NUS National University of Singapore

COBSEA COORDINATING BODY ON THE SEAS OF EAST ASIA

# STATUS OF RESEARCH, LEGAL AND POLICY EFFORTS ON MARINE PLASTICS IN ASEAN+3

A Gap Analysis at the Interface of Science, Law and Policy

This report was prepared by a research team from several research centres at the National University of Singapore (NUS) under the coordination of the Centre for International Law (CIL) and support from the Coordinating Body on the Seas of East Asia (COBSEA), with support from the Global Partnership on Marine Litter (GPML) and the SEA circular project implemented by COBSEA and the United Nations Environment Programme (UNEP), as well as support by the Singapore Maritime Institute under CIL-MPA Oceans Governance Research Programme - Project ID SMI-2019-MA-03 and the National Research Foundation of Singapore. The report was prepared with the aim of supporting and strengthening marine litter research and informing more robust policy making, in line with the COBSEA Regional Action on Marine Litter (RAP MALI) and other regional actions plans applicable in ASEAN+3. However, this report represents the opinion of the authors writing in their academic capacity. It does not purport to represent the view of COBSEA participating countries nor has been vetted by COBSEA governing bodies. But it has been shared for information with COBSEA participating countries.


## Lead authors

Youna Lyons, Mei Lin Neo, Amanda Lim, Yuke Ling Tay and Vu Hai Dang from NUS

## Contributors

Kanin Laopirun from National University of Singapore, Natalie Harms and Jerker Tamelander from COBSEA Secretariat



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Enquiries can be sent to: younalyons@nus.edu.sg; unep-cobsea@un.org

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The Global Partnership on Marine Litter (GPML) is a multi-stakeholder partnership that provides a unique mechanism to bring together all actors working to prevent marine litter and microplastics, with the aim of sharing knowledge and experience and advancing solutions to this pressing global issue. Its mission is to protect the global marine environment, human wellbeing and animal welfare by addressing the global problem of marine litter, in line with Target 14.1 of the Sustainable Development Goals (SDGs). Any entity working to prevent and reduce marine litter can join the Partnership at: www.gpmarinelitter.org

The SEA circular project is implemented by the United Nations Environment Programme (UNEP) and the Coordinating Body on the Seas of East Asia (COBSEA), with support from the Swedish Government. SEA circular works in partnership with governments, businesses, civil society, academia, and international partners to reduce and prevent plastic pollution. The initiative promotes market-based solutions and enabling policies to transform plastic value-chain management, strengthens the science base for informed decision making, engages consumers and disadvantaged groups through targeted outreach, and leverages COBSEA's regional mechanisms to tackle the transboundary challenge of marine litter. www.sea-circular.org

# EXECUTIVE SUMMARY

*STATUS OF RESEARCH, LEGAL AND POLICY EFFORTS ON MARINE PLASTICS IN ASEAN+3: A GAP ANALYSIS AT THE INTERFACE OF SCIENCE, LAW AND POLICY*

## Scope and Content

The **scope** of this study is pollution from marine plastic in Southeast Asia and East Asia, with a focus on the 13 member states of ASEAN+3: Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, The Philippines, Singapore, Thailand and Viet Nam (Vietnam), plus The People's Republic of China (China), Japan and The Republic of Korea (RO Korea)

The **objective** is to provide a comprehensive review of the current knowledge and scientific research on pollution from marine plastics in ASEAN+3, as well as the approaches and work streams on this topic by international and regional intergovernmental bodies and initiatives that have a relevant mandate or scope in this sphere. The study is divided into two main parts.

**Part 1** focuses first on reviewing the status of scientific research on pollution from marine plastics in ASEAN+3. It includes an overall regional summary of this status and an analysis of the findings. Second, it reviews and discusses the mandates, approaches and status of work by international and regional intergovernmental bodies, as well as relevant regional public-private and fully-private initiatives that seek to combat pollution from marine plastics.

**Part 2** is a gap analysis between the scientific research and the information needs for policy-making purposes, with a focus on the Regional Action Plan on Marine Litter (RAP MALI) of the Coordinating Body on the Seas of East Asia (COBSEA) and the ASEAN Framework of Action on Marine Debris (FAMAD). The work of other regional bodies is also considered. This part also discusses regulatory approaches and obstacles to combat pollution from marine plastics based on four previous reviews. - Recommendations on research needed and ways to improve the science-policy-law interface are provided at the end.

## Findings in Scientific Research

This study includes a stock-taking inventory of 371 scientific publications on pollution from marine plastics in ASEAN+3 from 2001 to 2019. The inventory is publicly available online at https://cutt.ly/kstW1Qy.

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

Of these publications, 145 are from ASEAN countries and the remaining 226 are from the three East Asian countries. Scientific research in marine plastics is an important and ongoing effort within ASEAN+3, particularly as most of the 145 research papers from the ASEAN countries were published from 2017 onwards. However, an analysis and comparison of the scientific research reveals a more nuanced picture. First, only RO Korea and Japan have published research in the full range of possible research areas. They both have publications in all 10 of the research clusters identified in this report. Second, China, Indonesia and Malaysia follow closely with nine out of 10 research clusters, although China has substantially more publications than the other two states. Finally, over the years, research foci on marine plastics in China, Japan and RO Korea have expanded from examining the distribution and presence of plastic debris in the environment and within organisms, to investigating the impacts of plastics in organisms through experiments and predictive models to improve environmental monitoring.

Of the 10 research clusters reviewed, the **weakest research clusters** relate to:

- ◊ the **interactions of plastics with the marine environment**, such as the impacts of plastic-associated (organic and inorganic) contaminants to the marine environment and organisms;
- ◊ **social perceptions and behaviour** in the context of measures to combat pollution from marine plastics;
- ◊ **fragmentation, degradation patterns, behaviour and transport of plastic particles**; and,
- ◊ **contribution of plastics from marine fisheries** (including ALDFGs) as well as other sea-based sources of pollution (including shipping and offshore installations).

Specific **gaps within research clusters** are:

- ◊ a lack of **baseline on the distribution and abundance of plastic debris** on the seabed and in the subsoil at the regional scale, including a lack of understanding of **sources and pathways;**
- ◊ **plastic polymer-specific research** (e.g. PP, PE, EPS, PET) based on their presence in the marine environment, and potential biological toxicity to marine biota;
- ◊ research on ecological and environmental impacts such as the **physical and physiological impacts of marine debris in biota and marine habitats**, including uptake and accumulation in the organisms' bodies (e.g. respiratory and branchial systems), transfer of plastic particle through the food chain;
- ◊ research on **microbial assemblages** found on plastic debris in biota; as well as
- ◊ research on socio-economic impacts such as **human health, food safety, and economic loss** to quantitatively assess socio-economic costs due to marine plastic pollution in local communities.

## Findings in the Work of Governmental Institutions and Other Initiatives

This study also analysed the work of seven global bodies or regimes that have a particular interest in marine plastic pollution. Three of these international bodies/regimes stood out with their interest in most research topics considered: UNEA and UNEP; the LC/LP, the body in charge of regulating disposal of waste at sea; and GESAMP, a UN research body. The critical work undertaken under the auspices of the Basel Convention to combat marine plastic pollution would therefore benefit from greater cooperation and outreach with these bodies at global and regional levels.

At regional level, five regional bodies that include different combinations of most of the ASEAN+3 countries are engaged in combatting pollution from marine plastics: the ASEAN, ASEAN+3, EAS (the East Asia Summit), COBSEA and APEC (the Asia-Pacific Economic Cooperation). The extent to which on-going research efforts are sufficient to support the work of these bodies as well as approaches to ensure mutually supporting efforts are included in the gap analysis and in the recommendations.

Gap Analysis at Regional Level

Whilst ongoing research is providing critical information to inform the work of intergovernmental bodies, as well as to engage other public or private initiatives involved in addressing pollution from marine plastics, there are several factors that limit the guidance that this research can provide to the identification of specific response measures:

## 1. Scientific uncertainty and risk assessment

Whilst understanding of exposure and ingestion of plastic has progressed greatly, there remains areas of uncertainty that limit the clarity needed by governments to adopt effective measures. This includes in particular, an understanding with sufficient granularity of:

(i) The status of plastic pollution in the marine environment with adequate baselines in different environs and at a scale where policy measures can be adopted;
(ii) The transformation and fate of plastic particles in the marine environment (i.e. degradation, fragmentation, transport, sinking rate, etc);
(iii) Presence and persistence of different polymers in the marine environment and their toxicity to human health and marine ecosystems, including through associated organic and inorganic contaminants. Areas that need further research include the understanding of uptake by marine organisms through other paths than ingestion, experimental studies of physiochemical impacts, relative exposure of different species and ecosystems to entanglements, composition of microbial assemblages and tropic transfer; and
(iv) Different sources and pathways of plastic debris into the marine environment which are likely to be specific to activity and geography in order to adopt activity-specific measures and regulations that may be effective in decreasing input of marine plastics.

## 2. Priority in waste management: Closing the tap

The global discourse on combatting plastic pollution emphasises the development of a circular economy in order to reduce the production of plastic that may reach the natural environment. It is a mid- to long-term goal that all the UN documents emphasise and most agree on, even if as a conceptual goal. Whilst regional instruments also refer to the development of a circular economy, specific actions within these instruments focus instead on waste management, an immediate concern for most countries in SEA. Consistently, this report highlights the general focus of ASEAN+3 countries on waste management and their timid steps towards an Extended Producer Responsibility (EPR) approach which would make producers responsible for the full management of their project's life cycle. The EPR measures adopted to date focus on involving private actors in the management of the post-use of the products distributed by them to consumers. Further elaboration of the components of a circular economy in SEA is necessary before specific measures can be effectively adopted on this path. This should include shared and agreed definitions of the meaning of biodegradability in the context of plastic materials, as well as their recyclability. Research and development in waste management, low cost-low and technology recycling technologies, biodegradability and new plastics are therefore critical. In this context, the clean-up measures highlighted in several regional action plans appear realistic and necessary until waste management measures become effective.

## 3. Research and protocol fragmentation

COBSEA RAP MALI and ASEAN FAMAD include the development of several guidelines, standards and national reporting with a coordinated approach. Common objectives include the development of regional guidance for the monitoring of marine plastic pollution and for standardised methods. The ASEAN FAMAD also proposes the development of baselines for pollution from marine plastics. As a number of guidelines and protocols are being used in ASEAN+3 that suit different context and available technologies, research on comparable measures and/or bioindicators would be useful for that purpose.

The number of articles in ASEAN+3 that discuss methodologies and surveys (66%) suggests that the region is ready to develop its own adequate standardised methodology or a set of methodologies that result in comparable measures of marine plastic pollution. Importantly, such methodologies should have both a scientific and a policy-making aim and build on existing guidelines such as those from GESAMP and IOC WESTPAC. For such standardized methodologies to be commonly used by scientists, they have to be vetted by the specialised research community of the region on this subject area, which means that they would have to be developed in consultation with both the scientific community and governments. Similarly, research could better inform national policy through improved communication channels between both spheres of work (research and governance/policy), whether directly or through regional organisations. Finally, buy-in of other relevant stakeholders is also critical to ensure implementation of policy. This suggests the need for further research cooperation that integrates public, civil society and private efforts. An example of this is the SEA of Solutions held at the UN regional headquarters in Bangkok in October 2019.

Recommendations

A dominating feature of this study is the multi-layered complexity of the issues raised by pollution from marine plastics globally, as well as at regional level, in ASEAN+3. This complexity includes 1) the number of intergovernmental institutions involved and the resulting fragmentation of the governance framework (if not conceptually, at least at human level), 2) the diversity of stakeholder groups, and 3) unresolved scientific questions and risk assessment of the impact of marine plastics on human health and on marine ecosystems. Recommendations are divided into four axes of work:

## 1. Substantive issues in need of further research

This is a summary of the most pressing research needs according to this study:

- ◊ Risk assessment approach to characterising the **magnitude of the risk**
- ◊ **Standardisation of definitions for plastic products and biodegradability**
- ◊ **Sources and pathways** into the marine environment, including the determination of **criteria or guidelines for the identification of hotspots** where clean-up may be considered and identification of prevalent land-based and sea-based sources of plastics
- ◊ **Persistence, transformation, transport and fate** in the marine environment, including a mapping of the behaviour, transport and fate of plastic particles in the marine environment as well as exposure and vulnerability of marine areas and resources of particular ecological, social or economic value
- ◊ **Regional baseline and monitoring** with standardised or comparable measures that include microplastics in the water-colum, seabed and sub-soil and sensitive habitats

◊ Progress on the **understanding of impact on marine ecosystems and on human health**, possibly through measures of exposure and magnitude of the risk

**2. Research development and coordination** aimed at coordinating among stakeholder groups to further develop and consolidate a multi-disciplinary regional expert community, knowledge management and data sharing, as well as stakeholder engagement and consultation.

Research centres from ASEAN+3 that are engaged in supporting the East Asian Seas Regional Node of the GPML regional node could function as an organisational backbone of this network of regional experts. The agenda of this network of exchange would be focusing on addressing concerns and priorities highlighted by COBSEA WGML, taking into account the ASEAN's action plan and priorities in order to ensure consistency and mutual benefits for the region.

The research inventory established through this study for the region and made available online on the website of NUS Centre for International Law will be maintained to be used as a first regional database for knowledge management and transfer. It has been developed to be further enriched and updated over time.

**3. Cooperation bridges between relevant intergovernmental institutions and with regional experts** to develop guidelines and standardised definitions and procedures that may be used consistently throughout the region. Activities shared across regional bodies and open fora such as those that COBSEA may organise in the context of the GMPL may be leveraged for this purpose. In particular, mechanisms of exchange need to be developed between the ASEAN and ASEAN+ and COBSEA. Coordination with the EAS and APEC is also advised in order to synergise efforts and optimise resources.

**4. Develop context-specific outreach and education** to ensure effective transfer of relevant knowledge and capacity building in local coastal communities, as well as more generally, plastic producers, retailers and users.

Such transfer requires further research on social perception of pollution from marine plastics to improve the understanding of the readiness of relevant communities and stakeholder groups to embrace new measures, the barriers that may be encountered and the threshold of acceptability of different types of measures. Findings from research on these issues would usefully inform realistic and effective policy-making at local and national level. It would also be valuable to inform regional policy-making (in regional bodies) and support the taking into account commonalities and differences.

### Authors, sponsors and partners

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# TABLE OF CONTENTS

# ACRONYMS & ABBREVIATIONS

## ASEAN+3 MEMBER STATES' DESIGNATION

| | |
|---|---|
| BRN | Brunei Darussalam |
| KHM | Cambodia |
| IDN | Indonesia |
| LAO | Lao People's Democratic Republic |
| MYS | Malaysia |

| | |
|---|---|
| MMR | Myanmar |
| PHL | The Philippines |
| SGP | Singapore |
| THA | Thailand |
| VNM | Viet Nam (Vietnam) |

| | |
|---|---|
| CHN | The People's Republic of China (China) |
| ROK | The Republic of Korea (RO Korea) |
| JPN | Japan |

## INSTITUTIONS/ORGANISATIONS/BODIES/PROGRAMMES

| | |
|---|---|
| A*STAR | Agency for Science, Technology and Research (Singapore) |
| ACB | ASEAN Centre for Biodiversity |
| AEC | ASEAN Economic Community |
| AEPW | The Alliance to End Plastic Waste |
| AHEG | Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics |
| APEC | The Asia-Pacific Economic Cooperation, a group that aims to support sustainable economic growth and prosperity in the Asia-Pacific region |
| APFIC | Asia Pacific Fisheries Commission |
| APSC | ASEAN Political-Security Community |
| APT | ASEAN Plus Three (ASEAN+3) |
| ARF | ASEAN Regional Forum |
| ASEAN | Association of Southeast Asian Nations, a regional intergovernmental organisation (IGO) that promotes cooperation and economic integration among its members |
| ASEANO | ASEAN-Norwegian cooperation project on local capacity building for reducing plastic pollution in the ASEAN region |
| ASCC | ASEAN Socio-Cultural Community |
| AWGCME | ASEAN Working Group on Coastal and Marine Environment |
| AWGCW | ASEAN Working Group on Chemicals and Waste |
| BC | Basel Convention |
| BC COP | Basel Convention Conference of the Parties |
| BOBLME | Bay of Bengal Large Marine Ecosystem (BOBLME) project of the UN Food and Agricultural Organisation (FAO) |
| BPF | Best Practice Framework (GGGI framework on ALDFG) |
| BUITEMS | Balochistan University of Information Technology, Engineering, and Management Sciences (Pakistan) |
| CBD | 1992 Convention on Biological Diversity |
| CCOA | Commonwealth Clean Ocean Alliance |
| CEFAS | Centre for Environment, Fisheries and Aquaculture Science (UK) |
| CLiP | Commonwealth Litter Programme |

| | |
|---|---|
| COBSEA | Coordinating Body on the Seas of East Asia |
| COFI | Committee on Fisheries, FAO |
| CSEAS | Centre for Southeast Asian Studies (Indonesia) |
| CSIRO | Commonwealth Scientific and Industrial Research Organisation |
| CTI-CFF | Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security |
| DENR-BMB | Department of Environment and Natural Resources - Biodiversity Management Bureau, the Philippines |
| DEPR | Department of Environment, Parks and Recreation (DEPR), Ministry of Development in Brunei Darussalam |
| DMCR | Department of Marine and Coastal Resources, Ministry of Natural Resources and Environment, Thailand |
| EAF-Nansen | FAO programme “Supporting the Application of the Ecosystem Approach to Fisheries management considering climate and pollution impacts”, using research vessel “RV Dr Fridtjof Nansen”. |
| EAS | East Asia Summit |
| ECNU | East China Normal University (China) |
| ENS | Environmental Security Programme, INTERPOL |
| EU | European Union |
| FAO | UN Food and Agricultural Organisation |
| FFI | Fauna and Flora International, formerly known as Fauna and Flora Preservation Society, an international conservation charity and non-governmental organisation |
| FIA | Food Industry Asia |
| G20 | Group of Twenty – consists of Argentina, Australia, Brazil, Canada, China, the European Union, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, Republic of Korea, Turkey, the United Kingdom, and the United States (as of 2017) |
| G7 | Group of Seven – consists of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States |
| GEF | Global Environment Facility |
| GESAMP | The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection – an advisory body, established in 1969, that advises the United Nations (UN) system on the scientific aspects of marine environmental protection |
| GGGI | Global Green Growth Institute (RO Korea) |
| GGGI | Global Ghost Gear Initiative |
| GNC | Global Network of the Committed – a platform addressing marine litter linked to the UNEP´s Global Partnership on Marine Litter (GPML) |
| GPA | Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities |
| GPAP | Global Plastic Action Partnership |
| GPML | Global Partnership on Marine Litter – a 2012 launch during the United Nations Conference on Sustainable Development of a voluntary open-ended partnership for international agencies, Governments, businesses, academia, local authorities, nongovernmental organisations and individuals |
| ICC | International Coastal Cleanup |
| ICCS | International Coastal Cleanup (Singapore) |
| IETC | The International Environmental Technology Centre (Japan) |
| IGES | Institute for Global Environmental Strategies (Japan) |

