +3

Whilst it shows that ASEAN governments are concerned with pollution by marine plastics and are pushing for a better understanding of the issues, activity is recent and still at an early stage. Most of the research topics are mentioned as area of interest but little as yet been implemented through active research efforts. The lack of implementation may be illustrated by the lack of visibility of work done by ASEAN specialised bodies on these topics. However, a very large number of initiatives are being launched by governments, public interest groups, industries and partnerships between them all. Section 2 of this report has shown that one of the early actions taken by many ASEAN governments has been focused on limiting the use of plastic bags in supermarkets.

3.3 Programmes or actions plan, reports and events organised by other intergovernmental regional bodies

This section includes all the regional bodies identified in Charts 1 and 2.

3.3.1 COBSEA - Coordinating Body for the Seas of East Asia

Funding comes from different sources depending on activities/projects and spending types (UNEP, GEF, external donors)

Mandate

The Coordinating Body of the Seas of East Asia (COBSEA) was established by the 1981 East Asian Seas Action Plan. It promotes compliance with existing environmental treaties ‘based on member countries’ goodwill.’ The authority to determine the content of the East Asian Seas Action Plan, to review its progress and to approve its programme of implementation is vested in the regular, periodic meetings of governments forming COBSEA. Today it has 9 members: Cambodia, China, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand, and Viet Nam. Its secretariat is based in Bangkok, Thailand.

The three original aims of 1981 East Asian Seas Action Plan were:

1. Assessment of the state of the marine environment;
2. Management of those marine and coastal development activities which may have an impact on environmental quality or on the protection and use of renewable marine resources on a sustainable basis;
3. Development of suitable coordinating measures for the successful implementation of the action plan.

The management of marine plastics therefore falls within the mandate of COBSEA. The "New Strategic Direction for COBSEA (2008-2012)" focused on: information management; national capacity building; strategic and emerging issues; and regional cooperation, 'emphasizing, in particular, land-based sources of marine pollution, sustainable management of critical habitat, related spatial planning including to build climate change resilience, as well as assessment and knowledge Management.'

The current emphasis of COBSEA on marine plastics is based on the Regional Action Plan on Marine Litter adopted during this period. The new strategic directions 2018-2022 are divided into three categories: Land-based marine pollution, marine and coastal planning and management; as well as an overarching governance theme. However, COBSEA is engaged in a revision of the Regional Action Plan for Marine Litter. (http://www.cobsea.org/4.%20COBSEA%20IGM%20EO-2%204%20RAP%20MALI%20revision.pdf)

The 2nd meeting of COBSEA Working Group on Marine litter took place in Bangkok in December 2018. The next Intergovernmental Meeting (IGM) will take place in Bali on 17-20 June 2019.

Reports

UNEP (2008) Marine Litter in the East Asian Seas Region, COBSEA Secretariat, UNEP, 62pp. https://www.cobsea.org/documents/Meeting_Documents/Marine%20Litter/Marine%20Litter%20Report%202008.pdf

This initial report provided the basis for the Action Plan that followed.

Action Plan and subsequent work and projects

- COBSEA Regional Marine Litter Action Plan (RAP MALI) adopted in 2008
- COBSEA Strategic Directions 2018-2022: http://www.cobsea.org/aboutcobsea/COBSEA%20Strategic%20Directions%202018-2022.pdf
- Meeting of the COBSEA Regional Working Group on Marine LItter, 13-14 Dec 2018; https://www.cobsea.org/Report%20COBSEA%20ML%20WG%20Meeting%20Bangkok%20Dec%202018%20[final].pdf
- Regional Review of Marine Litter in the East Asian Seas Region, zero-draft, UNEP/COBSEA IGM EO 2/INF 6, 28 April 2018 https://www.cobsea.org/3.%20COBSEA%20IGM%20EO-2%20INF%206%20Regional%20ML%20review%20180422.pdf

Project led by COBSEA and UN Environment - Reducing Marine Litter by addressing the management of the Plastic Value Chain in Southeast Asia - 2018-2021 - USD6.3 Mi by Swedish International Development Cooperation Agency (SIDA)

https://openaid.se/activity/SE-0-SE-6-5102017601-ASI-41010/ and presentation in ppt slides https://www.dmcr.go.th/dmcr/fckupload/upload/147/file/ppt1/ar2-02.pdf

4 outputs:

1. Market-based solutions towards 'less plastic wasted'
2. Strengthening the scientific basis for decision-making
3. Outreach on marine litter and plastic pollution
4. Regional networking

3.3.2 PEMSEA

Mandate

The Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) originated in the GEF/UNDP Prevention and Management of Marine Pollution in the East Asian Seas project, with the International Maritime Organization (IMO) as an executing body. It now has the status of an independent international organisation.

PEMSEA has 11 country partners (Cambodia, People's Republic of China, Indonesia, Japan, DPR Korea, Lao PDR, Philippines, Republic of Korea, Singapore, Timor-Leste and Viet Nam). Of these, Japan, DPR Korea and Timor-Leste are not members of COBSEA. It notably does not include three South China Sea and Gulf of Thailand coastal states (Thailand, Malaysia, Brunei) as members although they can participate to meetings as observers. Thailand has been the subject of PEMSEA projects despite not being a member and Malaysia attends most meetings as an observer.

Marine plastic falls within the scope of PEMSEA's mandate.

Limited work on marine plastics at this stage

PEMSEA specialises on projects at a local scale and operates generally with a network of partners throughout the region. It does so for marine plastics with IUCN in Thailand and Viet Nam in the context of the SDS-SEA Implementation Plan 2018-2022 (http://pemsea.org/sites/default/files/PEMSEA_SDS-SEA_IP_2018-2022_(20181018).pdf). Two of the priority areas of this plan are pollution reduction and waste management. In this context, the work with local governments in Thailand and Viet Nam focuses on investments in waste management to reduce marine debris, plastics and microplastics. The Implementation Plan also highlights contribution from rivers and the need to promote integrated river basin management.

Cambodia also made a recommendation to develop a Joint Commitment of Marine Debris and Plastic Waste, including a regional and national plan of action. (PEMSEA Council meeting in July 2018 - http://pemsea.org/sites/default/files/Proceedings%20of%20the%2010th%20East%20Asian%20Seas%20Partnership%20Council%20Meeting.pdf). This initiative may be an important part in PEMSEA's Post 2020-plan (to be funded by GEF). PEMSEA Resource Facility.

See above section 3.2.3- ACB, the Letter of cooperation signed with the ACB on 4 September 2018.

3.3.3 APEC

Mandate

The Asia-Pacific Economic Cooperation (APEC) began as an informal ministerial-level dialogue in 1989. Over time it has undergone some limited formalisation and institutionalisation, but continues to exist as a multilateral trade and economic dialogue forum that does not create binding commitments or treaty obligations. However, guidelines can be developed by working groups such as the ongoing effort to develop marine debris management guidelines or a manual for the APEC Region. There are currently 21 members who use APEC as a forum for cooperation, based on consensus through working groups and capacity building projects.

Projects and events

APEC Ocean and Fisheries Working Group organises technical workshops on issues of concern. Specific 2018 projects with respect to marine plastics pollution include:

- Capacity Building for Marine Debris Prevention and Management in the APEC Region Phase 2 – Implementation of Advanced Marine Debris Management Policies, and
- Study on the Origin and Distribution of Microplastics in Typical Marine APEC Region. https://www.apec.org/Groups/SOM-Steering-Committee-on-Economic-and-Technical-Cooperation/Working-Groups/Ocean- and-Fisheries.

Capacity Building for Marine Debris Prevention and Management in the APEC Region Phase 2 was held in Busan, June 2018. It included 52 participants from 16 APEC economies, observers, and international experts from NOWPAP RCU, ASEAN Secretariat, World Bank and Ocean Conservancy.

Ongoing work

In 2009, APEC estimated the costs of marine plastic pollution to tourism, fishing, and shipping industries to be $1.3 billion for the region. In 2016, APEC endorsed the Policy and Practice recommendations to overcome barriers to the financing of waste management projects in the APEC region.

A ‘Workshop’s Recommendation for Draft on APEC Marine Debris Management Guideline’ has been developed and approved by the Oceans and Fisheries Working Group (OFWG) of APEC in August 2018. This document is currently being circulated to all relevant APEC Working Groups for additional comments. The results will be presented during the 12th APEC OFWG which will be held in 2019, Chile. Ideally the final document will be submitted as an agenda item to the APEC Senior Official’s Meeting.

‘Update of 2009 APEC Report on Economic Costs of Marine Debris to APEC Region’, an ‘APEC Marine Debris Stakeholder Meeting on Improving Data and Coordination and Developing New Partnership’ was held in Bali, November 2018. The US Report will be submitted to the APEC Secretariat in the second half of 2019.

APEC also established a virtual working group on marine debris that brings together the OFWG and the Chemical Dialogue on marine debris. This group established an Action Plan and emphasises waste management issues.

3.3.4 Coral Triangle Initiative (CTI-CFF)

Mandate

At governmental level, the Coral Triangle Initiative designates broadly the commitments of six governments in the Coral Triangle (Indonesia, Malaysia, Papua New Guinea, Philippines, Solomon Islands and Timor-Leste) to engage in cooperative action to address threats to coral reefs, fisheries and food security (CTI-CFF). The initial commitment was the Leaders Declaration on Coral Reefs, Fisheries and Food Security of 15 May 2009 in Manado. Subsequent agreements include the 2011 Agreement on the Establishment of the Regional Secretariat of the CTI-CFF.

The CTI-CFF covers the Sulu-Sulawesi Seas as well as part of the Java Seas and the Western Pacific, within a triangle linking north Philippines to South Java to the Solomon Islands.

Marine Plastics

The CTI-CFF has made several communications on the impact of plastics and the need to keep it out of this area. They seem to be primarily focused on beach clean-ups, education and outreach as information on research projects on marine plastics under this programme are not readily available. Nevertheless it is expected that international NGOs involved in this project (TNC, WWF and Conservation International) are looking into it.

3.3.5 APFIC/SEAFDEC (Plastics from fisheries)

Mandate

The Asia Pacific Fisheries Commission (APFIC) and the Southeast Asian Fisheries Development Centers (SEAFDEC) are the two main regional intergovernmental bodies for fisheries, together with the ASEAN Working Group on Fisheries.

The APFIC was founded by the Fisheries Committee of the UN Food and Agriculture Organization (FAO) in 1948. it has a wide membership including the majority of states in the region.

The SEAFDEC is an autonomous intergovernmental body. It was established in 1967 with the mandate of developing and managing the potential of fisheries in the region. Its mission includes ensuring sustainability of fisheries and aquaculture in Southeast Asia. It has 11 members, Brunei Darussalam, Cambodia, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Viet Nam, but notably does not include China.

Project

SEAFDEC has been studying the presence of microplastics in fisheries produce for a few years already. Lost or discarded fisheries gear has also been a focus area. However, few publications are available.

South of Southeast Asia, a study of causes of gear loss in the Arafura Sea provides some interesting valuable analysis. See Richardson et al (2018). https://www.sciencedirect.com/science/article/pii/S0308597X17307406

3.3.6 IOC-WESTPAC

Mandate

The Sub-commission for the Western Pacific of the Intergovernmental Oceanographic Commission, a UN body (IOC-WESTPAC) was established in 1989 to to promote international cooperation and to coordinate programmes in marine research, ocean observations and services, as well as capacity building in the Western Pacific and adjacent seas, in order to learn more about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of governance, sustainable development and protection of the marine environment. It is comprised of 22 states including Southeast Asia.

The IOC is the intergovernmental organization competent for marine science at global level, within the UN system; IOC-WESTPAC being the regional arm for the Western Pacific. At global level, the IOC focuses on marine litters including marine plastics. It has commissioned several reports on the topic including 2009 Guidelines on Survey and Monitoring of Marine Litter.

In this context, the IOC supports UN Environment CleanSeas Campaign and is a sponsor of GESAMP. http://www.unesco.org/new/en/natural-sciences/ioc-oceans/focus-areas/rio-20-ocean/blueprint-for-the-future-we-want/marine-pollution/

The 12th Intergovernmental Session of IOC-WESTPAC is taking place on 2-5 April 2019 in Manila, Philippines.

Projects

The IOC-WESTPAC has an ongoing project on the distribution, source, fate and impacts of marine microplastics in the WESTPAC (Asia Pacific region) (http://file.iocwestpac.org/WESTPAC-XII/meeting%20docs/pdf/XII-8-16%20Microplastics.pdf)

It includes 3 research areas:

1. Investigation of sampling and analysis methodologies for microplastics
2. Distribution, source, transportation and fate of microplastics in the marine environment
3. Effects of microplastics on the marine ecosystems.

From this project, guidelines for methodology are under development. The principal investigator on this project is the East China Normal University. The Program Steering Group includes East China Normal University, China; Korea Institute of Ocean Science and Technology, Indonesian Institute of Sciences, Indonesia; Huahong Shi, Phuket Marine Biological Center, Thailand; State Oceanic Administration No.1 Ocean Institute, China; and the Institute of Oceanography and Environment (INOS), University, Malaysia Terengganu, Malaysia.