| | |
|---|---|
| IMO | International Maritime Organisation |
| IMPEL | Implementation and Enforcement of Environmental Law (Europe) |
| INOS | Institute of Oceanography and Environment |
| IOC | Intergovernmental Oceanographic Commission, UNESCO |
| IOC-WESTPAC | Sub-commission for the Western Pacific of the Intergovernmental Oceanographic Commission |
| IRD | French Institute of Research for Development |
| IUCN | International Union for Conservation of Nature |
| JASTRe | Acronym for Jabatan Alam Sekitar, Taman dan Rekreasi (in Bahasa Melayu), referring to the Department of Environment, Parks and Recreation in Brunei Darussalam |
| KIOST | Korea Institute of Ocean Science and Technology, formerly known as Korean Ocean Research and Development Institute (KORDI) |
| LC/LP | London Convention and Protocol, part of the 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its 1996 Protocol |
| LIPI | Lembaga Ilmu Pengetahuan Indonesia (LIPI), the Indonesian Institute of Sciences |
| MARPLASTICCS | Marine Plastics and Coastal Communities, IUCN project |
| MARPOL | International Convention for the Prevention of Pollution from Ships |
| MCC | Marine Conservation Cambodia (Cambodia) |
| MEPC | Marine Environment Protection Committee, IMO |
| MESTECC | Ministry of Energy, Science, Technology, Environment and Climate Change (Malaysia) |
| MEWR | Ministry of Environment and Water Resources (Singapore) |
| MOF | Ministry of Oceans and Fisheries, Republic of Korea (formerly known as MOMF) |
| MOMF | Ministry of Maritime Affairs and Fisheries, Republic of Korea (presently known as MOF) |
| NEA | National Environment Agency (Singapore) |
| NERC | National Environment Research Council (UK) |
| NGO | Non-governmental Organisation |
| NIVA | Norwegian Institute for Water Research |
| NOAA | National Ocean and Atmospheric Administration |
| NORAD | Norwegian Agency for Development Cooperation |
| NPAP | National Plastic Action Partnership |
| NRF | National Research Foundation (Singapore) |
| NRP | National Recycling Programme (Singapore) |
| NTU | National Technological University (Singapore) |
| NUS | National University of Singapore (Singapore) |
| OPEC | Ocean Pollution and Ecotoxicology research group (Malaysia) |
| OPTOCE | Ocean Plastic Turned into an Opportunity in Circular Economy, project led by SINTEFF in 2019, available at https://optoce.no/ |
| OSEAN | Our Sea of East Asia Network (RO Korea) |
| OSR | Our Singapore Reefs (Singapore) |
| P&G | The Procter & Gamble Company (USA) |
| PEMSEA | Partnerships in Environmental Management for the Seas of East Asia |
| PCWG | Pollution Crime Working Group, INTERPOL |

| | |
|---|---|
| PNLG | PEMSEA Network of Local Governments |
| PWMI | Plastic Waste Management Institute (Japan) |
| R3CS | Regional Capacity Centre for Clean Seas, COBSEA |
| RC | Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade |
| RFB | Regional Fisheries Bodies |
| RFMO/A | Regional Fisheries Management Organisations/Arrangements |
| SCELSE | Singapore Centre for Environmental Life Sciences Engineering |
| SDS-SEA | Sustainable Development Strategy for the Seas of East Asia |
| SEAFDEC | Southeast Asian Fisheries Development Center |
| SEC | Singapore Environment Council (Singapore) |
| SIDA | Swedish International Development Cooperation Agency |
| SIDS | Small Island Developing States |
| TIN | The Incubation Network, a Circular Initiative programme |
| UK | United Kingdom |
| UMT | Universiti Malaysia Terengganu (Malaysia) |
| UN | United Nations |
| UNCLOS | United Nations Convention on the Law of the Sea |
| UNDP | United Nations Development Programme |
| UNEA | United Nations Environment Assembly |
| UNEP | United Nations Environment Programme |
| UNESCO | United Nations Educational, Scientific and Cultural Organisation |
| UNGA | United Nations General Assembly |
| UN-REN | Regional Enforcement Network for Chemicals and Waste, a project under UNEP |
| USA | United States of America |
| USAID | U.S. Agency for International Development |
| UTB | Universiti Teknologi Brunei (Brunei Darussalam) |
| WEF | World Economic Forum |
| WESTPAC | Western Pacific |
| WHO | World Health Organisation |
| WMO | World Meteorological Organisation |
| WRI | World Resources Institute |
| WWF | World Wildlife Fund |

## TECHNICAL TERMS AND OTHER COMMON ABBREVIATIONS

| | |
|---|---|
| 3Rs | Reduce, reuse, recycle |
| 4Rs | Refuse, reduce, reuse, recycle |
| ALDFG | Abandoned, Lost or otherwise Discarded Fishing Gear |
| AP | Approved Permit |
| COP | Conference of Parties |
| EEZ | Exclusive Economic Zone |
| EPR | Extended Producer Responsibility |
| F&B | Food and beverage |
| FAD | Fishing Aggregating Device |
| FIP | Fish Improvement Projects |
| FRP | Fibre-reinforced plastic |
| FTIR | Fourier Transform Infrared Spectroscopy – An analytical technique used to identify organic, polymeric, and, in some cases, inorganic materials, through the use of infrared light |
| IGO | Intergovernmental Organisation |
| MRF | Materials Recycling Facilities |
| MSW | Municipal Solid Waste |
| NGO | Non-Governmental Organisation |
| PIC | Prior Informed Consent procedure – A mechanism for formally obtaining and disseminating the decisions of importing Parties as to whether they wish to receive future shipments of those chemicals listed in Annex III of the Convention and for ensuring compliance with these decisions by exporting Parties |
| POPs | Persistent Organic Pollutants |
| S2S | Source-to-Sea approach |
| SDG | Sustainable Development Goal |
| SEM | Scanning Electron Microscope – A type of electron microscope that produces images of a sample by scanning the surface with a focused beam of electrons |
| SWOT | Strength, Weakness, Opportunities, Threats – A strategic analysis technique used to help a person or organisation identify strengths, weaknesses, opportunities, and threats related to business competition or project planning |
| WWTP | Wastewater Treatment Plant |

## DEFINITIONS

**Action Plan** – A comprehensive framework and set of actions to help support the achievement of the goal

**Adsorption (onto plastic particles)** – Adhesion of atoms, ions or molecules from a gas, liquid or dissolved solid to a surface; here, a plastic particle, whether nano, micro, meso or macro-sizes

**Bioaccumulation** – The gradual increase and accumulation of substances in an organism

**Illegal trade of plastic waste** – The import and export of plastic waste, usually containing toxic and hazardous materials, against legal binding policies and trade systems

**Land-based sources (of pollution) –** Pollution resulting from the discharge of materials or substances from the terrestrial environment to the marine environment

**Macroplastics** – Relatively large particles of plastic found especially in the marine environment larger than microplastics and, where applicable, mesoplastics

**Mandate** – In the context of an institution (government body, corporation, NGO, Charity, etc), an official written authority and terms of action devolved to this institution by the individuals or entities that established it or govern it

**Marine debris –** any persistent solid material, manufactured or processed, that is disposed of directly or indirectly into the marine environment. Marine debris, marine litter are often used interchangeably. Marine plastic debris (or litter) is also often used interchangeably with marine debris (or litter) although debris (or litter) can include non-plastic materials. This interchangeable use of terms results from plastic debris being dominated by plastic particles and threats of pollution from marine debris being focused on the plastic components

**Marine environs** – Environment in the aquatic environment where the marine plastic is found occurring, including those of marine biota, shoreline, sea surface or water column and seafloor environment (as adopted from the 2019 GESAMP report)

**Marine litter** – See marine debris

**Marine plastics** – Term commonly used to designate plastic fragments or pieces found in the marine environment. They are used interchangeably with marine plastic debris, marine plastic litter or marine plastic particles and include macro- and micro-plastic debris

**Mesoplastics** – Plastic particles that are visible to the naked eye, generally >1-5mm and <1-2cm

**Microplastics** – Small plastic particles which can be formed from the degradation of larger pieces (secondary plastic) of plastic or as-is (primary plastic). Their size definition is commonly referred to as < 5 mm or < 1 mm (i.e. < 1,000 μm). This report generally follows this definition or indicates where researchers have preferred a different size boundary

**Nanoplastics** – Plastic particles that result from the degradation of larger plastic particles and are of the sub-micrometre scale. No agreed size definition. Possibly <0.1 to 1mm

**Plastic additives** – Chemical substances contained in all plastic products for enhancing polymer properties and prolonging their life, including those of plasticizers, flame retardants, antioxidants, acid scavengers, light and heat stabilizers, lubricants, pigments, antistatic agents, slip compounds and thermal stabilizers

**Plastic polymers types** – Plastic type based on its chemical composition

**Plastic-associated organic contaminants** – Chemical substances derived from living organisms and are associated commonly with plastic, either as a plastic additive or as sorbed from the surrounding environment

**Plastic-associated inorganic contaminants** – Chemical substances derived from non-living organisms and are associated commonly with plastic, usually as attached/sorbed from the surrounding environment onto the surface of the plastic and usually refer to heavy metals and its compounds

**Plastic sorption** – The surface attachment (i.e. adsorption) or detachment (i.e. desorption) of substances on the plastic

**Plastic waste** – Plastic that is deemed to be at the end of its life cycle, unable to be recycled or repurposed for a new purpose as plastic scrap

**Plastic scrap** – Plastic that may still hold potential value and can be used for other purposes when recycled or repurposed and is therefore not plastic waste

**Persistent Organic Pollutants (POPs)** – A group of chemicals possessing the following characteristics: (i) highly toxic to humans and wildlife; (ii) lasts for many years in the environment before degrading into less dangerous forms; (iii) bio-accumulates in the food chain (bio-accumulation); and (iv) transported over large distances through air and water, and can be found worldwide

**Primary plastic** – Plastic that is purposefully manufactured to carry out a specific function (e.g. abrasive particles, powders for injection moulding, resin pellets for bulk transportation of polymers between manufacturing sites);

**Sea-based sources (of pollution)** – Pollution that results from the direct release (accidently or purposely) of substances or materials into the marine environment by maritime activities e.g. shipping, fishing, offshore installations or dumping of refuse at sea

**Secondary plastic –** Plastic that represents the results of wear and tear or fragmentation of larger objects, both during use and following loss to the environment (e.g. textile and rope fibres, weathering and fragmentation of larger litter items, vehicle tyre wear, paint flakes)

**Virgin plastic** – Newly-created plastics without any components of recycled material in it, usually produced directly from petrochemical feed-stock, such natural gas or crude oil

For definitions on the 23 research foci identified in the analysis of this report, see Part 1, Section 1.2.2 on the methodology of scientific research.

## LIST I. PLASTIC POLYMER TYPE AND ITS ABBREVIATIONS (IF ANY)

| | | | |
|---|---|---|---|
| - | Acrylic polymers | PC/ABS | Polycarbonate/acrylonitrile butadiene styrene |
| AN | Acrylonitrile | PCB | Polychlorinated biphenyl |
| ABS | Acrylonitrile butadiene styrene | - | Polyester |
| ASA | Acrylonitrile styrene acrylate | PAK | Polyester alkyd |
| - | Alkanes C10-C13 | - | Polyether |
| - | Alkyd | PES | Polyethersulfone |
| - | Butadiene | - | Polyethyl acrylate |
| CP | Cellophane | - | Polyethyl acrylate styrene |
| CL | Cellulose | PE | Polyethylene |
| - | Dipar | PEPD | Polyethylene propylene diene |
| - | Epoxy (resins) | PET or PETE or or PETP or PET-P | Polyethylene terephthalate |
| - | Ethers | - | Polyethylene/ethylacrylate copolymer |
| - | Ethylene | PEP or PE/PP | Polyethylene-polypropylene copolymer |
| EDPM | Ethylene propylene diene monomer | - | Polyisoprene/polystyrene |
| EVA or PEVA | Ethylene-vinyl acetate or Polyethylene-vinyl acetate | PMMA | Polymethyl methacrylate |
| EPS | Expanded polyester | POM | Polyoxymethylene |
| XPS | Extruded polyester | - | Polyphenylene |
| FPS | Foamed polystyrene | PPS | Polyphenylene sulphides |
| GPPS | General purpose polystyrene | PP | Polypropylene |
| HDPE | High-density polyethylene | PP/EPR | Polypropylene/ethylene-propylene rubber |
| LLDPE | Linear low-density polyethylene | PP/EPDM | Polypropylene/ethylene-propylene-diene terpolymer |
| LDPE | Low-density polyethylene | - | Polysiloxanes/silicones |
| MDPE | Medium-density polyethylene | PS | Polystyrene |
| - | Melamine formaldehyde resins | - | Polystyrene–(ethylene–butylene)–styrene |
| - | Mixed PE, PP and PET | PSUL | Polysulfone |
| - | Nylon | PTFE | Polytetrafluoroethylene/teflon |
| - | Paraffin | PU or PUR | Polyurethane |
| - | Phenol formaldehyde resins | PVAC | Polyvinyl acetate |
| - | Phenoxy resin | PVA | Polyvinyl alcohol |
| PB | Poly(1-butene) | - | Polyvinyl butyral |
| - | Poly(1-octene) | PVC | Polyvinyl chloride |
| - | Polyacetals | - | Polyvinyl sulfate |
| - | Polyacrylate/styrene | PVDC | Polyvinylidene dichloride |
| PAN | Polyacrylonitrile | - | Rayon/viscose |
| PA | Polyamides | - | Resin |
| PAA or PARA | Polyarylamide | - | Styrene |

| | | | |
|---|---|---|---|
| PAE | Polyarylether | - | Styrene-acrylate |
| PBD | Polybutadiene | SAN | Styrene-acrylonitrile |
| PBMA | Polybutyl methacrylate | - | Synthetic cellulose |
| PBAT | Polybutylene adipate terephthalate | - | Urea formaldehyde resins |
| PBT | Polybutylene terephthalate | - | Urethane alkyd |
| PCL | Polycaprolactone | - | Vinyl |
| PC | Polycarbonate | - | Wax |

## LIST II. PLASTIC-ASSOCIATED CONTAMINANTS

### Organic contaminants as plastic additives

| | | | |
|---|---|---|---|
| 4-MBC | 4-methylbenzylidene camphor | PCB | Polychlorinated biphenyls |
| - | Aldrin | - | Polychlorinated dibenzo-furan (Any congenor of) |
| BP-3 | Benzophone-3 | - | Polychlorinated dibenzo-p-dioxin (Any congenor of) |
| BPA | Bisphenol-A and its analogues | PAH | Polycyclic aromatic hydrocarbon |
| BHT | Butylated hydroxytoluene | PHC | Polyhalogenated carbazole |
| - | Chlordane | SCCP | Short-chain chlorinated paraffins |
| DDE | Dichlorodiphenyldichloroethylenes | - | Technical endosulfan and its related isomers |
| DDT | Dichlorodiphenyltrichloroethanes | TBC | Tris-(2,3-dibromopropyl) isocyanurate |
| - | Dieldrin | - | UV320 |
| - | Endrin | - | UV326/Tinuvin 326 |
| - | Heptachlor | - | UV327 |
| HBCDD | Hexabromocyclododecane | - | UV328 |
| HCB | Hexachlorobenzene | BP-12 | UV531/BP-12 |
| α-HCH | Alpha hexachlorocyclohexane | - | UvinualMC80 |
| β-HCH | Beta hexachlorocyclohexane | **Pharmaceutical drugs** | |
| γ-HCH | Gamma hexachlorocyclohexane | TC | Tetracycline |
| δ-HCH | Delta hexachlorocyclohexane | SMX | Sulfamethoxazole |
| HEHA | Hexanoic acid, 2-ethyl-hexadecylester | CIP | Ciprofloxacin |
| - | Irgafos168 and its 2 degradation products: 2,4-di-tert-butylphenol (2,4-DTBP) and tris(2,4-di-tert-butylphenyl)phosphate2) | SMT | Sulfamethazine |
| - | Irganox 1010 | AMX | Amoxicillin |
| - | Irganox 1076 | CEP | Cephalosporin |
| - | Nonachlor | PRP | Propranolol |
| NPs | Nonylphenol and its antioxidants, plasticisers, and degradation products | SER | Sertraline |
| - | Organic cyanides | SDZ | Sulfadiazine |
| - | Organophosphorus compounds | TMP | Trimethoprim |
| - | Organohalogen compounds | TYL | Tylosin |
| - | Organosilicon compounds | **Antimicrobial agents** | |
| PeCB | Pentachlorobenzene | TCS | Triclosan |
| PHSxS | Perfluorohexane sulphonic acid, its salts and PHFxS-related compounds | **PPCPs (pharmaceuticals and personal care products)** | |
| PFOSA | Perfluorooctane sulfonamide | SMs | Synthetic musks |
| PFSO | Perfluorooctane sulfonic acid, its salts and perfluorooctane sulfonyl fluoride | **Others** | |

| | | | |
|---|---|---|---|
| - | Phenols; phenol compounds including chlorophenols | - | Lubrication oil |
| PAE | Phthalates esters/phthalic acid esters | E2 | 17b-Estradiol, E2 |
| PBDE | Polybrominated diphenyl ethers | | |

Inorganic contaminants as heavy metals and its compounds

| | |
|---|---|
| Al | Aluminium (Al) |
| Sb | Antimony (Sb); antimony compounds |
| As | Arsenic (As) |
| - | Asbestos (silicate dust and fibres) |
| At | Astatine (At) |
| Ba | Barium (Ba) |
| Be | Beryllium (Be) |
| Cd | Cadmium (Cd) and cadmium compounds |
| Cs | Cesium (Cs) |
| Cr | Chromium (Cr) and Hexavalent chromium compounds |
| Co | Cobalt (Co) |
| Cu | Copper (Cu) |
| - | Cyanides - Inorganic cyanides |
| - | Fluorides - Inorganic fluorine compounds excluding calcium fluoride |
| Fe | Iron (Fe) |
| Pb | Lead (Pb) and lead compounds |
| Mn | Manganese (Mn) |
| Hg | Mercury (Hg) and mercury compounds |
| Mo | Molybdenum (Mo) |
| Ni | Nickel (Ni) |
| Se | Selenium (Se) and selenium compounds |
| Ag | Silver (Ag) |
| Sr | Strontium (Sr) |
| Te | Tellurium (Te) and tellurium compounds |
| Sn | Tin (Sn) |
| Ti | Titanium (Ti) |
| U | Uranium (U) |
| V | Vanadium (V) |
| Zn | Zinc (Zn) |

## LIST III. TABLES, FIGURES AND CHARTS

### PART 1 SECTION 1 – METHODOLOGY



### PART 1 SECTION 2 – MARINE PLASTIC RESEARCH IN ASEAN+3 MEMBER STATES

# PREFACE

This study builds upon the earlier version by Lyons, Su and Neo (2019) titled "*A review of research on marine plastics in Southeast Asia: Who does what?*", commissioned by the British High Commission in Singapore and partly supported by the research institutions of the authors. The aim was then to provide a regional overview on the current knowledge in marine plastics research, the legal and institutional frameworks and policies guiding marine plastics research, and possibly recommend where research may be most useful. The scope of this initial review was limited to Southeast Asia, with a focus on the ten member states of the Association of Southeast Asian Nations (ASEAN) (Brunei Darussalam (Brunei), Cambodia, Indonesia, Lao People's Democratic Republic (Lao), Malaysia, Myanmar, The Philippines, Singapore, Thailand, and Viet Nam (Vietnam)). The aim was to provide a regional overview of marine plastics research in Southeast Asia.

This new study provides an update to the earlier review and extends the geographic scope to three neighbouring Asian countries: the People's Republic of China (China), Japan, and the Republic of Korea (RO Korea, or ROK). They are referred to together as ASEAN+3.

The study is divided into two main parts. Part 1 focuses first on the status of scientific research on and the understanding of pollution from marine plastics in ASEAN+3, including a regional summary of this status. Second, it reviews and discusses the mandates, approach and status of work by international and regional intergovernmental bodies as well as relevant regional public-private and fully private initiatives that seek to combat pollution from marine plastics. Part 2 is a gap analysis between scientific research and information needs for policy-making purposes in ASEAN+3, with a particular focus on the Regional Action Plan on Marine Litter (RAP MALI) of the Coordinating Body on the Seas of East Asia (COBSEA), and the ASEAN Framework of Action on Marine Debris (ASEAN FAMAD). This part also discusses regulatory approaches and obstacles to combat pollution from marine plastic based on four reviews published by UNEP. Recommendations on research needed and ways to improve the science-policy-law interface are provided at the end.