Events

2018 IOC WESTPAC Workshop on “Distribution, Source, Fate and Impacts of Marine Microplastics in Asia and the Pacific”, Shanghai, China on 15-17 October 2018. http://iocwestpac.org/calendar/882.html

2017 IOC WESTPAC Training Workshop on “Distribution, Source, Fate and Impacts of Marine Microplastics in Asia and the Pacific”, Phuket, Thailand.Hosted by Department of Marine and Coastal Resources, Phuket Marine Biological Center, and East China Normal University. The workshop covered the following: 1) an overview of global and regional status of microplastic research, monitoring and management, 2) national and/or institutional status of microplastic research, monitoring and management, and 3) discussion on developing a joint-monitoring plan on microplastic research, monitoring and management in Western Pacific. Attendees: 49 pax (attendees from Bangladesh, China, Indonesia, Republic of Korea, Malaysia, Philippines, Singapore, Sri Lanka, Thailand and Viet Nam) http://iocwestpac.org/calendar/834.html

3.3.7 Comparison of research focus by non-ASEAN regional bodies

Table 4 below summarises the research focus and interest of non-ASEAN regional intergovernmental bodies with respect to pollution from marine plastics. While none of these bodies cover all 20 research topics we have investigated, some cover more topics. It is important to note that of the six regional bodies considered, only three have a general mandate that covers all aspects of the protection of the marine environment: COBSEA, PEMSEA and APEC. The other three are specialised in biodiversity, biodiversity and fisheries, fisheries and marine science research, respectively. Not all of them also have a policy mandate which means that the first two research topics are not applicable to them.

This comparison also highlights that COBSEA stands out as the regional body with the most developed action plans and documents with respect to marine plastics, which can be explained by an earlier start on this topic through focus driven by UN Environment on marine debris. Another clear feature of this comparison is the regional focus on waste management, a key focus of all regional bodies with a general mandate with respect to the protection of the marine environment.

Table 4: Comparison of research focus by non-ASEAN regional intergovernmental bodies

Research Topic	COBSEA	PEMSEA	APEC	CTI-CFF	SEAFDEC	IOC/ WESTPAC
Policy, laws, administrative measures					NA	NA
Action Plan, guidelines and standards						
Public outreach / Beach clean-up						NA
Language and cultural barriers/data accessibility						NA
Upstream research / Waste management						NA
Research framework, coordination						
Surveys and monitoring / pollution status						
Methodology for the monitoring and assessment of marine litter						

Research Topic	COBSEA	PEMSEA	APEC	CTI-CFF	SEAFDEC	IOC/ WESTPAC
Source differentiation						
Port reception facilities						
Fiber reinforced plastic vessels						
Hull scraping and marine coating						
Discharge from offshore infrastructures (incl. aquaculture)						
Contribution of fisheries/Lost and abandoned fishing gear						
Contribution from rivers/river basin management						
Accumulation zones & Hotspots						
Fragmentation and degradation						
Microplastics						
Ecological and environmental impact						
Socio-economic impact						NA

(See legend in Table 3)

3.4 Between ASEAN member states and other states outside the APAC

3.4.1 World Bank

The World Bank approaches marine plastics from a socio-economic perspective, as a barrier to development and poverty alleviation. Its focus is on the development of waste management and upstream solutions, including infrastructure development and data collection in this context. It devoted a report in 2018 to solving marine pollution, which includes a long section on marine plastics globally, with an emphasis on Southeast Asia. http://documents.worldbank.org/curated/en/651521537901259717/pdf/130154-WP-PUBLIC-SolvingMarinePollution.pdf

It also mentions plastic pollution as an issue in the context of oceans, fisheries and coastal economies. Several of its blogs also highlight the seriousness of this issue in Southeast Asia. Planet over Plastic: Addressing East Asia's Growing Environmental Crisis

https://www.worldbank.org/en/news/feature/2018/06/08/planet-over-plastic-addressing-east-asias-growing-environmental-crisis

Together with funding from the embassies of Denmark and Norway in Jakarta, the World Bank conducted a marine debris hotspot assessment for Indonesia, at the request of and with the support of relevant Indonesia government agencies. This reports provides an informed and focused analysis of land-based leakage of solid waste, particularly plastics, to the marine environment. The assessment was a rapid study carried out in two phases, providing up-to-date information from 15 cities in western and central parts of Indonesia. The assessment

aimed to support Indonesia`s response to the growing crisis of plastics and debris in the country's and world's oceans.
http://documents.worldbank.org/curated/en/983771527663689822/Indonesia-Marine-debris-hotspot-rapid-assessment-synthesis-report

It is unclear whether similar projects are ongoing in other countries of Southeast Asia.

3.4.2 ASEAN-EU collaboration programme

EU-ASEAN Development Cooperation represents EUR 170 million for 2014-2020 and covers activities in the three ASEAN pillars. Biodiversity Conservation and Management of Protected Areas in ASEAN (BCAMP | 2016-2021) benefits from EUR 10 million EU budget contribution, and aims to enhance the conservation of biodiversity and effective management of protected areas in the ASEAN region. The programme will be implemented in close coordination with the EU Delegation in Manila and the ASEAN Centre for Biodiversity (ACB) in Los Banos, the Philippines. It is unclear whether marine plastics is included.

On 5 March 2019, Singapore's Minister for the Environment and Water Resources announced that as the current ASEAN-EU country coordinator, Singapore is working with the EU and ASEAN Member States to convene a policy dialogue on circular economy, marine litter and climate change to exchange best practices and explore collaborative partnership.

Further investigation is needed to identify the topics researched in this context with respect to marine plastics.

3.4.3 Support to ASEAN states provided by the Commonwealth

The 1949 London Declaration between Australia, Britain, Ceylon (now Sri Lanka), India, New Zealand, Pakistan, South Africa and Canada set the basis for the current association of 53 States named the Commonwealth. These include Brunei, Malaysia and Singapore. It is supported by more than 80 accredited organizations.

The Charter of the Commonwealth includes 16 values; the ninth value is 'sustainable development' and the tenth value is 'protecting the environment'. The more recent Blue Charter of the Commonwealth focuses more specifically on the protection of the marine environment including from plastics.
http://thecommonwealth.org/sites/default/files/inline/CommonwealthBlueCharter_0.pdf At the 2018 meeting of the Commonwealth Heads of Government, the importance of sustainable development of oceans was highlighted as well as threats posed from a number of sources including plastic pollution and the importance of the Commonwealth Blue Charter.
http://thecommonwealth.org/sites/default/files/inline/CHOGM_2018_Communique.pdf

A number of initiatives are being developed to support research in and limitation of pollution from marine plastics in this context. These include the Commonwealth Clean Ocean Alliance (CCOA, https://bluecharter.thecommonwealth.org/action-groups/marine-plastic-pollution/), Commonwealth Marine Plastics Research and Innovation Framework and the Commonwealth Litter Programme (CLiP), the latter being delivered by Cefas (see section 5.3.1 below). CCOA focuses on plastic reduction and involves 28 countries. It is led by the UK and Vanuatu and managed by the UK's Department for Environment, Food and Rural Affairs (Defra). In Southeast Asia, only Malaysia takes part in this alliance. CCOA members are asked to sign up to (and implement) the London Protocol, the UN Clean Seas campaign, and the Global Ghost Gear Initiative as means of meeting their commitments under Sustainable Development Goal 14.

3.4.4 The Asian Development Bank (ADB)

Blogs on the website of the Asian Development Bank (ADB) has blogs on pollution from marine plastic but most of ADB projects that were focused on this topic were not in Southeast Asia.

However, the ADB announced a commitment to expand its investments and technical assistance in ocean health and the blue economy to $5 billion between 2019–2024. It also announced a new Action Plan for Healthy Oceans and Sustainable Blue Economies in Asia and the Pacific as well as Oceans Financing Initiatives including the private sector. https://www.adb.org/sites/default/files/related/145036/Action%20Plan%20for%20Healthy%20Oceans%20and%20Sustainable%20Blue%20Economies.pdf

Marine plastics are highlighted as a critical threat to healthy ocean ecosystems. This suggests projects can be expected in Southeast Asia on this project. ADB's approach has five main components:

- Catalyzing the use of high-level and digital technologies for waste management, resource management and coastal cities planning;
- Strengthening policy and regulatory framework;
- Sharing knowledge on socio-economic costs, impacts and investment needs;
- Supporting regional cooperation on ocean health issues
- Engaging women, youth and communities.

4 Global intergovernmental and/or institutional policy frameworks, guidelines and initiatives relevant to Southeast Asia

This section focuses on marine plastics initiatives and research undertaken at global level with participation of ASEAN member states and/or otherwise relevant to Southeast Asia.

4.1 GESAMP

4.1.1 Function/mandate

The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is an advisory body, established in 1969, that advises the UN system on the scientific aspects of marine environmental protection. It is sponsored by 10 UN organizations with responsibilities relating to the marine environment (most of whom are involved in combating pollution from marine plastics). They utilise GESAMP as a mechanism for coordination and collaboration among them.

GESAMP functions are to conduct and support marine environmental assessments, to undertake in-depth studies, analyses, and reviews of specific topics, and to identify emerging issues regarding the state of the marine environment. GESAMP itself today consists of 17 experts, drawn from a wide range of relevant disciplines, who act in an independent and individual capacity. http://www.gesamp.org/publications/the-new-gesamp-science-for-sustainable-oceans

This institutional research mechanism is not intergovernmental and none of the current members are from Southeast Asia. However, GESAMP working groups call on experts around the world. Furthermore, their reports have an important credibility and legitimacy in the context of a number of intergovernmental organisations which set international law and policies that are applicable to Southeast Asia.

4.1.2 Reports, Studies and Guidelines

GESAMP has been undertaking research on marine plastics for more than 5 years. Several reports have been published:

- Guidelines For the Monitoring and Assessment of Plastic Litter in the Ocean, 2019 - An authoritative report which is likely to be closely considered if not followed by most intergovernemental organisations http://www.gesamp.org/publications/guidelines-for-the-monitoring-and-assessment-of-plastic-litter-in-the-ocean
- Sources, Fate and Effects of Microplastics in the Marine Environment: A Global Assessment (Part 2), 2016 - http://www.gesamp.org/publications/microplastics-in-the-marine-environment-part-2

- Sources, Fate and Effects of Microplastics in the Marine Environment: A Global Assessment (Part 1), 2015 - http://www.gesamp.org/publications/reports-and-studies-no-90

At its 45th session, GESAMP discussed the establishment of a new working group which will explore sea-based sources of marine litter, including fishing gear and shipping related sources. Activities are expected to commence in the second quarter of 2019. The next annual session of GESAMP will take place in New York in September 2019 (hosted by UN DOALOS and UNDP).

4.2 IMO work on plastic waste from shipping activities

4.2.1 Function/mandate

The International Maritime Organization (IMO) defines itself as a specialized agency of the UN for international shipping. It is charged with the global standard-setting authority for the safety, security and environmental performance of international shipping. Its main role is to create a regulatory framework for the shipping industry that is fair and effective, universally adopted and universally implemented.

With respect to the protection of the marine environment, all known adverse impacts from shipping activities are discussed at the IMO to determine whether they require an international treaty, recommendations, guidelines or more investigations. Sixteen international treaties have been negotiated and adopted by States at the IMO for this purpose. The body of the IMO that deal with negotiations of new regulations, amendments to old ones and review of implementation of treaties with respect to impact on the marine environment is the Marine Environmental Protection Committee (MEPC) of the IMO. It holds 3 sessions over a 2-year cycle. The last session was MEPC73 and was held in November 2018. The next one, MEPC74 is in May 2019.

Disposal of plastic from vessels as garbage has been handled at the IMO for decades through the International Convention for the Prevention of Pollution from Ships (MARPOL). MARPOL has 6 annexes; each is devoted to a different type of operational discharge from ships. Annex V is on garbage.

4.2.2 Origin of the current work on marine plastic in UN bodies

The pressing emphasis on plastic as a critical source of marine pollution of the marine environment at an international policy level has been enabled by the careful attention given by the United Nations General Assembly (UNGA) to the outcome document, ‘The future we want’, of the 2012 UN Conference on Sustainable Development in Rio (Rio + 20). UNGA Resolution 66/288, which followed Rio+20, endorsed ‘The Future We Want’, in September 2012. The UNGA is the highest deliberative, law and policymaking and representative organ of the UN. It has universal representation (193 Member States, with one vote each). UNGA resolutions are recommendatory but provide framework and scope to the work of specialised UN bodies.

The issue of plastic pollution in the marine environment also appeared in the annual UNGA resolutions on Oceans and Law of the Sea after Rio+20. The first mention of plastic was made in December 2012, in A/Res 68/70.

Another outcome of Rio+20 was the creation of the United Nations Environment Assembly (UNEA), the world’s highest-level decision-making body on the environment. The UNEA reports to the UNGA (see below section 4.5 on UNEA). The work of UNEA contributed to the

adoption by the UNGA, in 2015, of the 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs). These include SDG 14 to 'conserve and sustainably use the oceans, seas and marine resources for sustainable development'.

SDG 14 includes 7 targets and 3 means of implementation which cut across the 7 targets. The first target focuses on marine pollution including marine debris. UNEA has established several task-forces on marine plastic debris and foster cooperation between UN bodies (see below). Update on progress and importance of the issues are related in each report and decisions of UNEA.

The annual UNGA on Oceans and Law of the Sea reiterates decisions of the UNEA with respect to marine plastic pollution and microplastic and invites States to implement them.