As this publication is being finalised, the world is being greatly affected by the Covid-19 pandemic, a type of coronavirus disease that is highly infectious. Following its detection in late December 2019, spreading of Covid-19 prompted the World Health Organisation to declare a pandemic in mid-March 2020. Due to its proximity to the origins of the coronavirus in Hubei, China, ASEAN+3, as a region, has been perceived as a hotspot for Covid-19 attributed to and triggered adoption of a number of measures by states, companies and people in general to increase hygiene measures. Ongoing transfer of the virus in all ASEAN+3 countries appears to be resulting in a large increase in use of single-use plastics due to understandable concerns over health and hygiene. Several informal reports have raised concerns over this rise in plastic waste, with particular contributions from food delivery services and medical supplies. Whilst it is difficult to provide an assessment of impacts of the Covid-19 pandemic on pollution from marine plastics in ASEAN+3, several trends have been observed in the region: rise in the overall amount of plastic waste, new types of plastic debris discharges such as surgical masks and slow-down in field research on marine plastics due to restrictions on conducting any form of field surveys as well as in beach clean-ups which rely on volunteers and outdoor activities that have been also restricted. Furthermore, a number of initiatives and policies on plastic bans appear to have been temporarily lifted for this Covid-19 period. Findings of this report will therefore need to be reviewed when impacts of Covid-19 are clearer and have been studied. Broadly, the political will and recommendations towards combatting pollution from marine plastic in the countries of ASEAN+3 seem to still be present but delays in implementation are expected with the hope that nations will resume the work towards a sustainable plastic-free recovery post-Covid-19.

# PART 1 – STATUS OF RESEARCH

# SECTION 1 – METHODOLOGY

## 1. OVERALL GEOGRAPHIC SCOPE

This study focuses on the research on and efforts developed to combat pollution from marine plastic debris (interchangeably designated as marine plastic litter or marine plastics) in Asia. In this context, the overall geographic scope has been determined so as to include the states, intergovernmental processes, initiatives and programmes involved with marine plastics in Southeast Asia (SEA) and East Asia. As shown in Diagram 1 below, the most inclusive and focused group is the Association of Southeast Asian Nations Plus Three (ASEAN+3), which consists of countries of the Coordinating Body on the Seas of East Asia (COBSEA) and of the ASEAN. They are three formally-established intergovernmental bodies in the region that have taken strong positions on combatting pollution form marine debris. COBSEA and the ASEAN have also adopted action plans and specific measures to combat pollution from marine plastics. They either focus on SEA or include a focus on SEA as one of their main geographic areas of interest. Southeast Asia is at the centre of this study due to the region being identified in a number of publications as a major source or hotspot of marine plastic debris globally.

ASEAN+3 includes Brunei Darussalam (Brunei or BRN), Cambodia (KHM), the People's Republic of China (China or CHN), Indonesia (IDN), Japan (JPN), the Republic of Korea (RO Korea, or ROK), Lao People's Democratic Republic (LAO), Malaysia (MYS), Myanmar (MMR), the Philippines (PHL), Singapore (SGP), Thailand (THA), and Viet Nam (Vietnam or VNM). In the research review, research in the ASEAN member states are reviewed prior to the additional three states. This allows for an easier analysis of ASEAN states as a group, an important unit in intergovernmental dynamics.

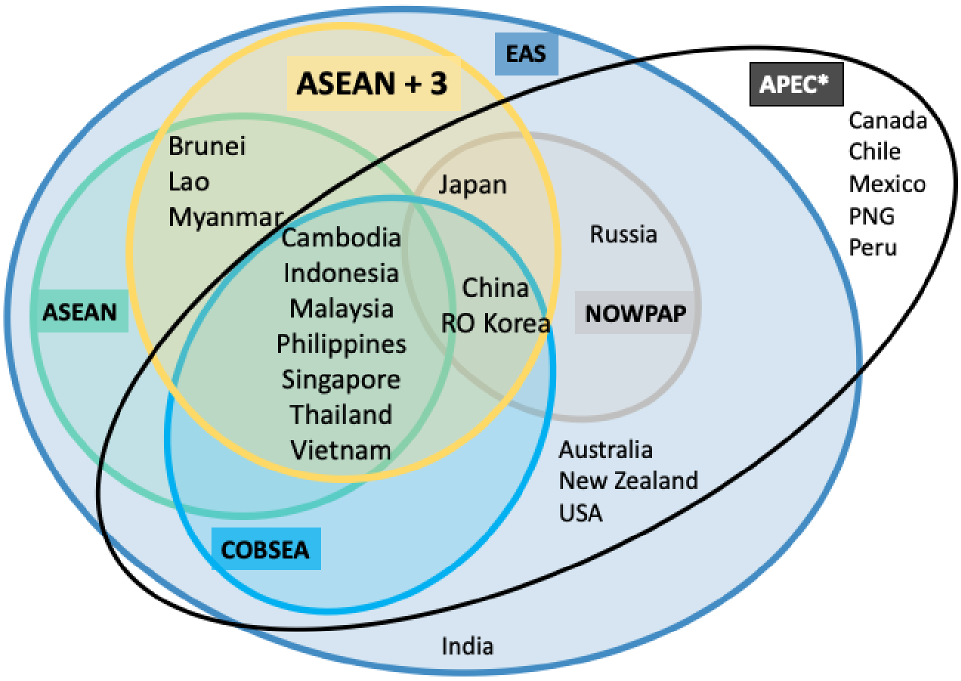



Diagram 1. Graphical representation of participation of states from ASEAN+3
in other intergovernmental organisations APEC, ASEAN, COBSEA, EAS and NOWPAP
** indicates that two economies are not mentioned in the diagram (not states recognised by the UN)*

Other relevant intergovernmental bodies with a wider geographic focus are also included in Diagram 1 above. These are: the Asia-Pacific Economic Cooperation (APEC), the East Asia Summit (EAS) and the Northwest Pacific Action Plan (NOWPAP). Given that these intergovernmental processes also involve the ASEAN and COBSEA states, the research conducted by APEC, the EAS and NOWPAP is also covered in this report, especially their declarations and action plans on marine plastic debris. However, research conducted in states that compose these organisations and are not included in ASEAN and COBSEA are not covered in this study. The methodology adopted for the selection of these institutions and analysis of their work is detailed in section 3 below.

## 2. SCIENTIFIC RESEARCH

The following analytical framework has been employed to conduct the literature review of scientific research relating to pollution from marine plastics in ASEAN+3. The analysis of the status of research on marine plastic pollution in each country is divided into four parts:

(i) context;
(ii) research review;
(iii) main players; and
(iv) summary of understanding.

The methodology of (i) and (ii) is set out below.

### 2.1 Approach to background context

To provide useful background information to the issue of pollution from marine plastics in each country, this section is divided into the three sub-sections set out in the table below.

Table 1.1.2.1. Sub-sections included in the background context of each ASEAN+3 state.

| Sub-section title | | Aim |
|---|---|---|
| 1 | National approach to plastic waste and its management | Waste management strategy applicable to plastic waste and new trends in tackling the issue. This includes the treatment of municipal solid waste, sorting, recycling capacity, etc. |
| 2 | Plastics as a proportion of solid waste | Solid waste produced and proportion of plastics within |
| 3 | Illegal trade of plastic waste | Review of past and present state of trade of plastic scrap/waste in the country and of any reported illegal trading of plastic waste |

Sub-section 3 on the illegal trade of plastic waste was added to this study as this topic has been raised in Southeast Asia, especially following China's 2018 'National Sword Policy' ban of plastic waste (HS 3195) imports. As a whole, ASEAN experienced a sharp 171% spike of plastic waste imports from 837,000 tonnes in 2016 to over 2 million tonnes in 2018 (Trademap, 2019 from Greenpeace, 2019). The majority of plastic waste exports originated from higher income countries such as the European Union (EU) and the United States of America (USA). Reports indicate that the lower income countries of Southeast Asia could be exploited as recipient countries because they lack transparent and standardised trade procedures, such as a Prior Informed Consent (PIC) Procedure. Varying interpretations of plastic waste versus plastic scrap also allow for potential misdeclaration that can be exploited by criminal organisations (2018 World Bank report by Kaza et al., 2018).

## 2.2 Review of scientific research in each country

For each ASEAN+3 state, scientific publications (in English) on pollution from marine plastic research from the last decade have been reviewed and analysed prior to being included in the inventory available in Appendix VI. This review focused on articles in marine plastics research and its related topics. Articles on plastic research which have no links to the marine environment were not focused on. These include research areas such as polymer design and development (i.e. material sciences), biodegradability of new plastics, plastic waste management, etc. Given their importance to the discussion of development of the circular economy, consideration may be given to the opportunity of including the more generic body of plastic research in a new version of the inventory established for this study.

Articles reviewed for the previous report are also included with updates since its publication in May 2019 until February 2020. Of special note, only English language publications were reviewed for China, and the review was limited to articles published from 2015 to 2019 due to the timeframe of this study and the large number of publications found in China. The decision to select 2015 as the start date for inclusion of studies in this report was based on the authors' observation that 90-95% of the articles were published from 2015 onwards. This timeframe is therefore expected to better reflect current trends in marine plastics research in China. Unfortunately, for the same reason of time constraints, publications from Taiwan were not included. However, the research inventory will be open for updates so that missing publications can be included from this and other included countries. This inventory has been designed as a living shared repository open to updates from research in ASEAN+3.

In order to analyse the scientific research publications, this study adopted a comprehensive set of 23 research foci within the overall research area of pollution from marine plastics, a comparative analytical framework, and a set of criteria and definitions for the database inventory.

### 2.2.1 Research foci and research clusters

The 23 research foci used for this study are listed as in Table 1.1.2.2 below. They were determined on the basis of existing areas of research, issues raised in scientific literature and those raised by intergovernmental bodies with a mandate on pollution from marine plastics. Of note, the research foci used in the NUS 2019 report on the status of research on marine plastics in the ASEAN were reviewed and extended to include additional areas of research that have become more prevalent in international discussions and/or are important research areas in China, Japan and RO Korea (such as contaminants associated with marine plastics).

Table 1.1.2.2. List and definition of the 23 research foci used for analysis in this study.

| No. | Research foci | Definition |
|---|---|---|
| 1 | Laws, administrative measures | Research that discusses (current or prospective) marine plastic laws, non-regulatory measures and policies to manage pollution from marine plastics. This includes discussions on action plans. |
| 2 | Guidelines and standards | Research that discusses applicable or prospective guidelines or standards to manage production, use, re-use, recycling and disposal of plastic products as well as sampling and monitoring for marine plastic litter. |
| 3 | Research framework and coordination | Research that discusses or investigates governance regimes, efforts to coordinate research between different research fields and other coordination mechanisms involving other relevant stakeholders to respond to pollution from marine plastics. |
| 4 | Upstream research/waste management | Research on sources of marine plastics prior to leakages to the marine environment, typically focused on waste management. This may also include studies of raw plastic production, polymer-specific uses and applications. |
| 5 | Methodology for marine plastic clean-up | Research that discusses different approaches, techniques and protocols for the clean-up of marine plastic including with respect to technologies available, assessment protocols and units of measure. |
| 6 | Survey and monitoring/pollution status | Research on the types of surveys/monitoring programmes to determine the amount of marine plastics in any environ. These serve as a first step to assessing the status of marine plastic pollution. This category of research typically involves the quantification and identification of either macro-, meso- and microplastic types. The resolution of these research is varied, as it is dependent on the objective of and conditions for the assessment. For example, a high resolution of the information may be gathered from scientific sampling of microplastics on coastal sediment surface, while a lower resolution of the amount of marine plastic debris (e.g., number of items and type) may be collected through citizen science beach clean-up programmes which also support outreach and education. The latter research is also typically reported in grey literature. |
| 7 | Methodology for the monitoring and assessment of marine litter | Research that discusses methodologies and technologies employed for surveying and/or monitoring and assessing the state of marine litter in specific environs, or comparing different methodologies. |
| 8 | Accumulation zones and hotspots | Research that discusses, establishes protocols for and seeks to identify areas where marine plastic accumulates and may be considered as hotspots of marine plastics or priority areas for marine plastic clean-up and research. This research topic often involves data mining surveys and monitoring programmes of marine plastics, investigation of sources and the generation of a hotspot map through numerical modelling (including sources, transport, sinks and fate). |
| 9 | Movement of plastics in water bodies | Research that discusses monitoring, assessing, and/or measuring movement of plastic debris in rivers or oceans. This may involve field surveys, monitoring programmes of marine plastics, and predictive modelling of transport of marine plastic debris. The resulting information shows where marine plastic debris from land- or sea-locations may end up and involves the modelling of transport and behaviour of passive particles and/or active particles (i.e. with pre- defined behaviour which may be based on expected fragmentation rate). |
| 10 | Source differentiation | Research that discusses sources of marine plastics designed to provide tracing of their origin and potential mismanagement of plastic waste resulting in leakage into the marine environment. This may include sources of marine plastics from the riverine system, runoffs due to flooding, aquaculture, fisheries activities (ALDFGs), etc. |
| 11 | Contribution from rivers | Research that discusses leakages of marine plastics into riverine systems, transport through them, and pathways to the marine environment. This may involve discussions of potentially necessary river-basin management strategies, though this report focuses on downstream imports from rivers. |
| 12 | Discharge from offshore infrastructures and shipping | Research that discusses plastic waste that is, or may be, generated from shipping, offshore installations including mining installations and aquaculture farms. |
| 13 | Contribution from fisheries/abandoned, lost or otherwise | Research that discusses abandoned, lost or otherwise discarded fishing gear (ALDFG), including “ghost gear” or “derelict fishing gear”, condition for abandonment, contribution to marine plastics, and response strategies. Research indicates that ALDFG would have |

| No. | Research foci | Definition |
|---|---|---|
| | discarded fishing gear (ALDFG) | accounted for close to half of the surface plastic waste of the Global Pacific Garbage Patch in 2015 (Lebreton et al., 2018) and up to 70% of the floating microplastic globally. |
| 14 | Fragmentation and degradation | Research that discusses the breakdown of marine plastics into smaller pieces (i.e. macroplastic to mesoplastic to microplastic). This includes studies examining the fragmentation and degradation of marine plastics (including polymer-specific) that may be driven by biochemical, physical, physicochemical, etc. processes. |
| 15 | Ecological and environmental impact | Research that elaborates on the impacts of marine plastics on marine organisms, their habitats, and the ecosystems they belong to. This Includes laboratory experiments as well as field work. Some studies can be opportunistic, due to events such as the beaching of large mammals or marine organisms, and subsequent examination of their gut contents. This category is divided further into the six sub-categories below (also in green). |
| (i) | Ingestion of plastic in the wild | Research that discusses the oral ingestion of plastic in the wild, through the digestive system of marine biota. Examination of this may be at any point along the digestive tract, including the gastrointestinal tract on a whole or specifically to the intestines and/or stomach. |
| (ii) | Branchial uptake of plastic in the wild | Research that discusses the branchial uptake of plastic in the wild, usually in reference to fish and its respiratory system of the gill organs and involve examination of particulate of plastic trapped in the gills. |
| (iii) | Entanglement by plastics in the wild | Research that discusses the physical strangulation or entanglement of marine organisms by plastic debris. |
| (iv) | Changes in microbial assemblages | Research that discusses microbial presence on microplastics, in different environs and associated with different polymers and possible linkages to fragmentation. |
| (v) | Experimental studies of physicochemical impacts | Research that is performed under laboratory setting to examine impacts of plastics in marine biota with various physicochemical pathways. This includes research on the toxicity of certain polymers or associated contaminants on the survivability, growth, development or other life functions of a particular marine biota taken at different life stages. |
| (vi) | Trophic transfer of plastics | Research that discusses the possible transfer of plastics from one trophic level to the next, resulting in a possible bio-accumulation of marine plastic and/or its associated contaminants. |
| 16 | Socio-economic impact | Research that discusses the impacts of marine plastics on human society of a societal or economic nature. This category is divided further into the two following sub-categories. |
| (i) | Human health/ food safety | Research that discusses impacts of marine debris on human health. This includes the sampling of plastics in marine-derived products like seafood and salt, or potential toxic chemicals in food packaging that are also found discarded in the marine environment. |
| (ii) | Economic loss | Research that seeks to quantitatively assess economic losses due to plastic pollution, for instance loss of tourism, costs to maritime operations through entanglement in propellers and costs of marine plastic clean-up. |
| 17 | Social perceptions | Research that investigate perceptions by the public of marine plastic pollution and the management of plastic waste. This includes studies on public awareness, perceived effectiveness of marine debris policies, behavioural studies, or willingness-to-pay studies. |
| 18 | Public outreach/beach clean-up | Research that discusses efforts of public outreach and/or beach clean-up, which refers to the engagement of public citizens in the collection of data on marine debris (plastic). |
| 19 | Contaminants associated with marine plastics | Research that examines marine plastics as a pathway for contamination by external contaminants other than polymers themselves. Associated contaminants may either be (i) additives that are added in the manufacturing of the plastic or (ii) sorbed contaminants which attach-detach to the surface of the plastic. For the purpose of this report and the research inventory, this category is further divided into the three following sub-categories. |
| (i) | Organic and inorganic pollutants from marine plastic debris | Research that discusses the presence/absence of plastic contaminants in marine plastic debris, either organic (i.e. plastic polymers or plastic additives) or inorganic contaminants (i.e. heavy metals). |
| (ii) | Adsorption-Desorption of chemicals/pollutants | Research that discusses the adsorption and/or desorption of contaminants, either organic (i.e. plastic polymers or plastic additives) or inorganic contaminants (i.e. heavy metals), on marine plastics. This includes studies conducted both in the field and laboratory experiments to understand how plastics interact with external chemicals and/or pollutants. |

| No. | Research foci | Definition |
|---|---|---|
| (iii) | Plastics as transport vector/medium | Research that discusses the way in which floating particles of plastics (of any size) can be carriers of organisms and/or contaminants that get transported over long distances and new habitats or organisms. This includes the possibility of marine plastic acting as a potential vector for introducing invasive species into a new environment. |
| 20 | Port reception facilities | Research that investigates the need, adequacy and characteristics of infrastructure available to receive waste generated from inbound vessels at ports. |
| 21 | Fibreglass-reinforced plastic vessels | Research that investigates current and prospective contributions of abandoned plastic-reinforced fibreglass vessels to marine plastic pollution |
| 22 | Hull scraping and marine coating | Research that investigates the contribution of hull scraping and marine coating to marine plastic pollution |
| 23 | Language and cultural barriers/data accessibility | Research that focuses on social and cultural behaviours, and barriers to accessibility of education and outreach on marine plastic pollution and response strategies |

### 2.2.2 Structure of each countries' scientific research review

The review of scientific research undertaken for each country follows the same enquiry and structure which is set out in Table 1.1.2.3 below.

Table 1.1.2.3. Sub-sections included in the research review of pollution from marine plastics in each of the ASEAN+3.

| Sub-section | | | Aim |
|---|---|---|---|
| 1 | Research review of pollution from marine plastics | *Research overview* | • Total number of scientific publications reviewed<br>• Any temporal trends in publications<br>• Geographic coverage of these studies<br>• Total number of research foci examined and its distribution |
| | | *Types of research conducted* | Types of plastics research foci<br>• Total number of research conducted for each plastic type (i.e. micro-/macro-/both micro- and macro- plastics)<br>• Emphasis (if any) on any plastic type<br>• General type of studies conducted for each plastic type<br>• Examination into plastic contaminants (if any)<br>Coverage of marine environs<br>• Total number of research conducted for each marine environ (i.e. shoreline/seafloor/marine biota/sea surface)<br>• Emphasis (if any) on any marine environ |
| | | *Survey and monitoring* | • Type of micro-/macro- plastics studies in different marine environ and its relevant scientific publications<br>• Mentions of interesting scientific publications (if any)<br>• Examination into the possible level of maturity and advancement of the country's micro-/macro-plastics research:<br>Microplastics<br>o If microplastics studied are of a consensus definition (i.e. less than 5mm)<br>o If microplastics were examined for their polymer types, if so, reports:<br>(i) Total number of studies that conducted polymer-level examination<br>(ii) Polymer types found in the natural environment and the common ones<br>o If microplastics were examined into finer structures of films and fibres<br>Macroplastics<br>o If macroplastics were examined into functional types (i.e. packaging/building and construction/textiles/consumer products/transportation/electrical/fishing gears/others)<br>• Examination into the consistency of methodology practiced |

| | | | |
|---|---|---|---|
| | | | o If methodologies of sampling were consistent<br>o If measurement of quantifications were consistent or comparable |
| | | *Source differentiation and pathways* | • Examination on the source/differentiation/leakage of marine plastics<br>• Examination on marine plastics as a potential pathway/medium/vector in transporting contaminants in the natural environment, such as the examination of (a) plastic polymers itself as a contaminant (b) plastic additives in plastic (added in the manufacturing of the plastic) (c) plastic-sorbed contaminants on the surface of the plastic, and if so, reports:<br>o The specific polymer type(s) examined – identity of polymer and if the specific polymer type examined is one of the common polymer types found across the relevant studies in the country<br>o The specific plastic-associated contaminant(s) examined |
| | | *Movement of plastics, accumulation and hotspots* | • Examination into the movement of plastic in the natural environment, either through modelling or simulation experiments, if so, reports:<br>o The specific polymer type(s) examined – including whether it is one of the common polymer types in use or found in surveys<br>• Examination into the possible accumulation zones and hotspots of marine plastic, possibly as a result of the use of models and simulation experiments |
| | | *Ecological and environmental impacts* | • Examination into the impacts of marine plastic on the marine biota/ecosystem/ecology, if so, reports:<br>o Type of impact posed by marine plastic (i.e. ingestion of plastic in the wild/branchial uptake of plastic in the wild/entanglement by plastic in the wild/changes in microbial assemblages/experimental studies of physicochemical impacts/trophic transfer of plastic)<br>o Type of marine biota examined (i.e. wild or cultured species or those of commercial importance and value) |
| | | *Abandoned, lost or otherwise discarded fishing gear* | • Examination into ALDFG, if so reports:<br>o Type of ALDFG study examined (i.e. quantifying/identifying presence-absence of ALDFG/ALDFG and related fishing management practices/ALDFG and its impacts) |
| | | *Social perceptions and socio-economic impact* | • Examination into the social perceptions of people, usually the locals living in the vicinity of the research study area, if so reports:<br>o Type of social perception study examined (i.e. on the public awareness of people on the issue of marine plastic pollution/willingness to partake in mitigating marine plastic pollution/viewpoint on individual responsibility on marine plastic pollution)<br>• Examination into the socio-economic impact posed by marine plastics, if so reports:<br>o Type of impact examined (i.e. human health and food safety/economic loss) |
| 2 | Main players | | • Composition of research efforts seen in the marine plastics research scene, either from local efforts or non-local efforts<br>• Identify and highlight prominent players in the marine plastics research field of the country and their institutions<br>• Where information is available, include current experts with relevant plastic research expertise |
| 3 | Summary of understanding | | • Breadth and depth of research foci, marine environs)<br>• What research area(s) has(ve) been conducted – is that sufficient?<br>• How advanced research is – smaller forms of plastics, polymer types, contaminants tests<br>• Study on impacts – what is present and what is missing<br>• Geographic coverage<br>• Sources (land-based or sea-based) - Leakage into the natural environment<br>• Modelling<br>• ALDFG |

### 2.2.3 Database inventory: criteria and definitions

The 371 scientific articles which have been reviewed in this study are included in the inventory database which is available online. The extraction and tabulation of information from each of the scientific publications is done according to Table 1.1.2.4 below.

Table 1.1.2.4. List of criteria and definitions used to categorise research papers and reports on marine plastics.

| *Criteria* / *Sub-criteria* | *Defined for this study as* |
|---|---|
| *Year Published* | This reflects the year that the article was published or produced. |
| *Country* | This describes the main institution carrying out the research, based on corresponding author (peer-reviewed papers) / if unavailable, lead author (non-peer-reviewed papers). |
| *Research Group(s)* | This describes all of the institutional affiliations of researchers. |
| *Source of Funding* | This reflects the source(s) of funding supporting the research. |
| *Aim of Research* | To briefly define purpose of study. |
| *Period of Study* | This usually reflects the time of sampling (i.e. dates, months, or years). |
| *Methodologies Used* | A set of keywords have been selected to describe the methodologies used by studies. |
| *Review (literature/ social media)* | - |
| *Monitoring* | Visual survey |
| *Quantification* | - |
| *Identification* | - |
| *Sampling* | Transect sampling; Quadrat sampling; Sediment sampling; Sediment grab sampling; Auger core sampling; Net tow sampling; Ekman trawl sampling; Bongo trawl sampling; Manta trawl sampling; Bottom trawl sampling; Neuston net sampling; Mesh plankton net sampling; Net fish sampling; Gillnet fish sampling; Local fisherman sampling; Local fishery market sampling; Coral fragment sampling; Plankton pump sampling; *In situ* filtration; Microplastics purchase |
| *Simulation model* | Hydrodynamic modelling; Particle tracking modelling |
| *Laboratory experimental work (Sorption of pollutants/chemicals)* | Sorption experiment; Batch equilibrium method; Sorption amount calculation; Sorption modelling; Pollutant chemical analysis; Brunner-Emmet-Teller surface are analysis; Chromatography; Liquid chromatography; Gas chromatography; Dynamic light scattering analysis |
| *Laboratory experimental work (Toxicity of plastic on development in marine biota life stages)* | Leaching experiments; Clam spawning induction; Toxicity exposure experiments; Larvae physiological assessment (rates of hatching, developmental, malformation, metamorphosis, …) |
| *Laboratory experimental work (Heavy metal analysis)* | Atomic fluorescence spectroscopy; Inductively coupled plasma mass spectrometry; Biota-sediment accumulation factor calculation |
| *Plastics extraction/preparation* | Sonication extraction; Solvent extraction; Chemical digestion; Flotation extraction; Modified flotation method; Filtration; Dissection and analysis (gut/stomach/etc); Density separation; Soxhlet extraction; Microplastics irradiation aging |
| *Plastics characterisation, identification, quantification* | Sieve-shaking sediment size analysis; NOAA analysis; Visual characterisation; Stereomicroscopy characterisation; fluorescence microscopy characterisation; SEM characterisation; X-ray diffractometre surface area analysis; Barrett-Joyner-Halenda (BJH) pore size analysis; Dissecting microscopy characterisation; Transmission electron microscopy analysis; Laser scanning microscopy analysis; FTIR spectroscopy polymer analysis; ATR-FTIR spectroscopy polymer analysis; μ-FTIR spectroscopy polymer analysis; GC-MS polymer analysis; Energy-dispersive spectroscopy polymer analysis; ATR-Lumos (Bruker) microscopy polymer analysis; |

| | |
|---|---|
| | Mass spectroscopy; Raman spectroscopy polymer analysis; Fluorescence labelling; Isotope labelling; Abundance calculation |
| *Social perceptions* | Questionnaire; Interview |
| *Type of Plastics Examined* | This describes the types and classifications of plastics examined. Keywords used are microplastics only, macroplastics only, microplastics and macroplastics. The types of plastic polymers also listed here, if information is available. |
| *Geographic Location of Work* | This describes where the research was carried out, if *in situ*. For *ex situ* studies, indicate as 'Laboratory' for those doing experimental studies. |
| *Marine Environs* | This describes the types of environment where plastics were found and/or studied. These include biological environs (i.e. marine biota), and non-biological environs (i.e. shoreline, seafloor, sediments). |
| *Key findings* | This describes key findings of the study. |
| *Source of Plastics* | This describes the potential sources of plastics, which include land-based, sea-based, rivers, and specific locations. |
| *Peer-reviewed Output* | To cite the full reference. |
| *Link to source* | Insert weblink to peer-reviewed output. |
| *Non peer-reviewed Output* | To cite the full reference. |
| *Link to source* | Insert weblink to non peer-reviewed output. |
| *Categories of Research Topics* | This describes the research topics covered by article. See lines 37-69 below |
| | Laws, administrative measures |
| | 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 |
| | Fibreglass- reinforced plastic vessels |
| | Hull scraping and marine coating |
| | Discharge from offshore infrastructures (incl. aquaculture) |
| | Contribution from fisheries/ ALDFG |
| | Contribution from rivers |
| | Accumulation zones and hotspots |
| | Fragmentation and degradation |
| | Ecological and environmental impact |
| | >> *Ingestion of plastic in the wild* |
| | >> *Branchial uptake of plastic in the wild* |
| | >> *Entanglement by plastic in the wild* |
| | >> *Changes in microbial assemblages* |
| | >> *Experimental studies of physicochemical impacts* |

| | |
|---|---|
| | >> *Trophic transfer of plastics* |
| | Socio-economic impact |
| | >> *Human health/food safety* |
| | >> *Economic loss* |
| | Methodology for marine plastic clean-up |
| | Movement of plastics in water bodies |
| | Social perceptions |
| | Adsorption-Desorption of chemicals/pollutants |
| | Plastics as transport medium/vector |
| | Plastic additives (produced either by chemical, physical, leaching, etc... methods) |
| *Checklist for Survey and Monitoring Protocols* | These parameters were selected based on GESAMP (2019), so as to identify key areas for improvement to survey and monitoring protocols. See from Lines 71-77. |
| *Types of macroplastics, according to uses* | To list down all the macroplastics for common applications, for example, fishing gears, utensils, textiles, bottles, etc... It is useful to provide a description of items to identify types and sources of litter. |
| *Types of plastic polymer* | To list down all the mentioned polymers identified in the study, using their common abbreviations. |
| *Size of microplastics defined as <5 mm* | To indicate '0' or '1' if the study adheres to the definition of microplastics <5 mm. If not, to state otherwise. |
| *Shape of plastics* | To list down all mentioned shapes of microplastics/plastics identified in the study. The identification of these morphologies can provide some indication of potential sources, such as textiles or ropes for fibres, as well as their behaviour within an environmental compartment (e.g. beached versus sank). |
| *Measure of abundance (number of pieces/density)* | To list down the units of measure for abundance, in terms of counts or density. |
| *Measure of abundance (weight/volume)* | To list down the units of measure for abundance, in terms of weight or volume. |
| *Status of degradation?* | To indicate '0' or '1' if the study had examined the state of plastics collected. |

## 3. RESEARCH IN INTERNATIONAL LAW, INTERGOVERNMENTAL ORGANISATIONS AND GOVERNANCE OF POLLUTION FROM MARINE PLASTIC

### 3.1 Structure

#### 3.1.1 Identification of bodies, institutions, legal instruments, programmes and initiatives

This study provides an inventory of regionally-significant work streams undertaken to respond to pollution from marine plastics in the ASEAN+3 from four categories:

(i) Global intergovernmental and/or institutional policy frameworks, guidelines and initiatives relevant to SEA;
(ii) Regional intergovernmental and/or track 1.5 institutional mechanisms, programmes and projects;
(iii) Funding organisations to ASEAN states; and
(iv) Notable partnerships, non-institutional research programmes and public-private initiatives in the region.

The first two categories seek to provide a comprehensive and exhaustive account of the intergovernmental processes that are engaged in combatting pollution from marine plastics at global and regional levels. However, the content of the work is based on documents that are publicly-available. Of note, track 1.5 processes have also been included as they are a key process through which governments engage with influential stakeholders. They are also particularly utilised in SEA due to important reliance on external donors to support research in most ASEAN states. Examples of track 1.5 processes are the Partnership for the Environmental Management of the Seas of Southeast Asia (PEMSEA) and the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF).

By contrast, the third and fourth categories are comprehensive but not exhaustive as not all of the initiatives they include are publicly available. These categories therefore focus on the most visible and largest programmes and initiatives of regional significance; a number of extremely valuable initiatives could not be mentioned, and the selection provided may not be fully representative of the diversity of those that exist. It is hoped by the authors that this study can provide the basis for the development of a shared and more exhaustive regional inventory hosted in the region.

#### 3.1.2 Substantive work reviewed

For each instrument, body, institution, programme or initiative the following components were analysed and reported in this report:

- Overview of establishment, mandates and members or participants;
- Relevant provisions, projects, initiatives or mechanisms to combatting pollution from marine plastics;
- Status of work.

The work conducted by these bodies and programmes has been reviewed and analysed on the basis of the authors' professional knowledge of these networks as invited experts, speakers or observers, complemented by further web-research on the most recent work completed by relevant organisations and institutions. This web-research includes political, legal, and grey literature, as well as websites. It is important to note that all reviewed materials were written in the English language. Additional review of the literature published in the language of each ASEAN+3 state would be necessary to gain a full picture of the research carried out nationally and regionally from their national perspective.

### 3.2 Comparative analysis

The 23 initial research foci used to categorise scientific research have also been used for to analyse the work of each body, programme or initiative. However, for the purpose of the analysis of their work, the grouping in 10 clusters which is appropriate to the analysis of scientific research did not provide sufficient granularity for analysis of the work of these bodies, programmes and initiatives.

Instead, the work of these bodies, programmes and initiatives has been grouped into the following 16 categories that are better adapted to policy and legal interventions:

1. Policy, laws, administrative measures, action plans and guidelines;
2. Upstream research, circular economy, waste management;
3. Methodology for monitoring of marine litter, surveys and monitoring, pollution status;
4. Accumulation zones and hotspots;
5. Contribution from rivers;
6. Source differentiation;
7. Discharge from offshore infrastructures;
8. Contribution from fisheries/lost and abandoned fishing gear (ALDFG);
9. Fragmentation and degradation;
10. Ecological and environmental impact;
11. Socio-economic impact;
12. Public outreach/bleach clean-up, social perception;
13. Organic/inorganic contaminants associated with marine plastics;
14. Port reception facilities;
15. Fibreglass-reinforced plastic vessels; and,
16. Hull scraping and marine coating.

This analytical framework is used to assess the breadth and depth of the work of the bodies on different aspects of pollution from marine plastics.

## 4. GAP ANALYSIS

The gap analysis seeks to examine the adequacy of research findings and ongoing research to meet the needs of policy bodies, as well as the adequacy of policies, mechanisms, programmes and initiatives at the regional level to respond to the findings from scientific research.

The gap analysis is divided into four parts. First, the gap analysis compares the regional framework of actions from the perspective of their (i) goals and objectives, (ii) actions and activities; and (iii) cooperation processes that are envisaged. To this effect, the provisions of COBSEA RAP MALI and that of ASEAN FAMAD are systematically compared. Second, it investigates the extent to which these two action plans seek to implement international law through express or implied reference to relevant provisions of international law. Third, the gap analysis examines the scientific research inventory and their findings in the context of the provisions of the two action plans. This is to determine whether they provide sufficient scientific data to support a science-based decision-making process for policy-making purposes to respond to pollution from marine plastics in ASEAN+3. The fourth part of the gap analysis examines domestic and regulatory approaches and obstacles on the basis of four UN reports on this topic. It draws lessons from these reports to inform the previous analysis. Overall findings from the research review and the gap analysis are discussed in Part 2, Section 6.

# SECTION 2 - MARINE PLASTIC RESEARCH IN ASEAN+3 MEMBER STATES

# 1. BRUNEI DARUSSALAM

*Summary of research topics: Two published peer-reviewed papers relevant to marine plastics could be found for Brunei Darussalam, but they refer to the same study with a more detailed discussion in the most recent article. The research topic of the study was focused on surveying and monitoring abundance and types of micro- and macro-plastics in selected riverine and coastal beaches of Brunei Darussalam.*

*Summary of understanding at national level: There has been limited number academic research conducted to understand marine plastic pollution issues in Brunei Darussalam, but the Department of Environment, Parks and Recreation (JASTRe) has national-level initiatives to tackle plastic waste issues. The studies indicate that most of the marine debris are macroplastics with size >20 mm (61.86%), followed by mega plastics with size >100 mm (22.29%), and hypothesise that they might be from land-based sources with higher flow in wet weather.*

*Keywords/research fields: National approach; solid waste; trade of plastic waste; research foci; marine environs; surveys and monitoring, source differentiation, contribution from rivers; main players*

## 1.1 Context

### 1.1.1 National approach to plastic waste and its management

Efforts to address plastic waste issues are underway in Brunei Darussalam, such as with the Brunei Vision 2035 (Wawasan Brunei, 2035) which aims to cultivate a green-oriented and long-term sustainable economy. This includes the adoption of the 3Rs practices to tackle plastic waste issues, and zero waste strategies that look into the upstream problems of marine plastics (Shams et al., 2014). Some specific examples include 'No Plastic Bag Everyday' initiative implemented to limit the use of PET bags by participating stores and shops daily, 'Plastic Bottle Free Initiative' by the Ministry of Development, reducing the use of polystyrene containers and phasing out the use of plastic bags in major supermarkets by 2019 (ASEAN Secretariat News, 2018: available https://asean.org/asean-joins-movement-beat-plastic-pollution/).

However, sorting of waste and treatment of separated plastic waste seems limited. The country has a waste collection system in place, therefore all the waste is often disposed of indiscriminately at common landfill sites, or discharged or leaked into water bodies. There appears to be a single waste recycling facility in Brunei Darussalam that targets used lubricants and oils derived mainly from Shell Petroleum company, but the recycling of other waste has yet to be established – an area that is acknowledged as requiring action by the government (Presentation by Yunos et al., 2010).

### 1.1.2 Plastics as a proportion of solid waste

Based on the figures reported by the Department of Environment, Parks and Recreation (JASTRe) (under the Ministry of Development), the Municipal Solid Waste (MSW) was at 189,000 tonnes in 2015.

In the following year, the MSW was estimated at 216,000 tonnes, equivalent to 1.4 kg per capita per day, and with a projection of reaching 263,000 tonnes in 2030 and 308,000 tonnes in 2050 (Kaza et al., 2018). In general, the bulk of the solid waste ends up in the six landfills in Brunei. For instance, the landfill at Sungei Paku in the Tutong District collects 400-500 tonnes of waste daily (JASTRe, 2015).

Of the solid waste generated in Brunei Darussalam, plastics rank third at 16% of total solid waste (Energy and Industry Department, 2017). Most of the plastic waste is derived from Brunei Muara District, the smallest of the four districts in Brunei, but the most populous with over half of the country's population (United Nations Framework Convention on Climate Change, 2017).

### 1.1.3 Illegal trade of plastic waste

Based on the recent Greenpeace Southeast Asia's ASEAN Policy Brief 2019 and import data from Trademap, there was a clear six-fold increase in plastic waste volume imported into Brunei Darussalam, from 30 tonnes in 2016 to 185 tonnes in 2018, following China's import ban in 2018. This said, the exact amount of plastic waste imported is not publicly verifiable. Brunei Darussalam is also party to the Basel Convention (see Part 1, Section 3.7).

## 1.2 Research review of pollution from marine plastic

### 1.2.1 Research overview

Academic research on marine plastics in Brunei Darussalam is limited, with only two published peer-reviewed papers identified here for assessment. The awareness of marine plastics among the scientific community is unknown but does not appear to be a main research thrust of research in Brunei.

Interestingly, though the papers are published in different contexts (Table 1.2.1.1), they both report the same study conducted in 2016, which geographically covers four coastal beach areas. They were focused on surveys and monitoring to understand pollution status. As both studies essentially report the same work, their research focus is the same and will only be captured once in this assessment. However, the following will discuss both studies in parallel.

Table 1.2.1.1. List of published work identified and examined in this study for Brunei Darussalam.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
| --- | --- | --- |
| Qaisrani et al. (2019)<br><br>Uni Teknologi Brunei (UTB); Balochistan Uni of Information Technology, Engineering and Management Sciences (BUITEMS, Pakistan); Prince of Songkla Uni (Thailand) | Understand the abundance and classification of marine debris accumulated along the beaches of Brunei Darussalam | May 2016 |
| Qaisrani et al. (2018) - Conference paper<br><br>BUITEMS (Pakistan); Uni Teknologi Brunei (UTB); Uni Brunei Darussalam (UBD) | Understand the abundance and classification of marine debris accumulated along the beaches of Brunei Darussalam | May 2016 |

### 1.2.2 Types of research conducted

Both Qaisrani et al. (2018) and Qaisrani et al. (2019) reported the following aspects of research: surveys and monitoring to understand pollution status, source differentiation, and the contribution of plastics (i.e. rivers). The surveys investigated the marine debris comprising microplastic and macroplastic found on their coastal beaches (i.e. shoreline environment).