4.2.3 Work on marine plastics at the MEPC

Adoption of the SDGs by the UNGA has been followed by the introduction of the SDGs in the strategic planning of a number of relevant international bodies. The IMO was one of the them.

One of the two vision statements in the Strategic Plan for 2018-2023 adopted by the IMO Assembly in December 2017 (A 30/Res.1110) focuses on addressing emerging issues and support Member States in their implementation of the SDGs. The Strategic Plan reiterates the importance of the SDGs in the overarching principles and in the context of its Strategic Direction 4, 'engage in ocean governance'. The Assembly also recognized the ongoing problem of marine plastic pollution and referred the issue to the following MEPC (and to the meeting of the governing bodies of the London Convention and the London Protocol - see next section) for detailed consideration and action as deemed necessary. The issue was widely supported as one that concerns plastic pollution from vessels and offshore structure.

Marine plastic litter was subsequently added as an agenda item of the MEPC in June 2018 (MEPC 72) with an output 'development of an action plan to address marine plastic litter from ships'. A working group on marine plastic litter was established at MEPC 73 (October 2018) and an Action Plan was adopted to address marine litter from ships, with measures to be completed by 2025. A paper submitted by Indonesia suggested the establishment of a database to store details on the state of marine plastic litter. However, this was not followed-up on at this time as the work of this forum has not arrived at this stage yet.

Items of the Action Plan include:

- Reduction of marine plastic litter generated from, and retrieved by, fishing vessels;
- Reduction of shipping's contribution to marine plastic litter;
- Improvement of the effectiveness of port reception facilities and treatment in reducing marine plastic litter;
- Enhanced public awareness, education and seafarer training;
- Improved understanding of the contribution of ships to marine plastic litter;
- Improved understanding of the regulatory framework associated with marine plastic litter from ships;
- Strengthened international cooperation; and,
- Targeted technical cooperation and capacity-building.

The report of the correspondence group includes three main items:

- Identification of issues to be studied on marine plastic litter from ships;
- Statistical issues to be considered under the IMO study on marine plastic litter;
- Action plan on a regulatory framework.

They will be considered together with new papers submitted by States at the coming MEPC meeting in May 2019. It is expected that GESAMP will be instructed to carry-out a study of sea-based sources of marine litter including plastics and microplastics and shipping-related sources.

These issues are of particular relevance to Southeast Asia where shipping density is particularly high and reception facilities for different waste streams from vessels are known to be often unavailable and generally insufficient. Abandoned, lost or otherwise discarded fishing gears are also a growing issue in the region as its fishing fleet is much larger than that of other regions and ghost nets are frequently found.

4.3 LC/LP work on dumping of waste at sea

4.3.1 Function/mandate

The objective of the 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its 1996 Protocol (LC/LP) is to promote the effective control of all sources of marine pollution and to take all practicable steps to prevent pollution of the sea by dumping of wastes and other matter. It does not apply to land-based pollution except if it is loaded onto a vessel to be disposed off at sea. The IMO provides the secretariat of the LC/LP but the meetings of the governing bodies are separate from the MEPC. The LC/LP is administered separately from other IMO treaties (all devoted to commercial shipping).

The bodies of the LC/LP see themselves as a body for international dialogue on all issues related to dumping of wastes and other matter at sea. Among ASEAN member states, the Philippines is the only party to the LC/LP with Thailand expected to follow soon. However, the need to adopt regulation to prevent, reduce and control dumping at sea and to establish a permitting procedure to dispose of waste at sea is also an obligation under UNCLOS. As the only international body competent to establish global standard on this is the LC/LP, their work is relevant to all States in Southeast Asia, whether they are a party or not.

4.3.2 Work on marine plastics

In 2014, the Scientific Group of the LC/LP agreed on a review of marine litter from waste streams that still needed to be addressed, with a target date of 2015. As a consequence, the Groups agreed that it would be beneficial to perform an initial review of marine litter in dredged material, sewage sludge and industrial discharges.

Given its scope, the LC/LP applies to marine plastics regulated under the waste streams covered by the LC/LP. The governing bodies therefore requested a study to review the current state of knowledge and information gaps in relation to litter, specifically plastics, in relation to wastes regulated under the LC/LP. The report was prepared by GESAMP and adopted by the LC/LP in 2015. It also discusses areas for further study in order to improve the understanding of the scale, nature and effects of plastics in sediments and sewage, and options for their

reduction and/or removal. (Review of the Current State of Knowledge Regarding Marine Litter in Wastes Dumped at Sea (under the LC/LP) - 2016 http://www.imo.org/en/OurWork/Environment/LCLP/newandemergingissues/Documents/Marine%20litter%20review%20for%20publication%20April%202016_final_ebook_version.pdf)

In 2016, the governing bodies of the LC/LP adopted a statement to encourage action to combat litter titled 'Recommendation to encourage action to combat marine litter' which is based on Rio +20. It expresses concern around the issue of plastic litter and microplastics in the marine environment; and encourage Member States to make every effort to combat marine litter, including through the identification and control of marine litter at source and to encourage monitoring, additional study and knowledge-sharing on this issue.

The Scientific Group and the governing bodies of the LC/LP are still investigating the issue. They are also developing an inventory of the work carried out by the LC/LP bodies on the issue of marine litter and microplastics, including a bibliography. Specific issues of particular on-going interest for these bodies include:

- developing methods to enable routine, reliable monitoring, assessment and reporting of microplastic contaminant levels in such waste streams as soon as possible
- Whether plastic waste can be classified as hazardous
- end-of-life management of fibre-reinforced plastic (FRP) vessels (http://www.imo.org/en/OurWork/Environment/LCLP/newandemergingissues/Documents/Fibre%20Reinforced%20Plastics%20final%20report.pdf)
- hull scraping and marine coating as source of microplastics (http://www.imo.org/en/OurWork/Environment/LCLP/newandemergingissues/Documents/Hull%20Scrapings%20final%20report.pdf)
- Plastics and microplastics in sewage sludge and dredged materials, sampling and analytical protocols and relationship between concentrations and effects.

The next meeting of the governing bodies is taking place at the IMO in October 2019.

4.4 Basel, Stockholm and Rotterdam Conventions

4.4.1 Function/mandate

The 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention) provides a framework for minimisation and safe management of environmentally hazardous waste material. Under the Convention, Technical Guidelines for the Identification and Environmentally Sound Management of Plastic Wastes and for their Disposal (UNEP/CHW.6/21) were developed.

The 2001 Stockholm Convention on Persistent Organic Pollutants (POPs) (Stockholm Convention) is a global treaty to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically, accumulate in the fatty tissue of humans and wildlife, and have harmful impacts on human health or on the environment. POPs are listed under the Convention and potential new POPs are reviewed for listing by a POP Review Committee. Additives used in plastic or found in recycled plastics are examined under the classification of 'POPs' under the Stockholm Convention.

The 2008 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention). It lists chemicals that are submitted to the prior informed consent procedure to ensure that recipients are fully informed of hazardous characteristics of certain chemicals before they buy them.

In 2011, the COPs of these conventions agreed to develop processes to improve coordination and cooperation between them. Since 2013, meeting of the COPs' have been organised back-to-back and include joint meetings on common issues. These "Triple-COP" meetings have raised awareness of the interlinkages between the 3 conventions and issues such as plastic pollution and marine litter. They focus on the toxicity of plastics and additives.

4.4.2 Work on marine plastics

In 2017, the COPs to the Basel and Stockholm Conventions acknowledged the issues of marine plastics and microplastics and encouraged their regional centres to work on this issue. A Working Group on Marine litter plastics and microplastics and its POPs and EDC components was also established. The open-ended Working Group of the Basel Convention was also tasked to consider the issue in the context of the Basel Convention and propose possible action for consideration at the following COP.

The next triple COP is taking place in Geneva 29 April-10 May 2019. Strengthening of regulations on the transboundary movement of plastic will be discussed. This will include consideration of the set-up of a new partnership on plastic wastes as well as of the proposal from Norway (supported by the Open-ended Working Group) to amend annexes II, VIII and IX of the Basel Convention to include greater scrutiny on the transboundary transport of solid plastic waste in order to ensure that the promotion of the movement of low-risk, clean wastes for recycling and control the high-risk movement of plastics that were difficult or impossible to deal with. (Report of the Open-ended Working Group to the COPs - UNEP/CHW/OEWG.11/15)

The Regional Centre of the Basel and Stockholm Conventions for Southeast Asia is based in Jakarta (BCRC/SCRC Indonesia) and works with the ASEAN. Donors/funds/agencies identified on issues related to marine plastic waste, mercury and new POPs in South-east Asian countries include the GEF, USAID and KemI (Swedish Chemicals Agency).

4.5 UNEA (United Nations Environment Assembly) and UN Environment

4.5.1 Function/Mandate

Section 4.2.2 above sets out the background of the involvement of the UN as a whole in the issues of marine plastics and microplastics and the importance of the 2012 Rio+20 Summit on Sustainable Development and the creation of the United Nations Environment Assembly (UNEA), the world's highest-level decision-making body on the environment.

The UNEA reports to the UNGA. The first UNEA (June 2014) adopted a resolution 1/6 on marine plastic debris and microplastic which highlights the complexity of the issue, the need for more knowledge and research, emphases the need for urgent action, and request the Executive Director to undertake a study on marine plastic debris and marine microplastics in consultation with other relevant institutions (UNEA-1 1/6) - See http://wedocs.unep.org/bitstream/handle/20.500.11822/17285/K1402364.pdf?sequence=3&isAllowed=y

Following adoption of the SDGs in 2015 , UNEA-2 adopted a new and longer resolution 2/11 on marine plastic litter and microplastics which reiterates the call for action and welcomes the activities of relevant UN bodies and organizations on this topic, including the IMO. Subsequent UNEA-3 and 4 (in January 2018 and March 2019 respectively) also adopted resolutions on marine plastic litters and microplastics. UNEA-3 established an Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics. (see the work of this group below)

UN Environment (the UN Environment Programme, formerly referred to as UNEP), is the leading global environmental agency within the UN system. It seeks to set the global environmental agenda and promote the coherent implementation of the environmental dimension of sustainable development. It is the UN coordinator for the implementation of policies set by the UNEA.

Work on marine litters started within UNEP and in the context of the GPA. It developed the GPML initiative described which is now a vehicle of implementation of decisions from UNEA. (see below section 5.5.3)

4.5.2 Work on marine plastics

The work of UN Environment and the impetus provided by the decisions of UNEA have resulted in the publication of numerous reports and collaborative initiatives. Important reports that are often referred to and relate to research on different aspects of pollution from marine plastics and microplastics are set out below.

Technical consultation - Hotspot Monitoring Methodologies

http://web.unep.org/environmentassembly/technical-consultation-hotspot-monitoring-methodologies

UNEP/IOC Guidelines in Survey and Monitoring of Marine Litter

Regional Seas Reports and Studies No.186, IOC Technical Series No.83

Reports

Marine Litter: A Global Challenge, 2009 (By UNEP, GPA and Ocean Conservancy)

https://wedocs.unep.org/bitstream/handle/20.500.11822/10744/MarineLitterAglobalChallenge.pdf?sequence=1&isAllowed=y

UNEP (2016) Marine Plastic debris and microplastics - Global lessons and research to inspire action and guide policy change. United nations Environment Programme, Nairobi. https://wedocs.unep.org/rest/bitstreams/11700/retrieve

UNEP (2017) Combatting marine plastic litter and microplastics: An assessment of the effectiveness of relevant international, regional and subregional governance strategies and approaches, UNEP/EA.3/INF/5

UNEP (2018) Compilation of the UN Environment Assembly resolutions on marine litter and microplastics, UNEP/AHEG/2018/1/INF/2

Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics

The first meeting of this Ad Hoc group took place on 29-31 May 2018 in Nairobi and the 2nd group in December 2018 in Geneva. https://papersmart.unon.org/resolution/second-adhoc-oeeg

4.5.3 Global Partnership on Marine Litter (GPML) between UN Environment and other UN Bodies

The GPML was established by UN Environment in 2012 and announced at Rio+20 (see section 4.2.2 above) prior to the establishment of UNEA. In 2012, member States of the Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA) adopted the Manila Declaration on Furthering the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities. This Declaration identified marine litter as a priority source category for action for 2012-2016 and triggered the development of the GPML. It also relied on the 2011 Honolulu Strategy - a global framework for prevention and management of marine debris. (http://wedocs.unep.org/bitstream/handle/20.500.11822/12347/ManillaDeclarationREV.pdf?sequence=1&isAllowed=y)

It is a global partnership gathering international agencies, Governments, NGOs, academia, private sector, civil society and individuals.Partners include the IMO, FAO and UNESCO-IOC. FAO provides technical advice to the GPML on the impacts of marine pollution on fisheries and aquaculture.

Objectives of the GPML include:

- To reduce the impacts of marine litter worldwide on economies, ecosystem, animal welfare and human health;
- To enhance international cooperation and coordination;
- To promote knowledge management, information sharing and monitoring of progress;
- To promote resource efficiency and economic development through waste prevention and by recovering valuable material and/or energy from waste;
- To increase awareness on sources of marine litter, their fate and impacts; and,
- To assess emerging issues related to the fate and potential influence of marine litter, including (micro) plastics uptake in the food web and associated transfer of pollutants and impacts on the conservation and welfare of marine fauna.