The major difference between Qaisrani et al. (2018) and Qaisrani et al. (2019) is the types of measures used to quantify abundance, in terms of density and weight (see Part 1, Section 2.1.2.3). In addition, the latter study conducted more extensive analyses and charting of the results obtained from the surveys compared to the former study, providing better insights into the current state of marine plastic pollution.

Efforts in public outreach and beach clean-ups are conducted through the Eco-Clubs (i.e. 16 secondary schools) that are registered under the Department of Environment, Parks and Recreation (JASTRe) in the Ministry of Development throughout Brunei Darussalam. The JASTRe organises environmental awareness activities such as beach cleaning campaigns to reduce the amount of litter along the beaches, especially plastics, in an effort to keep the beaches clean.

There is no published peer-reviewed study on plastic-associated (organic or inorganic) contaminants.

### 1.2.3 Survey and monitoring

Both Qaisrani et al. (2018) and Qaisrani et al. (2019) reported on the examination of the abundance and distribution of marine debris collected from four different coastal beaches along Brunei Darussalam in a May 2016 study. The study had categorised the debris found as plastic, metal, glass, rubber, cloth/fibre, lumber, and miscellaneous. They found that most of the marine debris were macroplastics with size between 20-100 mm (61.86%), followed by mega plastics with size of >100 mm (22.29%). The common types of plastic found and identified were from food 'stuff', plastic fragments and PET bottles. These items were made of either PET, PE, or PVC plastics.

Qaisrani et al. (2018) had quantified abundance of plastics based on counts (i.e. number of items) and weight of debris (i.e. kg per day), but Qaisrani et al. (2019) added further measures to quantify abundance of plastics. For instance, the latter study also quantified abundance based on area covered (i.e. number of items per unit area) and weight of debris (i.e. kg per unit area per week).

Studies of microplastics adhered to the definition of size <5 mm, but the shapes of microplastics were not reported. While the types of plastic polymers were not identified for microplastics observed, the studies broadly identified PET, PE and PVC from their macro- and mega-debris.

### 1.2.4 Source differentiation and pathways

Qaisrani et al. (2018) and Qaisrani et al. (2019) proposed that plastics could have originated from local land-based sources as a result of high tourism activities.

Whilst Qaisrani et al. (2016) is not included in the inventory of research prepared for this study because it focuses solely on a river system (flow into the Kedayan River), it provides interesting insights on debris flow in Brunei plastic debris flow and movement into this river. The study showed seasonal variations in the flow of plastic waste. A larger proportion of plastic debris was found in the river during wet weather compared to dry weather. This implies a correlation between movement of debris and intensity of rainfall resulting in runoff.

#### 1.2.5 Movement of plastics, accumulation and hotspots

There is no published peer-reviewed study on the movement of marine plastic debris, except from rivers (Qaisrani et al., 2016), nor accumulation and hotspots of marine plastics.

#### 1.2.6 Ecological and environmental impacts

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

#### 1.2.7 ALDFG

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

Given that marine capture fisheries have contributed significantly to the country's supply of fish for >20 years (SEAFDEC: available http://map.seafdec.org/Monograph/Monograph_brunei/marine.php), ALDFGs are expected to be a significant component of marine plastic debris in Brunei, as they are in the rest of the region.

#### 1.2.8 Social perceptions and socio-economic impacts

There is no published peer-reviewed study on the social perceptions and socio-economic impacts of marine plastics.

### 1.3 Main players in marine plastic research

This study found Qaisrani Z.N. of Universiti Teknologi Brunei (currently based in BUITEMS, Pakistan) to be the lead author of the research mentioned above. Additional information on Brunei's plastic waste situation was obtained from a policy brief produced by Greenpeace Southeast Asia (Greenpeace, 2019).

The government department, JASTRe, has played an active role in providing plastic pollution statistics (as reported in online news outlets). It has also launched initiatives to encourage Bruneians to use less single-use plastics.

### 1.4 Summary of understanding

The current understanding of marine plastic pollution status in Brunei Darussalam is limited to a single relevant peer-reviewed report. This 2016 study focused primarily on debris flow from selected riverine and coastal areas entering the beach environment. While some statistics are available from the government and research-driven studies in marine plastics, they are mostly presented in informal reports such as online news outlets with few details of methodology and results.

The 2016 study indicated that most of the marine debris were macroplastics with size >20mm (61.86%), followed by mega plastics with size >100 mm (22.29%), and hypothesised that they might have been from land-based sources with higher flow in wet weather.

Given the missing research foci and the prevalence of marine debris, improving the research capacity for Brunei Darussalam to understand source differentiation and pathways of marine plastic debris as well as the ecological and environmental impacts of ALDFGs, would be useful to guide the country's plastic waste management approaches.

## 2. CAMBODIA

*Summary of research topics: The few studies published in Cambodia relate results from surveying and monitoring of pollution from macroplastics in unspecified coastal ecosystem areas.*

*Summary of understanding at national level: The few studies and news reports have revealed plastic pollution as an emerging issue in the country. However, the level of understanding is limited to some macroplastic abundance in a few areas.*

*Keywords/research fields: National approach; solid waste; trade of plastic waste; research foci; marine environs; surveys and monitoring; main players*

### 2.1 Context

#### 2.1.1 National approach to plastic waste and its management

Whilst the definition of municipal solid waste (MSW) in Cambodia is not clearly defined, the management of MSW in Cambodia is often provided by the commune authority, or by private companies under the supervision of local authorities, using a collect-transport-dispose system (Sethy et al., 2013). There are several laws, sub-decrees, declarations and guidelines on waste management put in place (Figure 1.2.2.1), but waste management still varies across different provincial towns. Where there is no management system, the responsibility falls on the household and often results in burning or illegal disposal on vacant land or into river bodies. On the whole, the existing waste management system of Cambodia may not be sufficient to cope with the volume of waste produced.

Several challenges to waste management have been highlighted by the Cambodian government (pers. comms., N. Kim, Deputy Director General, Ministry of Environment Cambodia, 11 November 2019). Apart from dealing with increasing volumes of waste from different sectors, there are also challenges with respect to waste management standards, guidelines, compliance, enforcement and coordination between relevant waste management sectors at local levels. The low level of awareness on solid waste management is another challenge faced by Cambodia.

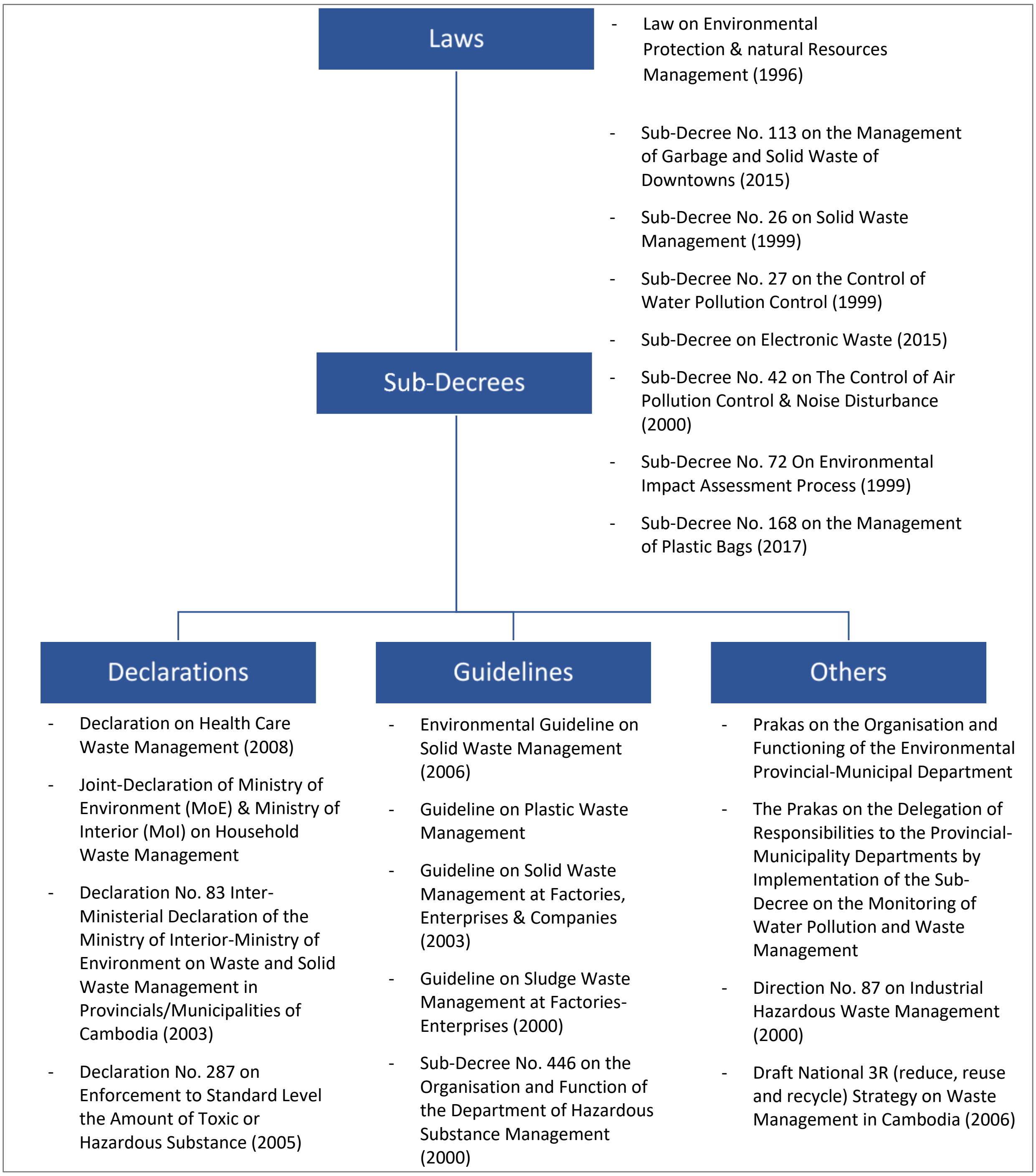



Figure 1.2.2.1. Mechanism of plastic waste management in Cambodia.

Less than 10% of the plastic waste generated are recycled in local recycling industries, where most recyclers appear to be cautious with plastic recycling due to the level of effort involved in collection and its relatively low pay-offs (World Resources Forum, 2019: available https://www.wrf-antwerp2019.be/sites/default/files/atoms/files/The%20effects%20of%20the%20Chinese.pdf). As a result, piles of plastic waste on the coast of Cambodia are a common sight (The Guardian, 2018: available https://www.theguardian.com/world/2018/apr/25/mountains-and-mountains-of-plastic-life-on-cambodias-polluted-coast).

Cambodia's Ministry of Environment launched its first plastic reduction campaign in May 2019 in Battambang Province, and later in Siem Reap and Preah Sihanouk (Phnom Penh Post, 2019: available https://www.phnompenhpost.com/national/ministry-campaign-tackles-plastic). The campaign aims to promote awareness of plastic waste and its impacts on the local population, and to encourage the reduction of plastic waste through the adoption of the 3R (reduce, reuse, recycle) framework. One reduction approach is to place regulatory charges on plastic bags, which has been implemented in major supermarkets of Cambodia. The Ministries of Environment, Interior, Economy and Finance, and Tourism pushed this bill through with support by the Fondazione ACRA, an NGO based in Italy (Greenpeace, 2019). Fondazione ACRA also launched a campaign to raise awareness on plastic alternatives (from 2014-2017, valued at €1,341,033, funded by the European Union).

### 2.1.2 Plastics as a proportion of solid waste

In 2016, the MSW for Cambodia was estimated at 1.2 million tonnes, and with a projection of reaching 1.7 million tonnes in 2030 and 2.6 million tonnes in 2050 (Kaza et al., 2018). The amount of MSW generated in Cambodia is approximately 6.8 million tonnes per year, based on a figure of 0.487 kg per capita daily (Sethy et al., 2013). This value has since increased, for example, the MSW 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). Waste collected and transported to dump sites in urban areas was approximately 317,550 tonnes in 2004, increasing to 518,053 tonnes in 2008 and 630,679 tonnes in 2011 (Sethy et al., 2013).

In Phnom Penh, plastics account for the second largest proportion of the waste generated at 20.9% (Singh et al., 2018). The consumption rate of single-use plastic bags in Phnom Penh measures at 10 million pieces daily, where individuals in urban areas use more than 2,000 plastic bags annually (Fondazione ACRA, 2016).

### 2.1.3 Illegal trade of plastic waste

Illegal imports of plastic waste appear to have made their way into Cambodia (mostly from the United States of America and Japan according to a Greenpeace report). Following China's ban on plastic waste imports in 2018, the plastic waste imports into Cambodia would have approximately doubled, from 650 tonnes in early 2016 to 1,700 tonnes in end-2018 (Greenpeace, 2019). However, recent coverage from the Phnom Penh Post reports that Cambodia is now implementing its regulation more stringently to curb these illegal imports, through a collaboration between the Ministry of Environment and relevant institutions, including the General Department of Customs and Excise (Phnom Penh Post, 2019: available https://www.phnompenhpost.com/national/illegally-imported-plastic-waste-returned-back-us-canada).

In July 2019, Cambodia has announced plans to repatriate 1,600 tonnes of illegal plastic waste back to the exporters of United States of America and Canada. The legal grounds of this decision is presumably based on more stringent application of the Basel Convention and local regulation (The Guardian, 2019: available https://www.theguardian.com/world/2019/jul/17/cambodia-plastic-waste-us-canada-send-back).

## 2.2 Research review of pollution from marine plastic

### 2.2.1 Research overview

Research on marine plastics in Cambodia remains limited with some preliminary works on the surveying and monitoring of macroplastics.

One peer-reviewed report has been found for this study (Table 1.2.2.2), which looked at surveying and monitoring the environmental status specifically in the Kep Archipelago.

Table 1.2.2.2. List of published work identified and examined in this study for Cambodia.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Reed et al. (2015)<br><br>Marine Conservation Cambodia (MCC) | Examining the marine environmental status of the Kep Archipelago (Koh Seh, Koh Mak Prang, Koh Angkrong), in relation to reef ecosystems health | March 2014 |

In addition, two ongoing research projects related to marine plastics were also found, albeit with no published reports available at the time of this study. These two projects are conducted by the international NGO Fauna & Floral Institute (FFI) and the United Nations Development Programme (UNDP). The FFI project, 'Tackling plastic pollution for communities and coral reefs in coastal Cambodia' surveys and monitors for macroplastic debris on coastal Cambodia (Koh Rong, Koh Sdach, Sihanoukville). See FFI: available https://www.fauna-flora.org/news/tackling-plastic-pollution-communities-coral-reefs-coastal-cambodia.

The UNDP project, 'Combating Plastic Pollution in Cambodia' is a policy review report which examines the local regulation laws involving macroplastic products (bags, foams and straws) as well as their challenges, and provides recommendations. See UNDP: available https://www.kh.undp.org/content/cambodia/en/home/projects/our-action-for-plastic-pollution-in-cambodia.html.

### 2.2.2 Types of research conducted

*Types of plastics research foci*

The three research projects focused entirely on macroplastics with no polymer identification.
No published peer-reviewed study on plastic-associated (organic or inorganic) contaminants.

*Coverage of marine environs*

Information on marine environs that have been studied is only available in the research project of FFI, which focuses on macroplastics found on the shoreline. Unfortunately, this publication does not specify surveying locations and other specific findings.

### 2.2.3 Survey and monitoring

The research conducted by MCC examined the coral reef ecosystems of selected islands in the Kep Archipelago in 2014 and found macroplastics, mostly in the form of fishing gear, line, and other plastic waste. The main objective of these annual reports however, lies in assessing the status of marine biota (e.g. vertebrate, invertebrate, environment), and they have since 2015 made no further mention of marine plastic pollution in the Kep archipelago, perhaps due to the fact that marine plastic was simply not an objective of these reports.

The FFI has teamed up with local researchers and communities in initiating marine plastic research in Cambodia through surveys of coastline debris (including macroplastic), waste sorting and household interviews. Preliminary results of the coastline surveys have found that plastics account for approximately 80% of debris, and that single-use plastic bags and bottles are major components of plastics entering Cambodian waters, alongside food packaging, disposable cutlery, straws and fishing gear.

These research projects on macroplastics do not identify polymer types.

### 2.2.4 Source differentiation and pathways

There is no published peer-reviewed study that seeks to differentiate different sources of plastic debris and their leakage into the ocean and pathways, nor the extent to which marine plastic debris are a pathway for associate contaminants or invasive species.

### 2.2.5 Movement of plastics, accumulation and hotspots

There is no published peer-reviewed study on the movement, accumulation and hotspots of marine plastics.

However, news records suggest that abundant plastic trash in Cambodia, without the right management, often ends up in piles on public streets, beaches and in waterways (The Guardian, 2018: available https://www.theguardian.com/world/2018/apr/25/mountains-and-mountains-of-plastic-life-on-cambodias-polluted-coast).

### 2.2.6 Ecological and environmental impacts

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

There have been several informal reporting of marine biota death possibly as a result of plastics, as seen in the dead Irrawaddy dolphin found on Koh Rong Samloem beach with visible plastic mass in its mouth and intestines (Khmer Times, 2018: available https://www.khmertimeskh.com/523122/dead-irrawaddy-dolphin-found-on-beach/).

#### 2.2.7 ALDFG

There is no study focusing on ALDFG, although fishing gear are mentioned in Reed et al. (2015).

#### 2.2.8 Social perceptions and socio-economic impacts

There is no peer-reviewed study on the social perceptions and socio-economic impacts of marine plastics.

However, plastic waste accumulation and degradation at dumping sites appears to have social impacts on local populations living or working near such sites, especially with regards to their quality of life and on their health (Channel News Asia, 2018: available https://www.channelnewsasia.com/news/asia/with-cambodia-drowning-in-a-wave-of-waste-plastic-could-be-10388780).

### 2.3 Main players in marine plastic research

The marine plastic research, though limited, is driven by several researchers from academic institutions (i.e. the Royal University of Phnom Penh), local SCUBA divers (i.e. Kuda Divers), local NGOs (i.e. Marine Conservation Cambodia) and international NGOs (i.e. FFI and UNDP).

FFI appears to have stepped in to lead preliminary research on marine plastics. The FFI has a Marine and Coastal Conservation Programme which identifies strategies for minimising marine plastic waste, conducts plastic waste research, and consultations in Phnom Penh and coastal areas.

The two other organisations identified appear to have limited emphasis on marine plastic research. The UNDP produced policy report reviews on plastics that would leak into the natural environment eventually as marine plastics, but focuses more on upstream management on the 4Rs (refuse, reduce, recycle, reuse). Reports from the MCC, which undertakes the annual marine assessments in the Kep archipelago, do not emphasise marine plastic research except for a brief monitoring in the 2015 report.

### 2.4 Summary of understanding

The few marine plastic assessment studies and news reports have revealed that plastic pollution is an emerging issue in Cambodia, despite its relatively smaller coastline compared with other ASEAN+3 member states. However, the limited studies found on marine plastics research do not provide the understanding of pollution from marine plastic that Cambodia would need to plan a response.
It will be useful for Cambodia to improve its understanding of this issue through consistent and more holistic surveying and monitoring efforts of marine plastics that are existing across different aquatic environments, sources, leakages and pathways, as well as the extent of impact on its people and the environment that they are living in.