The GPML functions as a network with regional nodes and there is no regional node for Southeast Asia. The level of participation in the GPML is low in Southeast Asia (in March 2019). (See: http://marinelitternetwork.com/global-membership/) See also 2018 Global Partnership on Marine Litter (GPML) Framework Document, UNEP/GPA/IGR.4/INF/25.

4.5.4 UN Environment - CleanSeas

CleanSeas is a campaign launched by UN Environment in February 2017 with the aim of engaging governments, the general public and the private sector in the fight against marine plastic pollution.

https://wedocs.unep.org/bitstream/handle/20.500.11822/25398/Clean%20Seas%20Campaign%20on%20marine%20litter.pdf?sequence=2&isAllowed=y

This campaign focuses on:

- educating and engaging citizens - resources are available on the Cleanseas website https://www.cleanseas.org/resources
- collaborating with governments and the private sector, and
- replicating and scaling up efforts around the world.

Indonesia, Philippines and Thailand take part in this campaign, out of 57 countries globally.

One of the recent outcome of this initiative is the 'Massive Open Online Course on Marine Litter' created by UN Environment and the Open University: https://www.ou.nl/-/unenvironment-mooc-marine-litter

Japan and UN Environment also announced in March 2019 that they will join hands in effort to boost information and know-how to develop countermeasures against marine plastic litter in Southeast Asia. The project will develop a simulation model for plastic leakage and monitor to determine leakage hotspots along the Mekong river (as well as the Ganges in India). https://www.cleanseas.org/impact/japan-and-un-environment-announce-new-cooperation-boost-knowledge-marine-litter-southeast

4.5.5 Massive Open Online Course on Marine Litter

This is organised by Open Universiteit, with support from UN Environment. GPA, Clean Seas and GPML. https://www.ou.nl/-/unenvironment-mooc-marine-litter

The second course is due to take place in May 2019.

4.6 FAO Committee on Fisheries (COFI)

4.6.1 Function/mandate

The Committee on Fisheries (COFI), which was established in 1965, is a subsidiary body of the Council of the Food and Agriculture Organization, a specialized agency of the UN. It is an inter-governmental forum where major international fisheries and aquaculture problems and issues are examined and global recommendations and guidelines are adopted. Treaties have also been negotiated under the auspices of COFI.

Brunei Darussalam and Lao PDR are the only States of Southeast Asia that are not a member of COFI.

4.6.2 Work on marine plastics: Combating, Abandoned, Lost or Otherwise Discarded Fishing Gear (ALDFG)

A main topic of focus of the FAO is ALDFG with a timeline to 2025 to reduce ALDFG. Two pilot projects were launched in 2017:

- A global feasibility study focusing on the marking of fish aggregating devices (FADs); and,
- A field project in Indonesia focused on the practical application of gear marking and lost gear retrieval in small-scale coastal fisheries.

  http://www.fao.org/3/MW869EN/mw869en.pdf

FAO's 2016 study on the global status of ALDFG with respect to gillners and trammel nets shows a lack of data for Southeast Asia. http://www.fao.org/3/a-i5051e.pdf

FAO-COFI also collaborates with other organizations on ALDFG and marine litter. In addition to the GPML, it is involved in the Global Ghost Gear Initiative as well as through engagement, advice and workshop with the fishing industry.

At its last meeting of COFI in July 2018, the Committee expressed concern about effects of pollution, including microplastics, from gold mining and other sources, on aquatic resources, and encouraged FAO to continue collecting information on its impacts on aquaculture and fishery resources, and implications for food safety, both in marine and freshwater systems, including the work of the EAF-Nansen Programme (http://www.fao.org/in-action/eaf-nansen/en/).

This is based on an FAO study Microplastics in Fisheries and Aquaculture dated June 2018. Key findings of the study include that:

- Plastic contamination of aquatic environments will continue to increase, resulting in growing amounts of micro- and nanoplastics in these environments;
- There are gaps in the occurrence of microplastics including details on entry rates and global distribution in aquatic environments and organisms, their distribution in the water column, and the specific contribution of the fisheries and aquaculture sectors to microplastic contamination;
- Trophic transfer of microplastics will not lead to accumulation in seafood, and associated PBTs and additives have a negligible effect on the total human dietary intake of these compounds;
- basic knowledge on nanoplastics is still lacking. Data on nanoplastics are essential, because there is concern that nanoplastics may have a high biological impact;
- Consumers should be aware that according to the current state of knowledge on the toxicity of microplastics, the risk associated with the consumption of fishery and aquaculture products contaminated with microplastics is negligible and benefits from fishery and aquaculture products are known to be numerous;
- Nonetheless, preventive and corrective measures should be taken at international, governmental and consumer levels to evaluate the toxicity of common polymers, to reduce plastic use and encourage the use of alternative materials, recycling and the adoption of sustainable practices in using plastics and managing plastic pollution.

The recommendations formulated in this study include:

- Application of environmental risk assessment approach to potential microplastic contamination;
- Facilitate and promote improved cost-effective and well-targeted monitoring of microplastics in the environment, biota and seafood products;
- Quantify the relative contributions of all critical land-based and sea-based sources and investigate pathways of marine litter, including macrolitter and microlitter;
- Prioritize actions for marine litter mitigation, including the identification of hotspots and the examination of future scenarios, by the use of best available technologies; and

- International organizations (such as FAO, UNEP, IOC, WHO, others) as well as regional organizations (regional fisheries organizations, regional seas programmes, others) should collaborate on microplastic and nanoplastic contamination of aquatic environments and potential impacts on food safety and fishery and aquaculture resources.

  http://www.fao.org/3/MX201EN/mx201en.pdf

4.7 Other UN Organization and global intergovernmental bodies involved in marine plastics research

4.7.1 Global Environment Facility (GEF)

The Global Environment Facility (GEF) was established on the eve of the 1992 Rio Earth Summit to help tackle the most pressing environmental problems. It is an international partnership of 183 countries, international institutions, civil society organizations and the private sector that addresses global environmental issues. Its site indicates that it has provided over $17.9 billion in grants and mobilized an additional $93.2 billion in co-financing for more than 4,500 projects in 170 countries.

The GEF now has marine litter and microplastics within its focal areas, under the 7th replenishment of the GEF Trust Fund.

Marine plastics were a key topic of the 2018 GEF Assembly held in Viet Nam. The statement made by the Assembly emphasises that the circular economy approach to marine plastics is well-aligned with the GEF commitments and indicates strategic intervention points focused on plastic life cycle:

- Material and design engineering;
- Consumer use; and,
- Recovery and recycling.
  https://www.thegef.org/sites/default/files/publications/GEF%20Assembly_MarinePlastics%20Factsheet_9.4.18.pdf

4.7.2 G7 and G20 Action Plans to Combat Marine Litter

The Group of Seven (G7) consists of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. The G7 have been meeting annually since 1975. In 2015, the G7 highlighted marine litter and in particular plastic litter as posing a global challenge and adopted a G7 Action Plan to Combat Marine Litter. Overarching principles of the plan include prevention and removal. The plan is structured around the following priority actions:

- Address land-based sources, including improvement of waste management;
- Removal, including the identification of accumulation areas of marine litter and to alleviate threats to sensitive marine ecosystems;
- Sea-based sources, including through port reception facilities and the identification of key waste items from the fishing industry; and,
- Education, research and outreach.

  https://www.env.go.jp/water/marine_litter/07_mat13_2_%EF%BC%93-2ALD.pdf

With respect to marine plastics, the plan includes, in the context of actions to address land-based sources:

- Investigating sustainable and cost-effective solutions to reduce and prevent sewage and storm water related waste, including micro plastics entering the marine environment;
- Promoting best practices along the whole plastics manufacturing, and value chain from production to transport, e.g. aiming for zero pellet loss;

  https://www.who.int/pmnch/media/events/2015/elmau_annexes.pdf

In 2017, the Group of 20 (G20) also adopted an Action Plan on Marine Litter. The G20 is composed of the G7 countries plus Argentina, Australia, Brazil, China, European Union (EU), India, Indonesia, Mexico, Russia, Saudi Arabia, South Africa, South Korea and Turkey. This action plan mostly reiterates the priorities of the G7 action plan and adds financial, socio-economic and research considerations as well as a risk management approach. They also launched a Global Network of the Committed (GNC), a platform linked to UN Environment GPML. https://www.mofa.go.jp/mofaj/files/000272290.pdf

Both action plans also highlight the central role played by UN bodies and initiatives, especially UN Environment and the GPA.

4.7.3 Convention on Biological Diversity

Key objectives of the 1992 Convention on Biological Diversity (CBD) are the conservation of biological diversity and the sustainable use of its components. The CBD applies to both terrestrial and marine biodiversity. The governing body of the CBD is the Conference of the Parties to the convention who meets every two years and advances implementation of the convention. All the ASEAN member States are a party to the CBD.

As for many other intergovernmental bodies, concern with marine plastics arose in the context of a prior concern for the impact of marine debris on marine biodiversity. 2011 report available here:https://www.cbd.int/doc/meetings/mar/mcbem-2014-03/other/mcbem-2014-03-sbstta-16-inf-15-en.pdf

In 2012, CBD COP decided to organize an expert workshop to prepare practical guidance on preventing and mitigating the significant adverse impacts of marine debris on marine and coastal biodiversity and habitats. The workshop took place in 2014 and identified the following categories of knowledge gaps:

- On land-based sources of marine debris: quantity entering the ocean, quantification of impacts through habitat loss and degradation, lack of harmonised monitoring, analysis and reporting, distribution including habitat modelling for different indicator species and species risk assessments, rate of degradation or fragmentation, detection of invasive species on floating marine debris, socio-economic research and impact evaluation as well as social factors which lead to the production of marine debris;
- On sea-based sources of marine debris: types and magnitude of marine debris generated and location, valuation of marine debris (replacement and disposal costs and lost time) and impacts of the marine debris on habitat and/or species; as well as a focus on aquaculture;
- To increase knowledge and information on the sources, volumes and areas of accumulation, the report highlights the need to develop risk assessment of impact by

modelling the overlap between areas of accumulations and marine species habitats and migration routes; to understand and quantify the impact, the report recommends to focus on impacts in potential hotspots of different debris types and sources;

- On monitoring, modelling and data application, including microplastics and other microparticles, data for the deep sea and seabed;
- On contribution from offshore development industries and sacrificial fishing gear;
- Overall, understanding the population-level effects of marine debris rather than on a limited number of species subject to entanglement or ingestion of large marine debris, pathways, trophic transfer, etc.

Report available in UNEP/CBD/SBSTTA/20/INF/7* and background document for the preparation of this practical guidance in UNEP/CBD/MCB/EM/2014/3/INF/2.

In 2016, CBD COP acknowledged a Voluntary Technical Guidance on Preventing and Mitigating the Impacts of Marine Debris on Marine and Coastal Biodiversity and Habitats and urged States to take them into account. This guidance document focuses on actions to address:

- Land-based sources of marine debris and prevent waste from reaching the ocean, including empowering relevant stakeholders/civil society groups, engaging the private sector on a series of possible paths, mainstreaming marine debris issues into national regulatory and policy frameworks, enhancing international and regional cooperation and influencing consumer choice and behaviour;
- Sea-based sources of marine debris, including ALDFG, area-based management to minimise loss of fishing gear, vessel-associated inputs and aquaculture;
- Emerging issues including wet storage, recreational fishing and tourism sector and inclusion of marine debris considerations in labelling and certification schemes.

In 2018, CBD COP reiterated earlier decisions and emphasised the importance of consultation and cooperation among relevant bodies.

4.7.4 The United Nations Development Programme (UNDP)

The United Nations Development Programme (UNDP) helps to achieve the eradication of poverty, and the reduction of inequalities and exclusion. It focuses on implementation of the 2030 Agenda for Sustainable Development and also contributes to UN work on waste management to prevent marine litter. Along with UN Environment, UNDP has been involved in the protection of the marine environment in Southeast Asia for decades, including through and with PEMSEA.

https://www.undp.org/content/undp/en/home/sustainable-development-goals/goal-14-life-below-water.html

4.7.5 World Health Organization (WHO)

WHO was established in 1948 and is based in Geneva. The regional office of WHO for Southeast Asia is in Indonesia. However, only Indonesia, Myanmar, Thailand and Timor-Leste are a WHO country.

Whilst the Indonesian regional office has not published particular focus on impact from marine plastics and plastic pollution in general, at global level, WHO has highlighted pollution from marine plastics and participated to the UN call to 'beat plastic pollution' on 2018 World Environment Day.

4.7.6 World Meteorological Organization (WMO)

The world Meteorological Organization (WMO) was founded in 1950. It provides a framework for international cooperation for the development of meteorology, climatology and operational hydrology. Its focus areas include environment, oceans and public health.

In June 2018, WMO contributed to World Environment Day and participated to a 'beat plastic pollution' campaign. https://public.wmo.int/en/media/news/world-environment-day-beat-plastic-pollution

However, of note, the 2018 new global coalition of UN Environment, WHO and WMO on health, environment and climate change appears to prioritise air pollution as a more pressing issue than pollution from marine plastics. https://public.wmo.int/en/media/news/new-coalition-health-environment-and-climate-change-launched

4.7.7 Comparative analysis

Table 5 below shows a comparative analysis of research interest by nine international intergovernmental bodies with a particular interest in marine plastic pollution. Two of these bodies stand out with an interest in most research topics considered: UN Environment and the body in charge of the limitation of disposal of waste at sea, the LC/LP. UN Environment is the UN agency with the general mandate of protection of the marine environment and ASEAN member States attend are invited to participate in its work. However, LC/LP meetings, which also has an important interest in marine plastics and has been studying for more than 10 years, are generally attended only by the Philippines. The fact that some international bodies have a limited interest in some of the research topics is a reflection of the specialisation of their mandate in particular aspects of the marine plastics and sources of plastic pollution.

Table 5: Comparison of research focus by international intergovernmental bodies

(See legend in Table 3)

Research Topic	WORLD BANK	GESAMP	IMO - Shipping	LC/LP - Dumping	BSR - Toxic waste	UNEA / UNE/ GPML/ CleanSeas	FAO	GEF	CBD
Policy, laws, administrative measures									
Action Plan, guidelines and standards									
Public outreach / Beach clean-up									
Language and cultural barriers/data accessibility									
Upstream research / Waste management									

Research Topic	WORLD BANK	GESAMP	IMO - Shipping	LC/LP - Dumping	BSR - Toxic waste	UNEA / UNE/ GPML/ CleanSeas	FAO	GEF	CBD
Research framework, coordination									
Surveys and monitoring / pollution status									
Methodology for the monitoring and assessment of marine litter									
Source differentiation									
Port reception facilities									
Fiber reinforced plastic vessels									
Hull scraping and marine coating									
Discharge from offshore infrastructures (incl. aquaculture)									
Contribution of fisheries/Lost and abandoned fishing gear									
Contribution from rivers/river basin management									
Accumulation zones & hotspots									
Fragmentation and degradation									
Microplastics									
Ecological and environmental impact									
Socio-economic impact									

An additional point emphasised by most of the global intergovernmental bodies reviewed in this section (and not identified in Table 5 above) is the importance of a risk approach to identifying priorities and determining research agenda to respond to pollution from marine plastics.

5 Notable partnerships, non-institutional research programmes and public-private initiatives in the region

5.1 Global hybrid partnership with international organisations

5.1.1 Addressing Marine Plastic, a Systemic approach

This is a partnership led by UN Environment, in collaboration with New Plastics Economy, Ocean Conservancy and GRID Arendal and funding from the GEF. The project aims to develop a strategic roadmap to help guide transition to circular plastic economies at local, national and global scales. It includes four components:

Component 1 by New Plastics Economy

Global alliance platform for circular economy, to redesign plastics from inception;

Component 2 by Ocean Conservancy

To mobilise investment in waste management infrastructure and advance waste management solutions in Asia-Pacific;

Component 3 by UN Environment (Economy and Ecosystems Divisions)

To develop a roadmap for GEF engagement and strategy Development including the identification of intervention points; and,

Component 4 by GRID-Arendal.

To facilitate knowledge sharing and project coordination for effective delivery.

http://gefmarineplastics.org/partners

5.1.2 The Global Plastics Action Partnership (GPAP)

The Global Plastics Action Partnership (GPAP) is a new initiative to tackle plastic waste from source to sea by fast-tracking circular economy solutions. It was launched in September 2018. It is hosted by the World Economic Forum in collaboration with the World Resources Institute and networks of experts, civil society, government and industry leaders. The partnership aims to have investable solutions in place by 2020. Initial funding of USD10+million was provided by the UK Government, Canada, Coca-Cola, Dow Chemical and Pepsico.

The first collaboration is with Indonesia (launched on 11 March 2019). Ambitious targets have been set to curb ocean waste:

- Reduction of marine plastic debris by 70%, of solid waste by 30%; and,
- Handling of 70% of solid waste by 2025.

5.1.3 IUCN: Close the Plastic Tap Programme

The International Union for Conservation of Nature (IUCN) was established in 1948. It is a membership Union composed of both government and civil society organisations. It is therefore a hybrid of intergovernmental and non-governmental organisations and functions has an environmental network.

The IUCN's programme of work on marine plastics focuses primarily on tackling pollution at its source. Several projects are run within this programme. Projects that apply in Southeast Asia are:

- Marine Plastics and Coastal Communities (MARPLASTICCs) funded by the Swedish International Development Agency (Sida), launched in 2017; The overall goal of this three-year initiative is that governments and regional bodies within the Eastern and Southern Africa and the Asia regions promote, enact and enforce legislation and other effective measures that contain and reduce marine plastic pollution; This project focuses solely on Thailand and Viet Nam;

  https://www.iucn.org/sites/dev/files/marplasticcs_factsheet_final.pdf

- Tackling marine plastics in Thailand: from community-based actions to policies (Phase 1, 2018/2019), funded by the Coca-Cola Foundation; aims to raise transformative awareness and change people's behaviour towards solid waste management in key strategic locations in Thailand.

  https://www.iucn.org/theme/marine-and-polar/our-work/close-plastic-tap-programme/projects

5.1.4 The Global Ghost Gear Initiative (GGGI)

The GGGI came out of issues linked to abandoned fishing gear. Research now suggests that ghost gear may make up as much as 70% of all macro-plastics in oceans globally. Recent research found that 46% of litter in the North Atlantic Garbage patch is fishing gear. https://www.youtube.com/watch?time_continue=287&v=V0QSfDy1B-8

The GGGI consists in a series of projects reviewed by the GGGI Project Review Board and approved by the GGGI Steering Group. Participants to the projects include 13 governments, two international organisations (regional organisations from the Pacific Ocean), 38 private sector participants and 53 non-governmental organizations. https://www.ghostgear.org/

Whilst the extent of participation of states from Southeast Asia seems still limited at this stage, the map of events of lost gear include data from Southeast Asia (Map 1 below). This initiative has developed a Ghost Gear Reporter app than is used to populate this data portal.

Gear-marking pilot projects appear have been run in this context in Indonesia (https://static1.squarespace.com/static/5b987b8689c172e29293593f/t/5bd6e743a4222f4430aabf3b/1540810590236/Casestudy-INDONESIA.mk2.single.pdf). GGGI website also mentions a net-recycling project in the Philippines. https://www.ghostgear.org/projects/2018/10/10/steveston-harbour-net-recycling-initiative?rq=philippines

Map 1: Extract from the data portal of ghostgear.org

5.2 Organised and sustained international clean-up efforts - Civil Society

This section focuses on the most visible regional initiatives or global initiatives with particular focus on marine plastics in the region. Another NGO focussed on combating plastic primarily through the development of a circular economy is the Ellen MacArthur Foundation. A workshop on circular design, organised in London in December 2018, by the Ellen MacArthur Foundation and the British Council included six makers, designers, and creative entrepreneurs from Thailand, Viet Nam, Indonesia, Malaysia and the Philippines.

5.2.1 Fauna and Flora International (FFI)

The Society for the Preservation of the Wild Fauna of the Empire (later to become FFI) was first established in 1903 in the UK. FFI focuses on biodiversity protection in all relevant habitat types, the marine realm is one of them.

Several projects of FFI have been focused on the marine environment in several ASEAN Member States including Cambodia and Indonesia.

Marine plastics has also progressively become a key focus area of FFI since earlier work in 2009, especially microplastics -https://www.fauna-flora.org/news/plastics-2018-escalated-quickly

FFI Marine Plastics Programme: https://api.fauna-flora.org/wp-content/uploads/2018/02/FFI_2018_-Marine-Plastics-Informed-solutions-to-an-ocean-emergency.pdf

(Also - https://www.fauna-flora.org/approaches/tackling-marine-plastic-pollution and https://www.fauna-flora.org/conservation-challenges/ocean-plastic-pollution)

5.2.2 Ocean Conservancy

Ocean Conservancy is an NGO established in 1972 which initially focused on whales, seals and sea turtles. However, its scope has since expanded to embrace all the global challenges faced by oceans.

It has been an early mover on marine plastic debris and marine plastics and has been at the original of an number of global initiatives, including:

- The International Coastal Cleanup (ICC)

  One of the first effort of this type; it started 30 years ago. It now operates throughout the ASEAN region through coastal clean-up operations that rely on volunteers but include a qualitative and quantitative assessment for a selection of items. Data are published on an annual basis. They focus on specific stretches of the coast.

  https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/

- The Trash Free Seas Alliance includes a number of private companies, academic, public and civil society partners https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean/trash-free-seas-alliance/

  With support from The Coca-Cola Company, the Dow Chemical Company, the American Chemistry Council, the Recycling and Economic Development Initiative of South Africa, and WWF as well as McKinsey Centre for Business and Environment, Ocean Conservancy led a study in 2015: Stemming the Tide: Land-based strategies for a plastic-free ocean. This report identifies land based sources, suggests solutions to reduce leakages and lists the requirements for global action to reduce leakage.

  https://oceanconservancy.org/wp-content/uploads/2017/04/full-report-stemming-the.pdf

In 2017, Ocean Conservancy released a report called The Next Wave: Investment Strategies for Plastic Free Seas: https://oceanconservancy.org/wp-content/uploads/2017/05/the-next-wave.pdf. This report lists participants from a number of countries including two ASEAN member states. Table 6 below identified academic partners in ASEAN countries.

Table 6

	Indonesia	Viet Nam
Partners	Siliman University, Jorge Emmanuel	Da Nang College of Technology Tran Tie Yen Ahn, and Yen Anh Tran Ho Chi Minh City Technical University and DONRE Viet Nguyen Trung
		The University of Danang Dr. Hoang Hai, Director, International Cooperation Department Thao Minh Trang, Head of Division for Environmental Engineering, Danang College of Technology

Ocean Conservancy is also involved in a number of UN initiatives to combat marine plastics.

5.2.3 Trash Hero

The Trash hero is a network which started in Southeast Asia in 2013 with weekly clean-ups in Thailand and extends (in the region) to Indonesia, Myanmar, Malaysia and Singapore. They work with civil societies and businesses to clean-up and provide education and outreach.

https://trashhero.org/wp-content/uploads/2018/08/Trash-Hero-World-Annual-Report-2017.pdf

5.3 Visible Scientific Research

Names of national development agencies and research centres appear in several research projects on marine plastics and the protection of the marine environment in Southeast Asia.

5.3.1 Plastics in Society Hub

The Plastics in Society Hub is led by Brunel University London with university partners in Indonesia, Thailand and Malaysia. Partners in Southeast Asia are listed in Table 7 below.

Table 7: Partners in Plastics in Society Hub in Southeast Asia (http://www.plasticsinsociety.global/)

	Brunei	Indonesia	Malaysia	Thailand
Partners	Plastics In Society Hub, Brunel University London	Institute Technology Bandung (ITB) - Indonesia Network Hub	University of Malaysia	Prince of Songkhla University, Phuket
		University of Indonesia	Sabah Parks, Malaysia	SEEK Phuket
		University of Indonesia		
		University of Indonesia		
		Padjadjaran University		
		Canara Plastics Manufacturer & Traders		
		Surabaya City Government		
		Coordinating Ministry of Maritime Affairs, Indonesia		
		Intera Lestari Polimer		
		Indonesian Waste Platform		

Out of six research themes, the following one is of particular relevance to this review:

- Sources and fate of plastic pollution, including the development of locally relevant protocols to monitor litter (in the waste stream, on land, in freshwater, on shorelines and at sea) by category including: size, use and, where feasible, source;

Other focus areas are more focused on re-designing the plastic system, designing and testing solutions, social and behavioural change or other geographic areas than Southeast Asia.

http://www.plasticsinsociety.global/work-package-themes

5.3.2 Cefas

The Centre for Environment, Fisheries and Aquaculture Science (Cefas) is the UK government centre for applied marine and freshwater science and research. However, it also carries out research for governments and entities other than the UK. Marine litter (including marine plastics) are a research focus of Cefas with an emphasis on waste management, reducing sea-based sources of litter and developing a more sustainable life cycle for plastic. Cefas is responsible for the delivery of the UK-funded Commonwealth Litter Programme (CLiP) which encompasses:

- Land-based sources of litter;
- Sea-based sources of litter;
- Removal of litter from the marine environment;
- Science and education; and,
- Outreach.

This programme started in the South Pacific in November 2018. It is expected to later work in countries of the Commonwealth foundation in Asia and other parts of the world.

https://www.cefas.co.uk/news/south-pacific-region-commonwealth-litter-programme-conference-to-discuss-marine-litter-research-monitoring-and-solutions-to-reduce-plastic-pollution/

5.3.3 CSIRO

The Commonwealth Scientific and Industrial Research Organisation (CSIRO) is an independent Australian federal government agency responsible for scientific research. Marine debris is a focus area of the CSIRO and, within this, research on marine plastics and outreach activities. https://research.csiro.au/marinedebris/

With support from UN Environment, CSIRO has also carried out a review of the state of knowledge and modelling approaches to identify sources, sinks, distribution and movement of marine litter, including microplastics in order to identify key areas where new data will be most informative. Workshops were organised and a report published. BD Hardesty, C Wilcox and L Lebreton (2016) Modelling and Monitoring Marine Litter Movement, Transport and Accumulation. https://research.csiro.au/marinedebris/projects/modelling-monitoring-marine-litter-movement-transport-accumulation/

Whilst much of CSIRO research on this topic is focused on Australia, CSIRO collaborates with partner organisations around the world, including Viet Nam. Researchers of CSIRO also carry out marine plastic research in several ASEAN member States. In 2017, CSIRO undertook a marine pollution survey, working with countries across the globe to help them assess and reduce the amount of litter entering the oceans. These were expected to include ASEAN member States. No results could be found online. The lead researcher is Denise Hardesty.