## 3. INDONESIA

***Summary of research topics:*** *Published research articles focus mainly on surveying and monitoring, with good coverage of micro- and macro-plastics (including ALDFG) through a combination of sampling, quantification, identification and characterisation methods. Various marine environs where marine plastics can be found have also been examined. The presence of marine plastics in the aquatic environment, downstream impacts in both ecological-environmental and socio-economic, source differentiation, movement and accumulation probabilities are also examined and well-understood.*

***Summary of understanding at national level:*** *Pollution from marine plastic is a known issue in Indonesia. This awareness has triggered research in various research foci and there is a holistic understanding of the issues raised. Research suggests that mangroves may be a plastic sink and accumulation areas and a greater concentration of microplastics in proximity to human settlements. Packaging was reported as the most common macroplastic across all studies, followed by consumer products, fishing gears and building and construction material. There is experience in source differentiation and pathways at local level as well as coastal communities' perception and willingness to mitigate pollution from plastic debris. Pollution from organic and inorganic contaminants associated with plastic are understood.*

***Keywords/research fields:*** *National approach; solid waste; trade of plastic waste; research foci; marine environs; waste management; guidelines; beach clean-up; national research framework; surveys and monitoring; methodology of monitoring and assessment of marine litter; source differentiation; contribution from fisheries; ALDFG; contribution from rivers; accumulation zones; hotspots; fragmentation and degradation; ecological and environmental impact; socio-economic impact; methodology for marine plastic clean-up; movement of plastics; social perceptions; main players*

### 3.1 Context

#### 3.1.1 National approach to plastic waste and its management

The management of municipal solid waste (MSW) in Indonesia is the responsibility of the municipality (local government). Publications indicate that most municipalities give low priority to solid waste services due to low allocation in their annual budget, which mainly covers operational costs but is insufficient for maintenance and investment (Damanhuri et al., 2013). Adequate management of MSW is one of the most challenging urban issues for city administrators in Indonesia, particularly in big cities. Although the general method embraced in principle in MSW management all over Indonesia is collect-transport-dispose, it appears that operations vary across the cities (Lestari and Tridiningrum, 2019). Almost half of the country continues to operate open dumping sites, according to 2018 Environment and Forest Ministry data (The Jakarta Post, 2019: available https://www.thejakartapost.com/news/2019/03/03/inadequate-landfills-worsen-indonesias-waste-problems.html).

Reports indicate that the amount of MSW is generally dominated by organic compositions (e.g. food scraps), followed by plastic and paper (e.g. packaging/wrapping materials). Although local methods employed for sorting and separation of MSW in Southeast Asian countries may be considered inappropriate for solid waste management systems as defined by developed countries, existing recycling practices provide an income stream for hundreds of thousands of people involved in this informal sector. They also enable for a far greater amount of MSW to be recycled (Damanhuri et al., 2013) than would otherwise be the case.

Approximately 9 to 10% of plastic waste is recycled while the remaining is burnt or disposed of at landfills. Out of 3.22 million tonnes of mismanaged waste in 2010, an estimated 0.48 to 1.29 million tonnes of plastics leaked into the marine environment annually (Jambeck et al., 2015). Of the top 20 polluted rivers identified based on a global river plastic inputs model, four main rivers (i.e. Brantas, Solo, Serayu, Progo) can be found in Indonesia (Lebreton et al., 2017).

Since the release of Jambeck et al. (2015) study, the Indonesian government has committed to a goal of 70% reduction in marine plastics by 2025 through Indonesia's Plan of Action on Marine Plastic Debris 2017–2025 (Coordinating Ministry for Maritime Affairs, 2018). This plan of action includes a commitment to an intervention based on five strategies for systemic change to improve the way plastics are produced, used, and disposed of. Thus far, Indonesia has imposed strict laws on managing plastic waste imports, limited imports to only recyclable plastics, and banned non-recyclable plastic waste (UNESCO: available http://www.unesco.or.id/publication/SC_Retreat/4_MarineDebrisIndonesia.pdf). Bans and/or taxes have also been imposed on the use of plastic bags.

### 3.1.2 Plastics as a proportion of solid waste

In 2016, the MSW for Indonesia was estimated at 65.2 million tonnes, and with a projection of reaching 88.0 million tonnes in 2030 and 119.0 million tonnes in 2050 (Kaza et al., 2018). Major urban centres in Indonesia produce nearly 10 million tonnes of waste annually, and this amount increases by 2-4% annually (Ministry of Environment, 2008). Jakarta uses a major landfill located at Bantar Gebang in the suburban town of Bekasi, which receives approximately 6,000 tonnes daily (Aprilia et al., 2012).

Plastic accounts for the second largest proportion of MSW and was estimated at 11% to 15% of waste generated across cities in Indonesia (Hoornweg and Perinaz, 2012; Shuker and Cadman, 2018; Lestari and Trihadiningrum, 2019). Based on Jambeck et al. (2015) estimates, Indonesia would have produced 3.22 million tonnes of mismanaged plastic waste in 2010 and approximately 0.48-1.29 million tonnes of plastic marine debris. Plastic bags were the most prevalent type of plastic waste, followed by plastic packaging (Shuker and Cadman, 2018).

Based on the abovementioned estimates (i.e. the 2018 World Bank estimate of national waste production; the estimate of 15% of waste being plastic; and the Jambeck et al. 2015 estimate of mismanaged plastic waste), Indonesia would be mismanaging 38% of its municipal plastic waste. However, it is unclear how to include past imports of plastic waste in these figures.

### 3.1.3 Illegal trade of plastic waste

Based on data from the Indonesian National Statistics Agency (2018), illegal imports of plastic waste into Indonesia were prevalent, with a spike in imports after China implemented its National Sword Policy in January 2018. The quantity of illegal plastic waste imports into Indonesia drastically surged following the 2018 China ban, with an increase of up to 141% from 2017 to 2018, and at a total of 283,000 tonnes in 2018, the highest ever in the past decade (Indonesian National Statistics Agency, 2018). The bulk of plastic waste appears to be coming from the Marshall Islands in Oceania (92,682 tonnes) and the United States of America (56,753 tonnes) (Greenpeace, 2019).

According to the Indonesian Minister of Environment and Forestry Siti Nurbaya Bakar, this was not the first-time illicit plastic had been imported into Indonesia. In 2015 and 2016, the Ministry had re-exported dozens of containers filled with illegal plastic waste or waste that was non-compliant with their regulations. Indonesian government's intent to re-export this illegal plastic waste is clear, although this may not always occur. (VOA News, 2019: available https://www.voanews.com/east-asia/indonesia-vows-send-back-illegal-plastic-waste).

## 3.2 Research review of pollution from marine plastic

### 3.2.1 Research overview

Among the 10 ASEAN member states, Indonesia appears to have done the most extensive research on pollution from marine plastics, especially in the years 2018 and 2019 (See complete table in Appendix III). Research efforts span a large geographical extent, involving 15 out of the 34 provinces in Indonesia, including the provinces of Java, Bali, Kalimantan, Sulawesi, Sumatra, Tenggara, Banten, Riau and Jakarta. Purba et al. (2019) provides a comprehensive overview of national marine plastic in 'Marine debris in Indonesia: A review of research and status'. This study found 64 relevant studies for assessing the current state of knowledge of marine plastics in Indonesia. Marine plastic research articles that were found span across 17 research foci (Figure 1.2.3.1).

Research efforts appear to place priority on surveying and monitoring to understand the pollution status (n=46) through sampling of microplastics floating on the sea surface or in the water column, sampling of macroplastics found among macro-debris on the shoreline, and sampling of microplastics in various marine biota. There is also an emphasis on impacts of marine plastics on the marine environment (e.g. plastic ingestion in biota, n=12), and on the socio-economy (n=8), particularly on human health and food safety. There are also attempts at understanding the movement of plastic in water bodies (n=7) through the use of modelling tools that lead to the discoveries of possible accumulation zones and hotspot areas (n=5), and studies on social perceptions (n=8), mostly to understand the level of awareness and perspectives the locals have of marine pollution responsibility.


Figure 1.2.3.1. Research foci of marine plastic research conducted in Indonesia.

### 3.2.2 Types of research conducted

*Types of plastics research foci*

Of the marine plastic research conducted, microplastics appears to be of utmost concern (n=30). This is followed by research of macroplastics-only (n=19) and of both microplastics and macroplastics (n=11) (Figure 1.2.3.2). The microplastic studies mostly examined the presence/absence of microplastic in marine biota and/or in the various abiotic environments (i.e. sea surface or water column, seafloor, shoreline). The macroplastic studies on the other hand were focused on macroplastics on the shoreline, such as in coastline debris surveys.

Of all the research, only a small proportion (<15%) further identified plastics into their polymer types. No published peer-reviewed study on plastic-associated (organic or inorganic) contaminants was found.

*Coverage of marine environs*

Most of the field research has been conducted on the sea surface or water column, from estuaries (mainly the Jakarta Bay), to coastal waters and out to the open ocean. The shorelines of Indonesia have also been well-examined, with studies looking into the different characteristics of sandy coastal beaches, mangrove ecosystems, remote beaches or shorelines with high anthropogenic pressure from nearby human settlement or aquaculture activities. There has been less studies conducted in marine biota and on the seafloor, i.e. surface and subsurface sediments (Figure1.2.3.3). Of note, Indonesia is the first ASEAN state to have studied microplastics present in deep-sea sediments of the southwestern Sumatera waters (Cordova and Wahyudi, 2016).

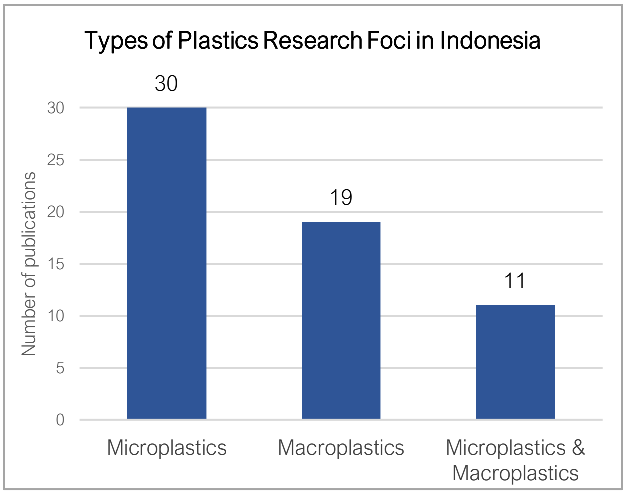



Figure 1.2.3.2. Distribution of marine micro-/macro-plastics researched in Indonesia.

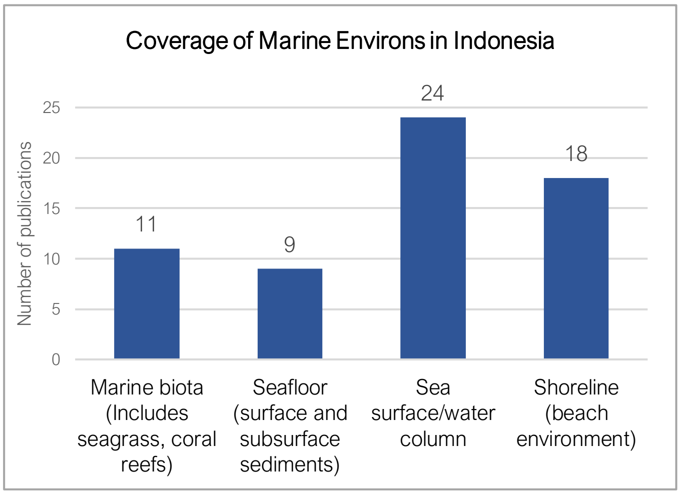



Figure 1.2.3.3. Distribution of marine environs researched in Indonesia.

### 3.2.3 Survey and monitoring

A great majority of the studies conducted in Indonesia focused on surveying and monitoring to understand the current status and extent of marine plastic pollution in the country.

*Microplastics*

Microplastics have been found and examined in an array of abiotic environments. Their prevalence is especially highlighted in environments with high human impact: in the coastal waters near human settlement (Afdal et al., 2019; Cordova et al., 2019; Falahudin et al., 2019; Hiwari et al., 2019; Rachmat et al., 2019; Ismail et al., 2018; Syakti et al., 2017, 2018) and in coastal sediments (Asadi et al., 2019; Yona et al., 2019; Wahyuningsih et al., 2018; Manalu et al., 2017; Balasubramaniam and Phillott, 2016; Dewi et al., 2015). They are also present in mangrove ecosystems (Rahmawati and Patria, 2019; Hastuti et al., 2014), seagrass ecosystems (Tahir et al., 2019), coral reef ecosystems (Cordova et al., 2018), pristine areas (Cordova and Hernawan, 2019), the open ocean (Pangetsu et al., 2016), deep-sea sediments (Cordova and Wahyudi, 2016) and across a mixture of physical environment (Ayuningtyas et al., 2019; Bangun et al., 2018).

Microplastics have also been monitored in various marine biota and their surroundings, from wild fish (Lubis et al., 2019; Germanov et al., 2019) to commercial fish and bivalves (Hastuti et al., 2019; Ismail et al., 2018, 2019; Rahmawati and Patria, 2019; Khoironi et al., 2018; Lestari et al., 2018; Rochman et al., 2015).

In these studies, 'microplastics' was commonly defined as being <5 mm, with the exception of 2 studies. Hiwari et al. (2019) defined microplastics as being <2 mm, while Rochman et al. (2018) did not make a clear distinction of the term 'microplastics' and simply considered debris found as 'small' as it averaged at 6.3 mm (±6.7 SD). Of the microplastic studies, one-third of the studies further identified microplastics to their polymer types. Commonly-found microplastics polymer types included PS, PE, PP, PET. Almost all studies characterised the morphology of plastics sampled into finer structure of films and fibres, with commonly reported forms of fibres, films or fragments.

In one particular study by Syakti et al. (2017), the status of microplastic degradation was examined using the measurement of carbonyl index. It determined that the floating microplastic sampled from the Cilacap Bay of Indonesia was slightly degraded.

In comparing the microplastic contamination across different studies, comparison seemed feasible where the measurement of abundance was reported in the same unit. This was the case for microplastics in sediments which were mostly reported using particles per kg of dry sediment, and for microplastics in marine biota which were mostly reported using particles per individual (only two studies used particles per 1g of animal tissue or per 0.25g animal tissue). Microplastics in sea water or the water column however, were reported in a range of units, e.g. particles per $m_3$, $km_2$, kg, litre or 100 particles per $m_3$. These studies also used a large diversity of methodologies and units with no clear preference for any. Nevertheless, many of these units can be converted, including, with some caveats, from areas to volumes.

In general, microplastics studies appear to have benefited from appropriate equipment and set-up for in-depth analysis. They however might not be performed across all institutions, or might have discrepancies in terms of methodologies and interpretation of results.

*Macroplastics*

Macroplastics were also found to be the most common among other debris types, especially on sandy beaches of varied types: recreational, private/remote, fishery-related (Isyrini et al., 2018, 2019; Maharani et al., 2018; Purba et al., 2017, 2018a, 2018b; Tahir et al., 2018; Husrin et al., 2017; Syakti et al., 2017; Attamimi et al., 2015). Beaches of mangrove ecosystems also showed similar trends (Maharani et al., 2018; Purba et al., 2017; Hastuti et al., 2014). Most studies reported that mangrove systems may possibly serve as a plastic sink and accumulation zone.

Most studies categorised macroplastics according to their uses. Packaging was reported as the most common macroplastic across all studies, followed by consumer products, fishing gears, and building and construction materials. Fishing gears, i.e. ALDFG, were examined in two studies on how ALDFG provides substrata for coral life, and also on the possible sources of ALDFG (see Part 1, Section 2.3.2.7). Only three macroplastics studies identified the polymer types, and revealed the common polymer type as PET.

### 3.2.4 Source differentiation and pathways

Source differentiation studies were focused on macroplastics, and mostly focused on determining the country of origin from existing labels on the macroplastics sampled (Maharani et al., 2018; Purba et al., 2017, 2018a, 2018b). These studies were able to point to the possible sources of marine litter i.e. nearby residential sources, fishery activities, shipping activities or from other origins as brought in by currents.

There appears to be no research in Indonesia on marine plastic acting as a pathway or vector for pollution by other organic substances, polymers and inorganic contaminants. Such research would focus on how these plastic additives or other contaminants may become adsorbed and transported by plastic debris, then released into the marine environment. Examples of studies in other countries relate to arsenic, lead and copper. Petrlik et al. (2019) also suggest that contamination by other persistent organic pollutants (POPs) (e.g. dioxins, PCBs, PBDEs, SCCPS and PFOS) could be possible as they are found in the terrestrial environment in proximity to dumping sites.

### 3.2.5 Movement of plastics, accumulation and hotspots

The use of models, hydrodynamic and particle tracking, are useful in revealing the movement of plastic in water bodies, and subsequently identifying potential accumulation zones and hotspots. Van Emmerik et al. (2019) found that annual plastic emission into the ocean through Jakarta's rivers and canals equals 3% of the city's total annual unsoundly disposed plastic waste. Jasmin et al. (2019) found that reclamation at Jakarta Bay has changed the existing trajectory of microplastic in the bay and may lead to accumulation in the eastern part of the bay, especially in wet seasons. Handyman et al. (2019) hypothesised that the Java Sea could be the biggest microplastics patch in Indonesia due to trapping caused by the reversing tidal current. Purba et al. (2019b) investigated the trajectory of microplastics at Savu Sea Marine National Park. Ramos et al. (2018) rebut the hypothesis of the Pacific Garbage Patch being a source of microplastics for Indonesian waters. Husrin et al. (2017) revealed that marine surface debris found in Kuta might be transported from the Bali Straits and other sources in the South of Bali to Kuta during the West Monsoon season. Purba and Faizal (2019) examined the efficiency and feasibility of using novel surface drifters (Float Artificial Debris) in measuring the spread and movement of marine debris.

These articles show Indonesia's research capacity on movements of plastic debris. With a similar approach to that of the World Bank (see Part 1, Section 5.1), Nordén and Karlsson (2018) took a risk assessment approach through the identification of plastic accumulation areas. Their paper sought to optimise the placement of clean-up systems for marine plastic debris at the mouth of the estuarine network in Jakarta Bay. It should be noted that this paper was written by undergraduate students, and that there is no other academic paper on this topic.

Research on movement of plastic debris seems to focus primarily on the Java Seas although research projects on pollution from marine plastics have also been carried out in many other parts of Indonesia. However, Kalimantan, Sulawesi and Papua seem to have generally been less studied.

### 3.2.6 Ecological and environmental impacts

Studies on ecological impacts mostly quantified plastic ingestion in wild animals through dissection and analysis, such as in grey-eel catfish (Lubis et al., 2019), benthic species (Tahir et al., 2019; Bangun et al., 2018), commercial fish and bivalves species (Hastuti et al., 2019; Ismail et al., 2018, 2019; Rahmawati and Patria, 2019; Khoironi et al., 2018; Lestari et al., 2018; Rochman et al., 2015).

These studies showed similar evidence of microplastic ingestion in animals, particularly in their digestive tract, as opposed respiratory organs. In fish, the varied ingestion rate was hypothesised to be due to the different feeding behaviours of different fish types. Germanov et al. (2019) validated microplastic ingestion in manta rays and whale sharks in Nusa Penida, Bali through a different approach of quantifying microplastic in their feeding grounds, and in their regurgitated or egested material.

The direct impact of plastic on the marine biota health has been studied in Syakti et al. (2019d), a study on *Acropora formosa* corals. Of note, this research was the only polymer-specific experiment realised in a laboratory setting. The choice of LDPE polymer differed from the polymers previously identified in the natural environment. The authors justified their choice on the fact that it is commonly found in the marine environment according to a GESAMP report (2015). In this study, coral fragments from the wild were exposed to different treatments of LDPE microplastics and had visible negative impacts of bleaching and necrosis when the LDPE exposed were of the right size and concentration. This impact on coral health was hypothesised to be due to the reduction of light penetration to allow for sufficient zooxanthellae photosynthesis or possibly, by the release of toxic chemicals acting on the corals.

Despite much general news coverage of the physical impact on and ingestion by wild animals of macroplastic such as whales and sea turtles, no peer-reviewed articles were found on this topic.

#### 3.2.7 ALDFG

Two studies on ALDFG were found. Hoeksema and Hermanto (2018) found plastic fishing nets on the seafloor and as an unstable and unnatural substrate for reef corals in the Lembeh Strait. Richardson et al. (2018) explored existing challenges in Indonesian fisheries management (i.e. over-allocation of fishing licenses and illegal, unreported and unregulated (IUU) fishing pressures) which are factors that may contribute to the issue of ALDFG.