5.3.4 East China Normal University

East China Normal University (ECNU) is a public research university in Shanghai. It has been involved in marine plastics research for a number of years.

Its hotspot monitoring methodologies have gained particular visibility through technical consultation they provided under funding by UN Environment (http://web.unep.org/environmentassembly/technical-consultation-hotspot-monitoring-methodologies) as well as presentation of their work to COBSEA (https://www.cobsea.org/Report%20COBSEA%20ML%20WG%20Meeting%20Bangkok%20Dec%202018%20[final].pdf).

5.3.5 International Environmental Technology Centre (IETC)

The International Environmental Technology Centre (IETC) is based in Osaka. It partners with UN Environment to promote the collection and dissemination of knowledge on Environmentally Sound Technologies with a focus on waste management. While specific projects in Southeast Asia were not found, it is likely that projects are on-going or being developed.

https://www.unenvironment.org/ietc/resources

5.3.6 GRID Arendal and NORAD

GRID-Arendal

GRID-Arendal is a Norwegian governmental foundation working closely with UN Environment and other partners. It was established in 1989 to support environmentally sustainable development. Marine debris (including marine plastics) has been a research focus for a number of years.http://www.grida.no/search?query=marine+litter. However, none of the published research focuses on Southeast Asia although the global studies include Southeast Asia. GRID-Arendal has built a particular reputation for its maps and graphics. https://wedocs.unep.org/bitstream/handle/20.500.11822/9798/-Marine_litter_Vital_graphics-2016MarineLitterVG.pdf.pdf?sequence=3&isAllowed=y

Some of the most current studies have been published in the context of global programmes that GRID-Arendal participates in such as ‘Addressing Marine Plastics - A Systemic Approach’ (See section 5.1.1 above and the 2018 Stocktaking report: http://gefmarineplastics.org/files/2018%20Stock%20taking%20report%20on%20marine%20plastics%20-%20final%20version.pdf)

NORAD

Norway announced in November 2018 that it has set aside 200 million dollars for the next four-year period to assist developing countries in combating marine litter, through the Norwegian Agency for Development Cooperation (NORAD). It includes support to the Indonesian government’s bold target of reducing plastic waste into the sea by 70% by 2025; this project focuses on waste management. NORAD is also funding the IMO Marine Environment Protection of the Southeast Asian Seas (MEPSEAS) Project which includes adoption and implementation of MARPOL Annex V in Cambodia and Thailand. This includes the management of all plastic waste by ships. NORAD has also approved a project proposal concerning the environmentally sound management of plastic wastes, the project entitled “Marine litter and microplastics: Promoting the environmentally sound management of plastic wastes and achieving the prevention and minimization of the generation of plastic wastes”. This is a project of the Secretariat of the Basel, Rotterdam and Stockholm Conventions.

However, the latter is implemented in Bangladesh only from the regional centre located in Indonesia.

5.3.7 Sida

The Sweden International Development Agency (Sida) is funding a project to combat marine litter and plastic pollution in Southeast Asia to be implemented by UN Environment and COBSEA. Sida is also funding the Marine Plastics and Coastal Communities (MARPLASTICCs) project under the IUCN Marine and Polar Programme.

5.4 Public-private and private-dominated partnerships

The two main initiatives that operate at regional level that we have been exposed to are GA Circular and Circulate Capital.

Other plastic industry groups may also exist that would be comparable to, in Europe,

- PlasticsEurope (Association of Plastics Manufacturers),
- plastic converters (European Plastics Converters - EuPC),
- plastic recyclers (European Plastics Recyclers - PRE), and
- machine manufacturers (European Plastics and Rubber Machinery - EUROMAP).

  https://www.plasticseurope.org/en/about-us/who-we-are

Further investigation with industry entities would be useful to complete the picture of these key bodies and initiatives in the private sector.

5.4.1 GA Circular

GA Circular is a public-private initiative founded in 2011 towards a circular economy in Asia.

It resulted from the organisation by the European Union Delegation to Singapore and the Embassy of the Netherlands in Singapore of a half-day conference on 25 October 2017 ‘Towards a plastic-free ocean: What role for policy makers, civil society and business?’. This conference brought together businesses, policy makers, non-government organisations and civil society to act on improving the ocean environment and promote the transition to a circular economy. This resulted in GA Circular projects for private partners such as Coca Cola, DANONE, Dole, Borouge, Amcor as well as the European Commission.
https://www.gacircular.com/

5.4.2 Circulate Capital

Circulate Capital is based in New York. It defines itself as an impact-focused investment management firm dedicated to financing companies, projects, and infrastructure that prevent the flow of plastic waste to the world's oceans and advance the circular economy. Rob Kaplan who works for this company is based in Singapore.

Their work includes the development of financing mechanisms for solutions to the problem of ocean plastic pollution in South and Southeast Asia ($100+ announced); targeted countries in Southeast Asia are Indonesia, Thailand, the Philippines and Viet Nam. A partnership with Closed Loop Partners, the Ocean Conservancy and companies including 3M, Coca-Cola, Kimberley-Clark, Dow, Pepsi-Co and Procter & Gamble.

Their focus is threefold:

- Reducing plastic in the waste streams;
- Improving solid waste management; and
- Increasing capture and reuse.

One of the investors in Circulate Capital is the Alliance to End Plastic Waste (AEPW). AEPW members include private sector companies that make, use, sell, process, collect and recycle plastic products.

Circulate Capital published in March 2019 a Handbook for Action: Investing oi reduce plastic pollution in South & Southeast Asia:
https://docs.wixstatic.com/ugd/77554d_3bb19c2c7b75435f8d2817edfc15a28f.pdf

5.4.3 Ocean Plastic Charter

The ‘Ocean Plastics Charter’ agreed on by five G7 states (Canada, France, Germany, Italy and the UK) and the EU in June 2018 has also been endorsed by a number of large corporations including Coca cola, Unilever and Nestle. Southeast Asia is an important market for some of these companies.

The Charter includes an action plan with five categories of action:

- Sustainable design, production and after-use markets,
- Collection, management and other systems and infrastructure,
- Sustainable lifestyles and education,
- Research, innovation and new technologies, and
- Coastal and shoreline action.

  https://international.gc.ca/world-monde/assets/pdfs/international_relations-relations_internationales/g7/2018-06-09-healthy_oceans-sante_oceans-annex-en.pdf

The coastal and shoreline action is focused on education and outreach, as well as accelerating implementation of the 2015 G7 Leaders’ Action Plan to Combat Marine Litter through the Regional Seas Programs, initiatives led by RFMOs, where appropriate, and targeted investments for clean-up activities that prove to be environmentally sound in global hotspots and priority areas, in particular on Abandoned, Lost or Otherwise Discarded Fishing Gears (ALDFG) and wastes generated and collected by fishery activities.

Of note is the emphasis on global hotspots and plastic wastes from fisheries.

5.5 Comparative analysis

The comparative table 8 shows the difference in breadth of different non-governmental efforts with respect to responding to pollution from marine plastics. Ocean Conservancy stands out as one of the organisations with the greatest breadth and involvement. Another clear common feature is a focus on waste management and the circular economy (especially by private actors) and/or surveys and monitoring. Comparatively, accumulation zones and hotspots get less interest although the risk approach is advocated by many.

Table 8: Comparison of research focus by non-governmental initiatives (See legend in Table 3)

Research Topic	AMPSA	IUCN	FFI	Ocean Conservancy	Trash Hero	Cefas	CSIRO	ECNU	NORAD/ GRID-Arendal	Sida	GA Circular	Circulate Capital
Policy, laws, administrative measures												
Action Plan, guidelines and standards												
Public outreach / Beach clean-up												
Language and cultural barriers/data accessibility												
Upstream research / Waste management												
Research framework, coordination												
Surveys and monitoring / pollution status												
Methodology for the monitoring and assessment of marine litter												
Source differentiation												
Port reception facilities												
Fiber reinforced plastic vessels												
Hull scraping and marine coating												
Discharge from offshore infrastructures (incl. aquaculture)												
Contribution of fisheries/Lost and abandoned fishing gear												
Contribution from rivers/river basin management												

NUS - Research on marine plastics in SEA – 15 May 2019

Research Topic	AMPSA	IUCN	FFI	Ocean Conservancy	Trash Hero	Cefas	CSIRO	ECNU	NORAD/ GRID-Arendal	Sida	GA Circular	Circulate Capital
Accumulation zones & Hotspots												
Fragmentation and degradation												
Microplastics												
Ecological and environmental impact												
Socio-economic impact												

6 Overall comparative analyses

6.1 Comparative analysis of research interest by international and regional bodies and initiatives

Table 9 below summarises and compares the findings of sections 3, 4 and 5 with respect to research interest for the 20 research topics reviewed in this report. Levels of interest (Low, Medium or High) in each research topic have been determined on the basis of the number of bodies and initiatives (reviewed in the report) that are engaged in active or proposed research on these topics or have expressed particular interest in these topics. Boundaries in the levels of interest take into account respective mandates of bodies and initiatives.

Two main features stand out. First, the bodies and initiatives reviewed share a generally high level of interest for these research topics: 20% of the research topics have a high level of interest. Of note, the topic of highest shared interest overall is upstream research and waste management. Second, this comparison also shows that NGOs and independent research centres play a particularly important role with respect to public outreach and language and cultural barriers where regional and global research interest is markedly lower.

Additional features of note in this comparison are the research topics that have the lowest interest. These include fiber reinforced plastic vessels and hull scraping. This low interest may result from the fact that they are new issues. However they may reveal important for Southeast Asia, especially the former, given the number of vessels found in the region. Furthermore, with respect to fiber reinforced plastic vessels, these are soon reaching their 50 years life span.

Table 9: Comparative analysis of research interest by international and regional bodies and initiatives

Research Topic	Reg'l overall	Global	RI & NGOs	Level of interest by bodies & initiatives
Policy, laws, administrative measures	Low	High	Low	Medium
Action Plan, guidelines and standards	High	Medium	Low	Medium
Public outreach / Beach clean-up	Low	Low	Medium	Medium
Language and cultural barriers/data accessibility	Low	Low	Medium	Low
Upstream research / Waste management	High	Medium	High	High
Research framework, coordination	Medium	Medium	Low	Medium
Surveys and monitoring / pollution status	High	Medium	Medium	High
Methodology for the monitoring and assessment of marine litter	Low	Medium	Medium	Medium
Source differentiation	Low	Low	Medium	Medium
Port reception facilities	Low	Medium	Low	Low
Fiberglass- reinforced vessels	Low	Low	Low	Low
Hull scraping and marine coating	Low	Low	Low	Low
Discharge from offshore infrastructures (incl. aquaculture)	Low	Medium	Low	Low
Contribution of fisheries/Lost and abandoned fishing gear	Low	High	Low	Medium
Contribution from rivers/river basin management	Low	Medium	Low	Low
Accumulation zones & Hotspots	Medium	High	Medium	High
Fragmentation and degradation	Low	Medium	Low	Medium
Microplastics	Medium	High	Low	Medium
Ecological and environmental impact	Medium	High	Medium	High
Socio-economic impact	Low	High	Low	Medium

6.2 Comparative analysis of research in natural science and research and interest by regional and global bodies and initiatives

Table 10: Comparative analysis of research interest overall

Research Topic	Level of interest by bodies & initiatives	Natural Science Research
Surveys and monitoring / pollution status	High	High
Methodology for the monitoring and assessment of marine litter	Medium	Low
Source differentiation	Medium	Medium
Fiber reinforced plastic vessels	Low	Low
Hull scraping and marine coating	Low	Low
Discharge from offshore infrastructures (incl. aquaculture)	Low	Low
Contribution of fisheries/Lost and abandoned fishing gear	Medium	Medium
Contribution from rivers/river basin management	Low	Low
Accumulation zones & Hotspots	High	Medium
Fragmentation and degradation	Medium	Low
Microplastics	Medium	High
Ecological and environmental impact	High	High

Table 10 above summarises interest levels of international and regional bodies and initiatives of the marine science community of Southeast Asia for the marine pollution research topics that fall within the scope of natural science research. Topics which could not be taken into account in the context of this comparison were removed from the list. The list of topics in this summary is therefore limited to 12 instead of 20 research topics considered overall. Research topics outside the strict scope of natural science (as defined for this report) are discussed in the recommendations below.

This summary and comparative tables show the following three key features. First, there is an overall consistency between research interest of the scientific community and that of regional and international bodies and initiatives. Second, natural science research is lagging behind the interest of international and regional bodies and initiatives in 3 research topics: monitoring and assessment methodologies, accumulation zones and fragmentation. Third, and interestingly, the interest of natural scientists in microplastics exceeds that of international and regional bodies and initiatives.

7 Conclusion

7.1 Regional characteristics of research in marine plastics

Realisation of the seriousness and complexity of issues raised by marine plastics is recent globally and even more so in Southeast Asia (less than 5 years). The general lack of a clear understanding of sources of plastics found in the coastal and marine environment, accumulation zones, plastic types and behaviour overtime, toxicity, pathways make the identification of short term effective solutions difficult. The lack of human and financial resources as well as waste management infrastructure resources to respond to the issues is further limiting the availability of effective short term solutions.