Indonesia has shown a particular interest managing ALDFG through tracking efforts, as part of the Global Ghost Gear Initiative (GGGI) (see Part 1, Section 6.1.4).

#### 3.2.8 Social perceptions and socio-economic impacts

Several studies have conducted interviews with locals to find out more about people's perspectives on or awareness of marine plastic pollution issues and their responsibility in waste management. The diversity of explorations summarised below appears to provide a basis to inform steps that may be helpful to improve education and outreach on the topic.

Kusumawati et al. (2020a) examined the perception of millennial youths in West Aceh towards marine litter, as well as the potential influence of environmental education. In Kusumawati et al. (2020b), the team also examined the perception of the locals of Aceh Jaya Regency towards marine litter responsibility. Husrin et al. (2017) and Attamimi et al. (2015) examined the awareness and perception of beach littering and cleanliness responsibility in locals of Bali. Giesler (2018) examined the status of understanding on existing environmental laws, with respect to plastic disposal and recycling, and the level of education received by the locals in Bali. Sur et al. (2018) explored the feasibility and the willingness of locals, specifically the younger generation, in participating in beach clean-up events. Shuker and Cadman (2018) and Oktaviana et al. (2014) assessed community perceptions to waste management and found varied community-level attitudes and practices in different community profiles.

Studies on the socio-economic impact of marine plastic are primarily framed around considerations of human health, especially in studies which quantify plastics in seafood that are commonly sold for human consumption. 27 common commercial species of fish were studied and tested positive for microplastics ingestion (Hastuti et al., 2019; Ismail et al., 2018, 2019; Rahmawati and Patria, 2019; Rochman et al., 2015). Two commercial bivalves, specifically *Perna viridis* and *Meretrix meretrix* examined also showed microplastic ingestion and contamination (Khoironi et al., 2018; Lestari et al., 2018).

Whilst not included in this research inventory, of note is a multi-NGO-led report titled "Plastic Waste Flooding Indonesia Leads to Toxic Chemical Contamination of the Food Chain" (Petrlik et al., 2019). It reported that eggs sampled from free-range chickens that had roamed and eaten food off the ground near Indonesian plastic waste dumping sites contained various hazardous POPs with potential toxicity to human health. Such impacts are likely to manifest in the marine environment of Indonesia, where an array of marine biota has been reported to ingest plastics – some of which are commercially important food items. This suggests that, within a risk approach to responses to marine plastic pollution, a meaningful step is to map coastal dumping sites in Indonesia.

### 3.3 Main players in marine plastic research

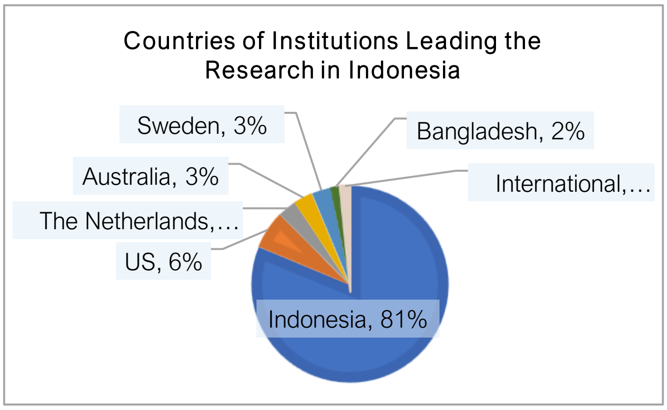



Figure 1.2.3.4. Composition of research efforts seen in Indonesia.

The majority of research studies were headed by local efforts with some research contributions from the US, the Netherlands, Australia, Sweden, Bangladesh and from one international organisation.

Well-known players in marine plastic research in Indonesia include the governmental authority for research and science known as the Indonesian Institute of Sciences, or as Lembaga Ilmu Pengetahuan Indonesia (LIPI). Renowned researchers of LIPI include Cordova M.R. Research teams like that of Purba N.P., Handyman D.I.W and Ismail M.R. from Padjadjaran University and Syakti A.D. from Jenderal Soedirman University also appear to be equally involved in marine plastic research in Indonesia.

Other research teams with experience in oceanographic modelling applied to substances, such as movement of oil particles following a spill, are expected to also have the necessary expertise for further studies of the movement of floating plastic debris. These include oceanographers Susanna Nurdjaman and Ivonne Radjawane from the Faculty of Earth Sciences and Technology of Bandung Institute of Technology.

### 3.4 Summary of understanding

There has been an impressive effort by Indonesia with respect to producing and publishing information in response to pollution from marine plastics within the country, especially based on the number of articles found in 2018–2019. An important characteristic of this research effort is also its breadth as it covers most aspects of pollution from plastic. Nevertheless, some of this research is still at a very early stage. All environs are also being investigated.

More than half of the articles published seek to quantify the presence and abundance of marine plastic debris. However, the methodologies used are varied and often not immediately comparable. Syakti's discussion of monitoring guidelines (Syakti, 2017) may be leveraged to improve coordination as full harmonisation may not be feasible nor desirable.

Whilst studies on microplastics were able to categorise samples into various forms including those of films and fibres, there is still a limited number of polymer-specific research to understand differences in degradation of different polymer-types in the marine environment, as well as their specific environmental and ecological impact. No research has been found so far either on marine plastics as a pathway for pollution by other organic substances, polymers or inorganic contaminants (e.g. POPs and heavy metals).

Research on ecological and environmental impacts is the second most common category of research focus. There is primarily interest in the ingestion of microplastics by marine life, especially organisms of socio-economic importance. No investigation on plastic transfer through the food chain has been found so far. Interestingly, there is no peer-reviewed article on the physical impact on wild animals (such as endangered migratory species like whales, sea turtles and seabirds) from the ingestion of macroplastic. Only one notable news report in 2018 was found on the impact of plastics in a sperm whale that had washed ashore in eastern Indonesia (off Kapota Island, Wakatobi National Park). The sperm whale was found dead with 6 kg of plastic in its stomach (National Geographic, 2018: available https://www.nationalgeographic.com/environment/2018/11/dead-sperm-whale-filled-with-plastic-trash-indonesia/).

Geographically, the articles reviewed covered most parts of Indonesia. The Java Seas get the most attention, while Kalimantan, Sulawesi and Papua appear to get the least attention.

Reports and research articles indicate that the management of MSW is a general issue throughout the country with a diversity of leakage pathways into rivers and into the marine environments. While there are no published articles that seek to quantify different leakage sources and pathways, a few articles provide insights on social perception that may inform the development of an effective waste management policy.

In this context, the research capacity of Indonesia on modelling the movement of marine plastics may be useful to guide a country-wide risk assessment approach or identification of hotspots approach. A multi-prong approach can take into account a number of parameters with different weights depending on local priorities (such as local communities, health, endangered marine life, tourism, etc) and different marine spatial plans. Of note, one example is the articles on marine plastic accumulation in mangroves (Maharani et al., 2018; Hastuti et al., 2014), a habitat that provides numerous ecosystem and social services, making it a priority area for conservation and management.

Finally, ALDFG, whille a recognised issue in Indonesia, appears to still be under-studied.

# 4. LAO PDR

*Summary of research topics: With Lao PDR being inland, there is no research on marine plastic pollution in the country. However, as the Mekong River flows into the South China Sea and through other ASEAN states, their waste management approach is relevant.*

*Summary of understanding at national level: Plastic pollution appears to have been missed as a priority in the scientific scene.*

*Keywords/research fields: N.A.*

## 4.1 Context

### 4.1.1 National approach to plastic waste and its management

Marine plastic pollution is not an important topic for Lao PDR, the only landlocked ASEAN state. In Lao PDR, plastic waste is typically discussed in the context of solid waste management which is a priority area identified as part of the Global Green Growth Institute (GGGI)'s green cities programme in Vientiane (GGGI, 2018). Plastics are considered recyclable materials that are collected by informal workers, but no major recycling industries are reported to exist in Lao PDR (GGGI, 2018).

Plastic waste management is also crucial as land-based leakage into the waterways of the Mekong River are important pathways through which plastic materials can enter the South China Sea. In order to reduce plastic waste, Lao PDR encourages the usage of recyclable bags which are sold in downtown cafes and markets (Greenpeace, 2019). In July 2019, the Minister of Industry and Commerce signed a ministerial order in a bid to protect the environment and improve the operations of plastic waste recycling plants, The order authorised the freezing of licences to new manufacturing plants that would utilise plastic waste as a raw material (Asian News Network, 2019: available http://annx.asianews.network/content/industry-ministry-orders-suspension-plastic-waste-recycling-plants-102439).

Socially, the consumer lifestyle of Laotians has been noted to shift towards reliance on imported and manufactured products, including those of plastic materials. However, there is no proper and established waste disposal management system, which often results in local solutions of either simply burning or dumping plastic into the rivers, as the Laotians appear to be lacking awareness of the harmful impacts that such solutions may bring about (Asia Foundation, 2017: available https://asiafoundation.org/2017/04/19/love-laos-keep-clean/).

### 4.1.2 Plastics as a proportion of solid waste

In 2016, the municipal solid waste (MSW) for Lao PDR was estimated at 364,000 tonnes, and with a projection of reaching 522,000 tonnes in 2030 and 748,000 tonnes in 2050 (Kaza et al., 2018). Based on these estimations, Lao PDR appears to be one of the smallest generators of MSW among the ASEAN+3 member states (UNEP, 2017).

Of the 500 tonnes of solid waste generated daily in Vientiane, the capital and largest city of Lao PDR, plastics made up 6.1% (Climate and Clean Air Coalition, 2015).

#### 4.1.3 Illegal trade of plastic waste

Following the 2018 China ban on import of plastic waste, plastic waste import into Lao PDR quadrupled from 1,120 tonnes in early 2016 to 4,800 tonnes in end 2018. The top exporters of this plastic waste were from Thailand and Japan (Greenpeace, 2019).

### 4.2 Main players in marine plastic research

No players are identified. Some information on Lao PDR's plastic waste situation was obtained from a policy brief produced by Greenpeace Southeast Asia (Greenpeace, 2019). No government agency or department could be identified.

### 4.3 Summary of understanding

Leakages of plastic into the waterways of the Mekong are important to the issue of marine plastics in Southeast and East Asia. A better understanding of sources, leakages and hotspots of plastic would be useful in the context of both local and transboundary pollution.

## 5. MALAYSIA

*Summary of research topics:* *A large proportion of peer-reviewed articles focus on the surveying and monitoring of both micro- and macro-plastics in various marine environs and with a geographic coverage of most of the country. Methodologies to monitoring and assessing were examined in few studies, considering the discrepancies seen across studies. Impacts posed by marine plastics were also explored, mainly in marine biota of commercial value and with a potential effect on human health. There have been some attempts at exploring the upstream origin of some marine plastic.*

*Summary of understanding at national level:* *Malaysia shows visible research efforts, with 36 literature reviews published, and has a good understanding of marine plastic pollution issues. Local research efforts are visible and active. The focus on surveying and monitoring provides valuable results for both abundance of macroplastic and microplastics. However, polymer types are generally not identified for microplastics, making any hypothesis of progress from macro- to micro-plastic difficult to be investigated. Ingestion by marine life is also explored but not transfer through the food chain, movement of plastic or plastic as a transport vector for its associated contaminants.*

*Keywords/research fields:* *National approach; solid waste; trade of plastic waste; research foci; marine environs; waste management; surveys and monitoring; methodology for the monitoring and assessment of marine litter; source differentiation; discharge from offshore infrastructures (including aquaculture); ecological and environmental impact; socio-economic impact; movement of plastics; social perceptions; plastics as transport vector; plastic additives; main players*

### 5.1 Context

#### 5.1.1 National approach to plastic waste and its management

The Malaysian government aims to increase plastic recycling to 20% of plastic waste by 2020. It is putting in place a waste separation and collection system which has yet to be adopted and fully implemented throughout all states of Malaysia. Malaysia put a strong emphasis on reducing single-use plastic through a phased approach in its 2018 Roadmap Towards Zero Single-Use Plastics 2018–2030 (MESTECC, 2018). Presently, the Ministry of Energy, Science, Technology, Environment and Climate Change (MESTECC) is looking to establish the Malaysian Plastic Pact – an initiative to involve all stakeholders in combating plastic pollution and increase extended producer responsibility by 2022.

Based on estimates in Jambeck et al. (2015), Malaysia would have been the eighth worst country worldwide out of 192 coastal countries for generation of plastic waste in 2010. They estimated that Malaysia would have had a production of nearly one million tonnes of mismanaged plastic waste in 2010, of which 0.14 to 0.37 million tonnes may have entered the oceans. Policies regarding solid waste management have greatly evolved over the years into formal policies such as the National Strategic

Plan for Solid Waste Management 2005 and the Solid Waste and Public Cleansing Management Act 2007 (Act 672).

### 5.1.2 Plastics as a proportion of solid waste

In 2016, the municipal solid waste (MSW) for Malaysia was estimated at 13.7 million tonnes, and with a projection of reaching 18.2 million tonnes in 2030 and 23.7 million tonnes in 2050 (Kaza et al., 2018).

In Malaysia, plastic constitutes 24% of its total MSW (Aja and Al-Kayiem, 2014). In a major city such as Kuala Lumpur, plastics ranked second by composition for solid waste generated, at 11.45% after organic waste in 2000 (Saeed et al., 2009).

### 5.1.3 Illegal trade of plastic waste

Since China's 2018 ban on imported plastics, Malaysia appears to have received 195,000 tonnes of plastic waste imports from the USA alone between January to July 2018 (Greenpeace, 2018). Imports increased three-fold from 288,000 tonnes in early 2016 to 873,000 tonnes in end 2018. Lack of appropriate processing facilities to cope with the high influx of plastic waste imports resulted in large piles of illegally-burnt plastic remains or unclaimed plastic, particularly at Port Klang. There was also a sharp rise in illegal factories for the processing of plastic waste.

In October 2018, Ms. Yeo Bee Yin of MESTECC announced Malaysia's strong stand against illegal import of plastic waste. This was followed by an import ban on all plastic waste, scraps and pairings, except those issued with an Approved Permit (AP) issued by the National Solid Waste Management Department. The Government adopted a definition of plastic waste (which can only be disposed of) versus plastic scrap (which can be reused or recycled) under the 2018 Basel Convention Amendments. As of November 2019, 240 illegal factories had since been stopped, and plastic imports without an AP were sent back (pers. comms., Z.A. Tajuddin, Regional Enforcement Officer, Selangor Malaysia, 14 November 2019).

## 5.2 Research review of pollution from marine plastic

### 5.2.1 Research overview

This study includes 36 peer-reviewed studies for Malaysia. They cover a large geographical area as they extended to almost all 13 states, with the exception of the state of Perlis Indera Kayangan.

The marine plastic research identified covered ten research foci (Figure 1.2.5.1). Most of the research effort has been devoted to surveying and monitoring abundance of marine plastic debris (n=26), macroplastics found among macro-debris on the shoreline, and microplastics in various marine biota. The next most common research focus is on the ecological and environmental impacts posed by marine plastics (n=9), mostly through the study of the ingestion of plastics by marine biota. There are also clear attempts at understanding the socio-economic impacts of marine plastics (n=6), particularly on human health and food safety, through examinations of the presence of plastics in marine biota that are meant for human consumption. There are also attempts at understanding source differentiation (n=5), mostly through the identification of the origins of macroplastics based on their existing printed labels.

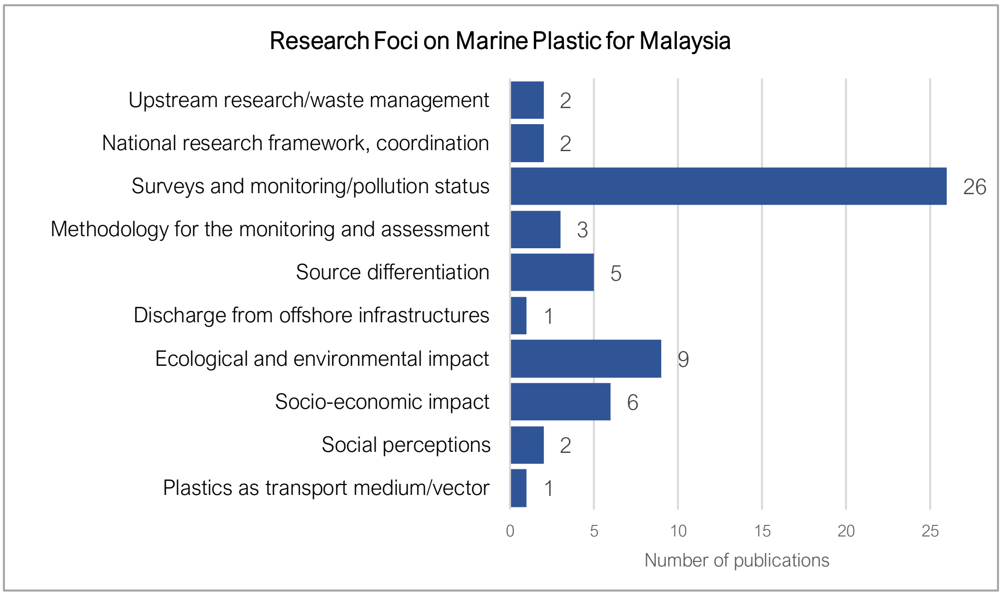



Figure 1.2.5.1. Research foci of marine plastic research conducted in Malaysia.

## 5.2.2 Types of research conducted

*Types of plastics research foci*

Microplastics studies appear to be of greater interest (n=20) to Malaysia's research community than macroplastics-only studies (n=14) and than both microplastics and macroplastics studies (n=2) (Figure 1.2.5.2). There has been an increase in the number of published studies on microplastics across various Malaysian institutions since 2016, which shows an increase in interest in the topic. The microplastics studies were mostly on the presence/absence of microplastics in marine biota and in the waters, while the macroplastics studies were mostly focused on the presence/absence of macroplastics on the shoreline as large marine debris.

In four studies, plastic-associated contaminants, particularly of plastic additives, were identified. In these studies, the microplastics of various polymer types examined revealed the identities of additives such as titanium dioxide, phthalocyanine, chromate yellow, hostaperm blue, hostasol green (Karami et al., 2017a, 2017b, 2019; Karbalaei et al., 2019).

*Coverage of marine environs*

Most of the research was conducted on the shoreline (n=18), followed by in marine biota (n=11) (Figure 1.2.5.3). Few studies have focused on either the sea surface or water column (n=5), or the seafloor (i.e. subsurface sediments) (n=1). Macroplastic prevalence has also been observed in riverine systems leading to the open ocean (Chukwuma et al., 2019) and on the sea surface (Estim and Sudirman, 2017).

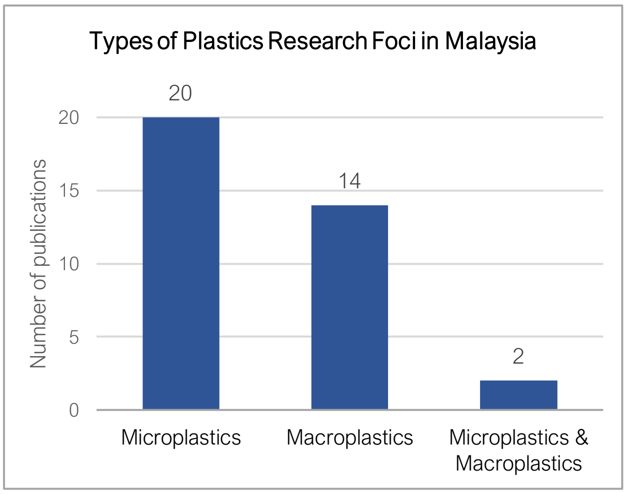



Figure 1.2.5.2. Distribution of marine micro-/macro-plastics researched in Malaysia.