Much of the on-going work is based on an (unverified but plausible) assumption of an 80% contribution to marine plastics coming from land. A European paper submitted to the IMO suggests that the share of sea-based pollution could be greater. More clarity on this is expected through research work undertaken by several international bodies.

7.1.1 Research accessibility

As the Southeast Asian countries continue to contribute to advancement in marine plastics research, there are a few barriers that impede regional cooperation. Firstly, research maybe conducted and/or communicated in the language of the land. This may be critical to dissemination of information within the nation, but discourages regional synthesis.

Without the establishment of a regional database for plastic research, crucial or fundamental information from unpublished or ongoing work may not be tapped upon by other researchers in the region until much later.

Lastly, the presence of non-public research in all states is acknowledged.

7.1.2 Communication between policy and science

As science pushes forward to understand marine plastics and its characteristics, the gathered information needs to be accessible to communities wider than the scientific fraternity. Accessibility in this context also means that the science needs to be framed so that it can guide law and policy. In the same respect, policy and frameworks outlining marine plastics pollution and key questions to remedy the situation must guide enough of the research thrusts of scientific inquiry to generate applicative science. Here, an ideal situation is proposed (Fig. 6), where a communicative model between policy and science elevates the literacy of the wider community to make informed choices, thus reducing marine plastics.

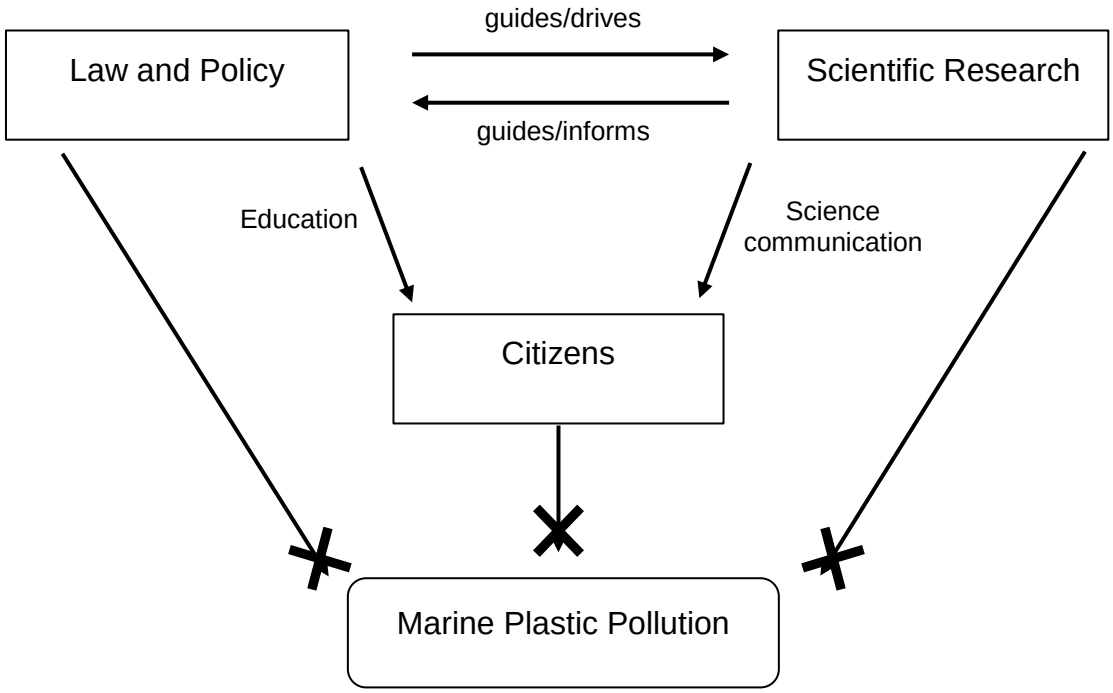

Figure 6: The ideal scenario where communication between policy and science informs the general public and reduces marine plastics.

7.2 Gaps and recommendations

7.2.1 A schematic representation of relationship between research topics on marine plastic pollution

Marine plastic pollution can be approached from different perspectives. The approach of the authors is conceptualised in Figure 7 below. It distinguishes three phases:

- Different sources of plastic pollution in the coastal and marine environment are represented at the top;
- Pollution from macro- and microplastics, which results from these sources, is represented in the middle;
- Resulting impacts are represented at the bottom.

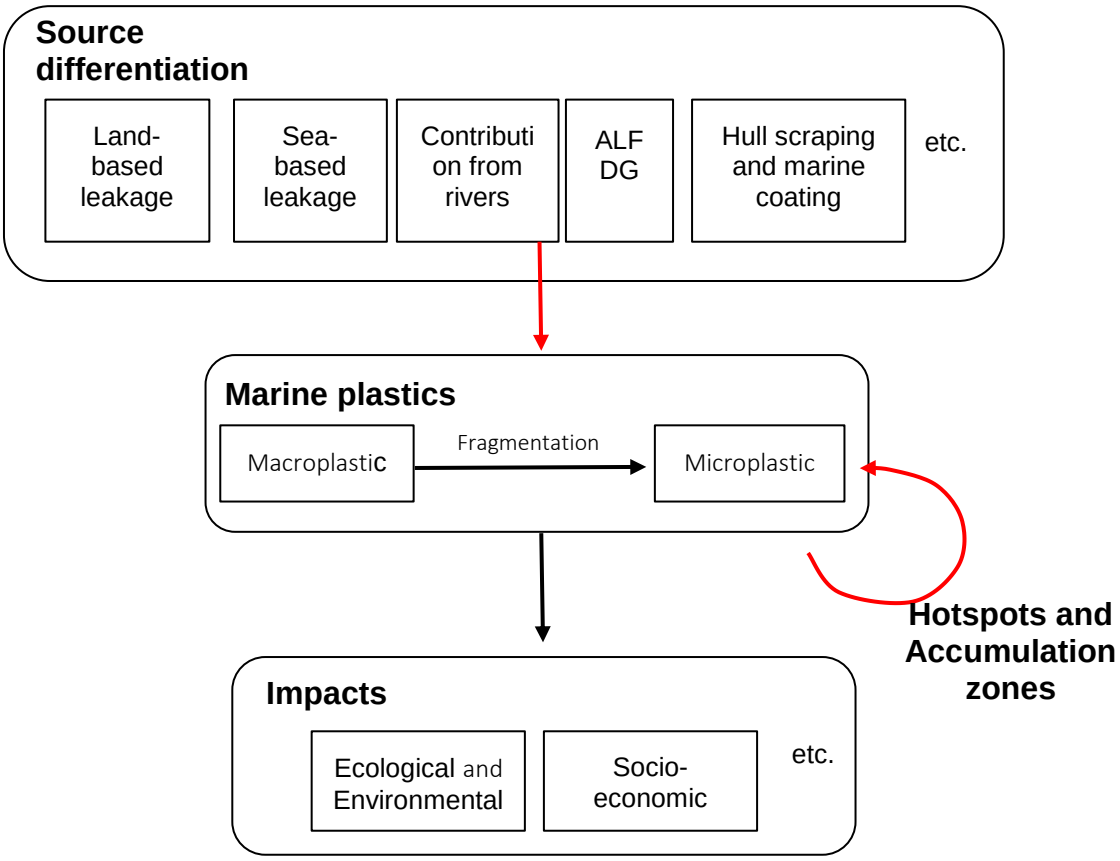

Figure 7: Relationship between research topics in marine plastic pollution. Red arrows indicate processes that generate marine plastics and thus breakage of these arrows is recommended.

Contribution from each phase to another is represented by an arrow. The red arrows represent the processes that may be stopped in priorities through human intervention, without new technological developments being necessary. Interruption to the top arrow would prevent further input of plastic into the marine environment. Intervention on the second arrow could limit the magnitude of impacts.

7.2.2 Gaps and Priorities

Table 11 below sets out a summary of the findings of this report and gaps identified on this basis.

Research topics which are the subject of shared medium or high research interest by both the research community and international and regional bodies and initiatives have been considered to be research priority. These are:

- Surveys and monitoring
- Source differentiation
- Accumulation zones & Hotspots
- Ecological and environmental impact
- Contribution of fisheries/Lost and abandoned fishing gear.

Table 11: Table of gaps and priorities in marine plastic research in Southeast Asia

Research Topic	Level of interest by bodies & initiatives	Natural Science Research	Recommended
Policy, laws, administrative measures	Medium	NA	Potential Gaps
Action Plan, guidelines and standards	Medium	NA	Potential Gaps
Public outreach / Beach clean-up	Medium	NA	Potential Gaps
Language and cultural barriers/data accessibility	Low	NA	Potential Gaps
Upstream research / Waste management	High	NA	Potential Gaps
Research framework, coordination	Medium	NA	Potential Gaps
Surveys and monitoring / pollution status	High	High	Priority
Methodology for the monitoring and assessment of marine litter	Medium	Low	Gap
Source differentiation	Medium	Medium	Priority
Port reception facilities	Low	NA	Potential Gaps
Fiber reinforced plastic vessels	Low	Low	More research needed
Hull scraping and marine coating	Low	Low	More research needed
Discharge from offshore infrastructures (incl. aquaculture)	Low	Low	More research needed
Contribution of fisheries/Lost and abandoned fishing gear	Medium	Medium	Priority
Contribution from rivers/river basin management	Low	Low	Gap
Accumulation zones & Hotspots	High	Medium	Priority
Fragmentation and degradation	Medium	Low	Gap
Microplastics	Medium	High	On-going
Ecological and environmental impact	High	High	Priority
Socio-economic impact	Medium	NA	Potential Gaps

Research topics which are the subject of medium or high level interest by international and regional bodies and initiatives but for which natural science research interest in low in the region have been considered to be gaps in research. These are:

- Methodology for the monitoring and assessment of marine litter
- Contribution from rivers/river basin management
- Fragmentation and degradation.

7.2.3 Recommendations

International and regional bodies and initiatives frequently refer to the need for a risk assessment approach to pollution from marine plastic to prioritise response mechanisms, including research. Of note, this risk approach is not mentioned in scientific research papers although it may have been taken into account in the framing of the research agenda. This review adopts a risk approach in the determination of the following recommendations.

In this light, findings of this review point to research topics identified as priorities in section 7.2.2 to be primary recommendations:

- Surveys and monitoring
- Accumulation zones & Hotspots
- Source differentiation
- Ecological and environmental impact
- Contribution of fisheries/Lost and abandoned fishing gear.

Research in ‘surveys and monitoring’ and ‘accumulation zones and hotspots’ are critical for the region to progress its understanding of pollution of marine plastics. Given the variety of surveying methods available, both research topics can be carried out concurrently. They can also usefully feed into one another and allow greater understanding of the issues.

Research on ‘source differentiation’ and ‘ecological and environmental impact’ can be carried out on the basis of the findings of the first two research topics and concurrently. In the context of the region, examples of potential research topics of interest include:

- Study of transboundary transport of marine plastics in the context of accumulation zones;
- Overlap between accumulation zones and critical habitats or migration routes of threatened and endangered species;
- Concentration of plastic in different types (taxa/trophic position) and sources (marine capture/aquaculture) seafood.

The topic of ‘lost and abandoned fishing gear’ has also been identified as a priority research topic. Although there is a strong push from international bodies on this topic, there is little interest from the regional bodies and limited interest from the research community. However, anecdotal evidence suggests that it may be a prevalent issue in this region.

Secondary recommendations are based on the gaps identified in section 7.2.2 above. They concern the following research topics:

- Methodology for the monitoring and assessment of marine litter
- Contribution from rivers/river basin management
- Fragmentation and degradation

Research on these 3 topics can also take place concurrently. In the context of the region, examples of potential research topics of interest include:

- Comparing plastic waste monitoring methodologies according to purpose;
- Consistency of units between upstream data from waste management and re-collection of waste;
- Standardised protocol;
- Fragmentation and degradation of plastic types that are the most common in the coastal and marine environment in the climatic conditions of Southeast Asia (combined impact of temperature, humidity, seawater, location in the marine environment and other relevant weathering factors);
- Life-cycle of plastic in the environmental condition of Southeast Asia (heat, humidity, etc for the most common types of plastic used).

This review also identified three research topics as needing more research. Although the interest level overall is low, these topics are relatively new research areas. The issues of pollution from fiber reinforced plastic vessels and from hull scraping and marine coating have been identified in the context of the limitation of dumping at sea. The number of small and medium-size fiber reinforced plastic vessels in the region suggests that it may be a threat to consider as they are reaching the end of their life span.

Finally, eight research topics for which natural science research was considered mostly not applicable are identified in the recommendation table (Table 11) as ‘potential gaps’ due to them being of interest to international and regional bodies and initiatives. These topics would deserve research attention from social scientists and multidisciplinary research teams.

References

Abreo NAS (2018). Marine plastics in the Philippines: a call for research. Philippine Science Letters 11, 18–19.

Abreo NAS, Macusi E, Cuenca G, Ranara CT, Andam M, Cardona CL and Arabejo GF (2015). Nutrient Enrichment, Sedimentation, Heavy Metals and Plastic Pollution in the Marine Environment and its Implications on Philippine Marine Biodiversity: A Review. IAMURE International Journal of Ecology and Conservation 15: 11–168.

Abreo NAS, Macusi ED, Blatchley DD, Cuenca-Ocay G (2016a). First evidence of plastic ingestion by the rare Deraniyagala's beaked whale (Mesoplodon hotaula). IAMURE International Journal of Ecology and Conservation 19: 16–36.

Abreo NAS, Macusi ED, Blatchley DD and Cuenca G (2016b). Ingestion of marine plastic debris by green turtle (Chelonia mydas) in Davao Gulf, Mindanao, Philippines. Philippine Journal of Science 145: 17–23.

Abreo NAS, Blatchley D and Superio MD (2019a). Stranded whale shark (Rhincodon typus) reveals vulnerability of filter-feeding elasmobranchs to marine litter in the Philippines. Marine Pollution Bulletin 141: 79–83.

Abreo NAS, Thompson KF, Arabejo GFP and Superio MDA (2019b). Social media as a novel source of data on the impact of marine litter on megafauna: The Philippines as a case study. Marine Pollution Bulletin 140: 51–59.

Alam FC, Sembiring E, Muntalif BS and Suendo V (2019). Microplastic distribution in surface water and sediment river around slum and industrial area (case study: Ciwalengke River, Majalaya district, Indonesia). Chemosphere 224: 637–645.

ASEAN Secretariat News (2018, July 2). ASEAN joins movement to beat plastic pollution. Retrieved from: https://asean.org/asean-joins-movement-beat-plastic-pollution/

Barasarathi J, Periathamby A, Fauziah SH, and Emenike C (2014). Microplastic abundance in selected mangrove forest in Malaysia. In Proceeding of The ASEAN Conference on Science and Technology 2014. Pp. 1–5.

Bhargava S, Lee SSC, Ying LSM, Neo ML, Teo SL-M and Valiyaveettil S (2018). Fate of nanoplastics in marine larvae: A case study using barnacles, Amphibalanus amphitrite. ACS Sustainable Chemistry and Engineering 6: 6932–6940.

Chua MAH, Lane D, Ooi SK, Tay S and Kubodera T (2019). Diet and mitochondrial DNA haplotype of a sperm whale (Physeter macrocephalus) found dead off Jurong Island, Singapore. PeerJ. 7. 10.7717/peerj.6705.

Climate and Clean Air Coalition (2015). Solid Waste Management City Profile - Vientiane Capital, LAO People's Democratic Republic. Retrieved from: http://www.waste.ccacoalition.org/sites/default/files/files/vientiane-_city_profile_vientiane_capital_lao.pdf

Coordinating Ministry for Maritime Affairs, (2018) Retrieved from: https://maritim.go.id/konten/indonesias-plan-action-marine-plastic-debris-2017-2025/

Cordova MR and Wahyudi AJ (2016). Microplastic in the deep-sea sediment of southwestern Sumatera waters. Marine Research in Indonesia 41(1): 27–35.

Curren E and Leong SCY (2019). Profiles of bacterial assemblages from microplastics of tropical coastal environments. Science of the Total Environment 655: 313–320.

Department of Environment, Parks and Recreation (2015). Recycle 123 Handbook. Ministry of Development, Brunei Darussalam 36 pp.

Entwistle A, Mihaylova D and Akester H(2018). Fauna & Flora International expands strategy on marine plastics. Oryx, 52(4), 613–614.

Fauziah SH, Liyana IA and Agamuthu P (2015). Plastic debris in the coastal environment: The invincible threat? Abundance of buried plastic debris on Malaysian beaches. Waste Management & Research 33(9): 812–821.

Fondazione ACRA (2016). ACRA Social Report 2016. Retrieved from: https://issuu.com/fondazioneacra/docs/acra_socialreport2016

Global Alliance for Incinerator Alternatives (2019). Plastics exposed: How Waste Assessments and Brand Audits are Helping Philippine Cities Fight Plastic Pollution. Philippines 59 pp.

Handyman DIW, Purba NP, Pranowo WS, Harahap SA, Dante IF, Yuliadi LPS (2019). Microplastics Patch Based on Hydrodynamic Modeling in The North Indramayu, Java Sea. Polish Journal of Environmental Studies 28:135–142.

Hoornweg D and Perinaz B-T (2012). What a Waste : A Global Review of Solid Waste Management. Urban development series knowledge papers no. 15. World Bank, Washington, DC.

Ibrahim YS, Azmi AA, Shukor SA, Anuar ST and Abdullah SA (2016). Microplastics ingestion by Scapharca cornea at Setiu Wetland, Terengganu, Malaysia. Middle-East Journal of Scientific Research 24(6): 2129–2136.

Ibrahim YS, Rathnam R, Anuar ST, Khalik WMAWM (2017). Isolation and characterisation of microplastic abundance in Lates calcarifer from Setiu Wetlands, Malaysia. Malaysian Journal of Analytical Sciences 21(5): 1054–1064.

Ismail MR, Lewaru MW and Prihadi DJ (2018). Microplastics ingestion by fish in the Biawak Island. World Scientific News 106: 230–237.

Jambeck JR, Geyer R, Wilcox C, Siegler TR, Perryman M, Andrady A, Narayan R and Law KL (2015). Plastic waste inputs from land into the ocean. Science 347: 768–771.

Kalnasa ML, Boter LC, Lantaca SM, Flores G, and VRK Galarpe (2018). Occurrence and characterization of surface sand microplastic and litter: first observation in Macajalar Bay, Philippines. Retrieved from: ResearchGate

Karami A, Golieskardi A, Choo CK, Larat V, Galloway TS and Salamatinia B (2017a). The presence of microplastics in commercial salts from different countries. Scientific Reports 7: 46173.

Karami A, Golieskardi A, Ho YB, Larat V and Salamatinia B (2017b). Microplastics in eviscerated flesh and excised organs of dried fish. Scientific Reports 7: 5473.

Karami A, Golieskardi A, Choo CK, Larat V, Karbalaei S and Salamatinia B (2018). Microplastic and mesoplastic contamination in canned sardines and sprats. Science of the Total Environment 612: 1380–1386.

Khalik WMAWM, Ibrahim YS, Anuar ST, Govindasamy S and Baharuddin NF, (2018) Microplastics analysis in Malaysian marine waters: A field study of Kuala Nerus and Kuantan. Marine Pollution Bulletin 135: 451–457.

Lahens L, Strady E, Kieu-Le TC, Dris R, Boukerma K, Rinnert E, Gasperi J and Tassin B (2018). Macroplastic and microplastic contamination assessment of a tropical river (Saigon River, Vietnam) transversed by a developing megacity. Environmental Pollution 236: 661–671.

Lebreton LCM, van der Zwet J, Damsteeg J–W, Slat B, Andrady A, and Reisser J (2017). River plastic emissions to the world's oceans. Nature Communications 8, 15611. https://doi.org/10.1038/ncomms15611

Manalu AA, Hariyadi S and Wardiatno Y (2017). Microplastics abundance in coastal sediments of Jakarta Bay, Indonesia. AACL Bioflux 10(5): 1164–1173.

Manullang CY (2018). Current Status and Future Prospect of Marine Pollution Research in the Banda Sea. IOP Conference Series: Earth and Environmental Science. 184. 012007. 10.1088/1755-1315/184/1/012007.

Mohamed Nor NH and Obbard JP (2014). Microplastics in Singapore's coastal mangrove ecosystems. Marine Pollution Bulletin 79: 278–283.

National Environment Agency (2019). Waste management statistics and overall recycling measures. Retrieved from: https://www.nea.gov.sg/our-services/waste-management/waste-statistics-and-overall-recycling

Ng KL and Obbard JP (2006). Prevalence of microplastics in Singapore's coastal marine environment. Marine Pollution Bulletin 52: 761–767.

Noik VJ and Tuah PM (2015). A first survey on the abundance of plastics fragments and particles on two sandy beaches in Kuching, Sarawak, Malaysia. In IOP Conference Series: Materials Science and Engineering, 78(1): 012035.

Nordén A and Karlsson S (2018). Optimizing the placement of cleanup systems for marine plastic debris: A multi-objective approach. Royal Institute of Technology, Stockholm, Sweden. 44 pp.

Ocean Conservancy (2018). Building a Clean Swell. The International Coastal Cleanup 2018 Report. Washington, DC. 25 pp.

Ocean Conservancy and McKinsey Centre for Business and Environment (2015). Stemming the Tide: Land-based Strategies for a Plastic-Free Ocean. 48 pp.

Ong R, Chim CK, Lee Y-l, Tong S and Tay T (2015). Blacktip reef sharks caught in trammel nets at Lazarus Island. Singapore Biodiversity Records 2015: 158–159.

Progresif (2018, August 17). So what's the problem with plastic waste? And what can we do about it? Retrieved from: https://progresif.com/the-problem-with-plastic-waste-and-what-can-we-do-about-it/

Provincial Departments of Planning (2015). Data Documentation on Provincial-Municipality Situation in 2015.

Purba NP, Syamsuddin ML, Sandro R, Pangestu IF and Prasetio MR (2017) Distribution of marine debris in Biawak Island, West Java, Indonesia. World Scientific News 66: 281–292.

Purba NP, Ihsan YN, Faizal I, Handyman DIW, Widiastuti KS, Mulyani PG, Tefa MF and Hilmi M (2018a). Distribution of macro debris in Savu Sea Marine National Park (Kupang, Rote, and Ndana Beaches), East Nusa Tenggara, Indonesia. World News of Natural Sciences 21: 64–76

Purba NP, Dewanti L Apriliani I, Herawati H and Faizal I (2018b). Distribution of Macro Debris at Pangandaran Beach, Indonesia. World Scientific News 103: 144–156.

Qaisrani Z, Shams S and Guo Z (2016). Analysis of Debris Flow in Kedayan River, Brunei Darussalam. Analysis of debris flow in Kedayan River, Brunei Darussalam. In: Brunei International Conference on Engineering and Technology (BICET), 2016. Universiti Teknologi Brunei (UTB). 3 pp.

Ramos A, Purba NP, Faizal I, Mulyani Y and Syamsuddin ML (2018). Microplastic tracking from Pacific Garbage to northern Indonesia Sea. Jurnal Perspektif Pembiayaan dan Pembangunan Daerah 6(1): 87–96.

Richardson K, Gunn R, Wilcox C and Hardesty BD (2018). Understanding causes of gear loss provides a sound basis for fisheries management. Marine Policy 96: 278-284.

Rochman CM, Tahir A, Williams SL, Baxa DV, Lam R, Miller JT, Teh FC, Werorilangi S, and Teh SJ. (2015). Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Scientific Reports 5: 14340.

Ryan PG (2018). Entanglement of birds in plastics and other synthetic materials. Marine Pollution Bulletin 135: 159–164.

Saeed MO, Hassan MN and Mujeebu MA (2009). Assessment of municipal solid waste generation and recyclable materials potential in Kuala Lumpur, Malaysia. Waste Management 29: 2209–2213.

Seng K, Kuok F and Hul S (2015). Analysis of solid waste composition and waste forecasting in Phnom Penh with the production of methane from Dangkor landfill, Cambodia. Institute of Technology of Cambodia.

Shams S, Juani RHM and Guo Z (2014). Integrated and sustainable solid waste management for Brunei Darussalam. In: 5th Brunei International Conference on Engineering and Technology (BICET), 2014. 6 pp.

Shuker IG and Cadman CA (2018). Indonesia - Marine debris hotspot rapid assessment : synthesis report (English). Marine Debris Hotspot Rapid Assessment (Synthesis Report). Washington, D.C. : World Bank Group. Retrieved from: http://documents.worldbank.org/curated/en/983771527663689822/Indonesia-Marine-debris-hotspot-rapid-assessment-synthesis-report

Singapore Environment Council (2018). Consumer Plastic and Plastic Resource Ecosystem in Singapore. Singapore 82 pp.

Syakti AD (2017). Microplastics Monitoring in Marine Environment. Omni-Akuatika 13(2): 1–6.

Syakti AD, Bouhroum R, Hidayati NV, Koenawan CJ, Boulkamh A, Sulistyo I, Lebarillier S, Akhlus S, Doumenq P and Wong-Wah-Chung P (2017). Beach macro-litter monitoring and floating microplastic in a coastal area of Indonesia. Marine Pollution Bulletin 122(1-2): 217–225.

Syakti AD, Hidayati NV, Jaya YV, Siregar SH, Yude R, Suhendy, Asia L, Wong-Wah-Chungg P and Doumenqg P (2018). Simultaneous grading of microplastic size sampling in the Small Islands of Bintan water, Indonesia. Marine Pollution Bulletin 137: 593–600.

Tharamon P, Praisanklul S and Leadprathom N (2016). Contamination of microplastic in bivalve at Chaolao and Kungwiman beach Chanthaburi province. Khon Kaen Agricultural Journal 44(1): 738–744.

Thushari GGN, Senevirathna JDM, Yakupitiyage A and Chavanich S (2017). Effects of microplastics on sessile invertebrates in the eastern coast of Thailand: An approach to coastal zone conservation. Marine Pollution Bulletin 124: 349–355.

van Emmerik T, Kieu-Le T-C, Loozen M, van Oeveren K, Strady E, Bui X-T, Egger M, Gasperi J, Lebreton L, Nguyen P-D, Schwarz A, Slat B, Tassin B (2018). A methodology to characterize riverine macroplastic emission into the ocean. Frontiers in Marine Science 5:372.

Wichai-utcha N and Chavalparit O (2019). 3Rs Policy and plastic waste management in Thailand. Journal of Material Cycles and Waste Management 21:10–22.

This publication is available from: https://cil.nus.edu.sg