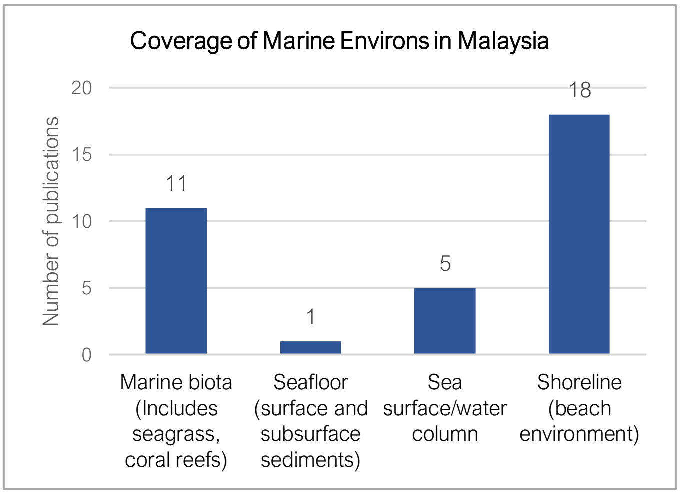



Figure 1.2.5.3. Distribution of marine environs researched in Malaysia.

## 5.2.3 Survey and monitoring

The great majority of published studies focused on surveying the extent of the presence of marine plastic in Malaysia.

*Microplastics*

Microplastics were found to be prevalent across a range of marine environs, especially marine biota and its surroundings. This includes microplastic contamination in wild fish, sea cucumber, bivalves and zooplankton (Amin et al., 2019; Ibrahim et al., 2016, 2017), as well as in commercial fish, sea cucumber (Karbalaei et al., 2019; Anuar et al., unpublished work; Ibrahim et al., 2017; Karami et al., 2018, 2017b) and in a sea turtle (Hocajo-Berná et al., unpublished work). Microplastics were also found in seafood-derived products of canned sardines and sprats (Karami et al., 2018). Apart from marine biota, microplastics were also found in abiotic environs including in the water column (Khalik et al., 2018), in the sediments of the open ocean (Matsuguma et al., 2017), on the shoreline sediments of sandy beaches (Estim and Sudirman, 2017; Noik and Tuah, 2015; Noik et al., 2015; Aris, 2012) and in mangrove ecosystems (Barasarathi et al., 2014).

In these studies, the microplastics studied were generally defined as being <5 mm, with the exception of 5 studies, mainly by Karami et al. (2017a, 2017b, 2018), Karbalaei et al. (2019) and Ibrahim et al. (2017). The former two authors defined microplastics as being within the 0.001–1 mm range, while Ibrahim et al. (2017) defined microplastics as being <1 mm. Microplastics have been further identified to its polymer types in most of the studies (90%). These studies reported common polymer types of PE and PP, as well as PET, PVC, PS, PA, LDPE, HDPE, PVA, as sampled from the natural environment. These studies were conducted by researchers from Universiti Putra Malaysia, University Malaysia Terengganu and Universiti Malaysia Sabah. Microplastics were also examined for their morphology and more than half (65%) of the studies reported finer structures of films and fibres among other structures of fragments, filaments, threadlikes, sphericals, pellets, foams and lines. Apart from microplastic contamination in the sea surface or water column, it appears that there is no clear consistency in the quantification of microplastics abundance across all marine environs studied. In the sea water or surface column studies, the microplastics of three studies were measured in units of particles per litre.

The studies on microplastic in marine biota used a variety of units, and reported quantities as particles with no other specifications, or as particles per individual, and also in density as gram per $cm_3$. In studies on the shoreline, microplastics were measured in quantity as number of particles or mean weight, and in density as gram per $cm_3$. In the sole seafloor study, microplastics were measured in units of particles per kg of dry sediment.

*Macroplastics*

Macroplastics were found to be the most common of all macro-debris, especially on the shoreline (Chee et al., 2019; Fauziah et al., 2019; Estim and Sudirman, 2017; Mobilik et al., 2017, 2016, 2015, 2014; Adnan et al., 2015; Fauziah et al., 2015; Noik and Tuah, 2015; Agamuthu et al., 2012; Khairunnisa et al., 2012; Razlan, 2011; Mobilik, 2008). All of these studies categorised macroplastics into functional types and were commonly of packaging, consumer products and fishing gears. However, polymer types do not appear to have been investigated.

### 5.2.4 Source differentiation and pathways

Source differentiation was attempted mainly on macroplastics found on the shoreline, through an examination of the country of origin on their product labels (Mobilik et al., 2014, 2015, 2017). Mobilik et al. (2016) examined marine litter on beaches located in proximity with shipping ports to explore whether shipping vessels docked were possible sources of plastic items found along the shoreline.

Praveena et al. (2018) studied microplastics in personal care and cosmetics products as a possible source for microplastics leaked into the natural environment with and without waste treatment.

Plastic-associated contaminants are also another concern when plastics can be transported as a vector along various environs. Plastic additives such as titanium dioxide, phthalocyanine, chromate yellow, hostaperm blue and hostasol green were found when examining microplastics of polymer types PE, PP, PET, PS, PVC, PAN, nylon-6, Polyisoprene/polystyrene (Karami et al., 2017a, 2017b, 2019; Karbalaei et al., 2019).

### 5.2.5 Movement of plastics, accumulation and hotspots

There is no published peer-reviewed study focusing solely on the movement, accumulation and hotspots of marine plastics. One study however, reported microplastic contamination in a remote mangrove ecosystem, suggesting that mangroves are potential accumulation zones for microplastics in the aquatic environment (Barasarathi et al., 2014).

### 5.2.6 Ecological and environmental impacts

Research efforts have focused on quantifying plastics ingested in various marine biota, through the dissection and analysis of marine biota including zooplankton sampled in the open ocean (Amin et al., 2019), and ark shell bivalves (Ibrahim et al., 2016). An opportunistic sampling in a green sea turtle off Tioman Island (Horcajo-Berná et al., unpublished work) was also performed, revealing the direct impact of plastic mass on the health of the animal. It was reported that plastic ingestion and mass accumulation had led to its starvation, which may have been its eventual cause of death.

Anuar et al. (unpublished work) in 2018 and Ibrahim et al. (2017) also quantified and compared the levels of microplastics ingested by wild and farmed marine biota, specifically sea cucumber and sea bass fish respectively. Although the two studies did not show common findings, it was interesting to note that the plastic ingestion rate in marine biota appears to be dependent on factors such as whether the wild animals are free to forage and if the caged animals are exposed to incoming tidal fluxes.

There were also studies looking into the quantification of plastic in commercial marine biota, such as in fish sold in fish markets (Karbalaei et al., 2019), in dried fish (Karami et al., 2017b) and in canned products of sardines and sprats (Karami et al., 2018).

#### 5.2.7 ALDFG

There is no published peer-reviewed study on ALDFG. However, a large amount of ALDFGs were informally reported from the coral reefs of Tunku Abdul Rahman Park in Sabah. The ALDFGs were found by divers who frequent the area (The ASEAN Post, 2018: available https://theaseanpost.com/article/ghost-fishing-threatens-marine-life).

#### 5.2.8 Social perceptions and socio-economic impacts

Two studies explored the social perceptions of the locals on marine plastic pollution responsibility. Agamuthu et al. (2012) interviewed the locals across the different states of Negeri Sembilan, Perak and Terengganu and explored their unwillingness to participate in beach clean-up activities or to pay for solid waste management services. The study found that despite their agreement on the importance of beach cleanliness, the locals were not willing to assist in beach cleaning or pay for beach management services. Mobilik (2008) however, found that the locals of Sarawak were willing to participate in beach clean-up activities and did acknowledge the issue of marine plastic pollution on the beaches.

The socio-economic impacts of marine plastic have mostly been considered indirectly, in the context of human health and in studies which quantify plastics in commercial seafood. Nine out of 11 species obtained from a local fish market in Selangor had ingested microplastic (Karbalaei et al., 2019). Four species of commercial dried fish that were eviscerated, revealed that evisceration does not necessarily eliminate the risk of microplastics intake by consumers (Karami et al., 2017b). Four out of 20 brands of canned sardines and sprats from 13 countries, including top brands from Malaysia, also contained microplastics (Karami et al., 2018). While the farmed sea bass fish (*Lates calcarifer*) showed lower microplastic contamination than its wild counterparts (Ibrahim et al., 2017), farmed sea cucumbers (*Holothuria scabra*) in a cage culture setting however, showed higher microplastic contamination than those in the wild (Anuar et al., unpublished work). One study also examined microplastic contamination in commercial salts obtained from different countries and reported that the microplastic contamination, though present, was too low to impose a human health risk on consumers (Karami et al., 2017a).

## 5.3 Main players in marine plastic research


Figure 1.2.5.4. Composition of research efforts seen in Malaysia.

Almost 90% of the research efforts in Malaysia was carried out by local researchers. There was one research study from each of the following additional countries: Nigeria, Japan and Iran.

There are at least three major research institutions with research teams at the forefront of marine plastics research in Malaysia. They are the University of Malaya (Fauziah S.H., Agamuthu P., Auta H.S, Emenike C.U.), the University of Sarawak (Mobilik J.M.), and the Universiti Malaysia Terengganu (Microplastic Research Interest Group comprising Khalik W.M.A.W.M, Ibrahim Y.S., Anuar S.T., Govindasamy S. and Baharuddin N.F.). Another group with an interest in plastic pollution had formed within the Universiti Malaysia Terengganu in late 2019. The group, Ocean Pollution and Ecotoxicology (OPEC: available https://www.facebook.com/Ocean-Pollution-Ecotoxicology-Research-Group-104974617658557/), comprises a multidisciplinary team of scientists with different expertise, including chemistry and biopolymer as well as physical oceanography, marine ecology and social sciences.

## 5.4 Summary of understanding

Like most ASEAN states hit by China's 2018 plastic import ban and the current 'plastic crisis', Malaysia has deployed considerable efforts to decrease plastic waste, improve waste management and understand the status of pollution from marine plastics in its coastal and marine environment. With respect to the latter, a number of research foci have been explored, although most of these explorations are still at an early stage. The breadth of research has been limited, with emphasis placed either on coastline macroplastics or on microplastics in marine biota.

More than half of the articles published sought to quantify the presence and abundance of marine plastic debris. However, there were variations in the research methodologies, and the studies are therefore not often comparable. For instance, variations could be found in the sampling methodology used for macroplastics (via strip transect, quadrat, belt transect or others), in the sampling design (e.g. considerations of factors of temporal variations (such as selected monsoon seasons), and in the classification of macroplastics and microplastics studies.

The macroplastics sampled from the shoreline were categorised into various uses (e.g. packaging goods, consumer products and fishing gears), but the studies used often various classification systems. The microplastics were often categorised into various forms including those of films and fibres, but some studies used other definitions that are not well-standardised (i.e. filaments, thread-like, spheres, pellets, foams and lines). The definition of microplastics was also not standardised as being <5 mm; Some studies explored a smaller range (0.001–1 mm; <1 mm). Most of the microplastics studies further examined microplastic into its polymer types, and some studies identified plastic-associated contaminants, particularly additives. While there are these polymer-specific identifications, there have been no further studies conducted to explore specific polymer or associated contaminants toxicity impacts, their potential as a vector for contaminants and their sorption mechanisms.

The second most common category of research focus was that of ecological and environmental impacts. The studies primarily examined the ingestion of microplastics by marine life, especially organisms of socio-economic importance. No investigation on plastic transfer through the food chain has been found so far. Interestingly, there is no peer-reviewed article on the physical impact and the impact from ingestion of microplastics by wild animals (such as endangered migratory species like whales, sea turtles and seabirds). However, there were several news reports highlighting the impact of plastics on turtles and marine mammals, such as whales, dolphins and dugongs (New Straits Times, 2018: available https://www.nst.com.my/news/exclusive/2018/10/417648/plastic-thrown-oceans-causing-deaths-aquatic-mammals).

Geographically, the research covered all but one of the 13 states in Malaysia, with more attention on the bigger states.

While there is an apparent accumulation of plastic waste in the landfills and on open grounds, and while there is inadequate waste treatment and recycling, there were only a few published articles on the possible leakage of plastic into rivers and into the marine environments. Given their relevance to other sources and leakages, ALDFG would especially need further investigation as the fisheries sector is an important sub-sector in Malaysia. There are however, attempts at understanding the social perceptions that may be used to inform the development of effective waste management policy.

An important feature of Malaysia is that several research institutions are proving to have strong developing capacity. This includes existing clusters of academics (e.g. Microplastic Research Interest Group) and newly-formed plastic pollution interest groups (e.g. Ocean Pollution and Ecotoxicology of Universiti Malaysia Terengganu).

## 6. MYANMAR

*Summary of research topics:* *The few marine plastic studies published in Myanmar concern four out of 17 research foci. The primary efforts deployed to date concern surveying and monitoring in three marine and riverine habitats (i.e. coastal beaches, upstream river basin and coastal surface waters and in coastal fish).*

*Summary of understanding at national level:* *There is a limited understanding of pollution from marine plastic in Myanmar at the national level, with only three research studies with a limited scope. A seminar has been conducted for capacity building in scientific research, including monitoring marine plastic pollution. Also of note is another ongoing surveying and monitoring project of marine plastics in coastal areas.*

*Keywords/research fields:* *National approach; solid waste; trade of plastic waste; research foci; marine environs; surveys and monitoring; contribution from rivers; main players*

### 6.1 Context

#### 6.1.1 National approach to plastic waste and its management

With an increase in plastic waste, the Environmental Conservation Department in Myanmar's Ministry of Environment Conservation and Forestry is in the process of developing a 'Master Plan for Solid Waste Management', which would cover the plastic waste issue and its management. Regarding plastic recycling, there is however a lack of information available. There is a movement towards the reduction of plastic use, fronted by campaigns carried out by Thant Myanmar, a grassroots movement formed in 2018.

Information and policies on plastic waste management in Myanmar is generally lacking, but it was reported that almost 119 tonnes of plastic waste enters the country's largest river, Ayeyarwady River, on a daily basis (non-peer reviewed report by Jeske (2019) and survey on plastic waste in the Ayeyarwady: available https://www.thantmyanmar.com/en/riversurvey).

While there appears to be some waste collection and plastic use reduction in some of the major cities in Myanmar (Premakumara et al., 2016), improper disposal of plastic waste is still a prevalent issue. In 2018, a fire broke out at Yangon's Htein Bin landfill, which holds waste generated from the city. The fire burned for 14 days, covering the city with smoke, polluting the air and affecting human health (The Guardian, 2018: available https://www.theguardian.com/cities/2018/may/17/yangon-two-week-landfill-fire-raises-burning-questions-for-authorities-myanmar).

#### 6.1.2 Plastics as a proportion of solid waste

In 2016, the municipal solid waste (MSW) for Myanmar was estimated at 7.5 million tonnes, and with a projection of reaching 9.32 million tonnes in 2030 and 11.2 million tonnes in 2050 (Kaza et al., 2018).

The composition of plastics in solid waste generated in Myanmar was estimated at 16% (Hoornweg and Perinaz, 2012) and at 8-13% for various major cities (Jeske, 2019).

#### 6.1.3 Illegal trade of plastic waste

Following China's 2018 ban on plastic waste imports, Greenpeace's 2019 Policy Brief reported a 103% increase in plastic waste import into Myanmar, from 688 tonnes in early 2016 to 71,050 tonnes in end 2018, out of which, 61,500 tonnes were imported from Thailand.

### 6.2 Research review of pollution from marine plastic

#### 6.2.1 Research overview

There are only three studies on marine plastics in Myanmar. They were conducted in 2016, 2018 and 2019 and have a small geographic coverage only at selected coastline beaches.

Of the three published studies, two were on the surveying and monitoring of the pollution status. One examined microplastics presence and abundance on coastal beaches that are potential sea turtles nesting sites (Balasubramaniam and Phillott, 2016), and the other examined floating macroplastics in the Ayeyarwady River Basin of Myanmar which leaks out to the ocean (Jeske, 2019). The other study was a literature assessment of the marine debris in coastal mangrove ecosystems (Min, 2018).

Table 1.2.6.1. List of published work identified and examined in this study for Myanmar.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Jeske (2019)<br>FFI Myanmar; Thant Myanmar | Quantifying, identifying and characterising floating macroplastics in 5 strategic rivers of the Ayeryarwady River Basin of Myanmar | Nov, Dec 2018; Jun 2019 |
| Min (2018)<br>Uni of Yangon | Reviewing of literature and assessing marine debris in coastal mangrove ecosystems, its gaps and challenges | N.A. |
| Balasubramaniam and Phillott (2016)<br>Asian Uni for Women | Quantifying, identifying and characterising of microplastics on sea turtle nesting beaches around the Indian Ocean, in relation to further examinations of the potential of microplastic threat to sea turtles | N.A. |

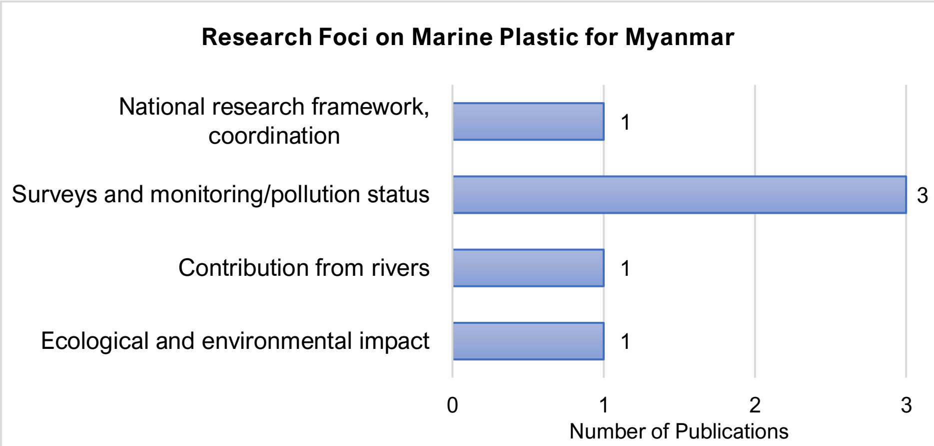



Figure 1.2.6.2. Research foci of marine plastic research conducted in Myanmar.

In addition to these published studies, there was one seminar and one ongoing research project with relevance to marine plastic pollution in Myanmar. The seminar was held in June 2014 under the Bay of Bengal Large Marine Ecosystem (BOBLME) project of the UN Food and Agricultural Organisation (FAO). Based on information available online (https://niva.brage.unit.no/niva-xmlui/handle/11250/282228), this seminar facilitated knowledge sharing between the Norwegian Institute for Water Research (NIVA) and experts from the University of Yangon, Department of Chemistry, and led to planning for capacity building in addressing marine pollution and water quality monitoring issues in Myanmar. This seminar also highlighted the lack of research capacity on marine plastic pollution in the country, which in turn explains the limited research done.

The latter ongoing research project is under FAO's programme of 'Supporting the Application of the Ecosystem Approach to Fisheries management considering climate and pollution impacts' (EAF-Nansen Programme). This project aims to monitor microplastics in coastal areas (sea-surface and water-column) and in fish in several regions of the Indian Ocean using the research vessel 'RV Dr Fridtjof Nansen'. Monitoring was conducted in August and September 2018 off the Rakhine State in the Ayeyarwady Region and Tanintharyi Region in Myanmar. The findings have not been published yet as this research is still ongoing and is expected to continue in the coming years. Given its significance, this research project is included in the following analysis.

### 6.2.2 Types of research conducted

*Types of plastics research foci*

With the limited research done, there was no discernible emphasis on research foci. Two studies focused on microplastics-only, while one study focused on macroplastics-only (Figure 1.2.6.3.). Of note, the assessment of marine debris in coastal mangrove ecosystems by Min (2018) had no definition or indication of the type and size of marine debris.

No polymer nor its associated organic or inorganic contaminants were identified.

*Coverage of marine environs*

Of the research studies, two looked at plastics in the sea surface/water column, while one studied plastic in the marine biota and one on the shoreline (Figure 1.2.6.4). There was no study investigating the presence of marine plastic in the seafloor and subsoil.

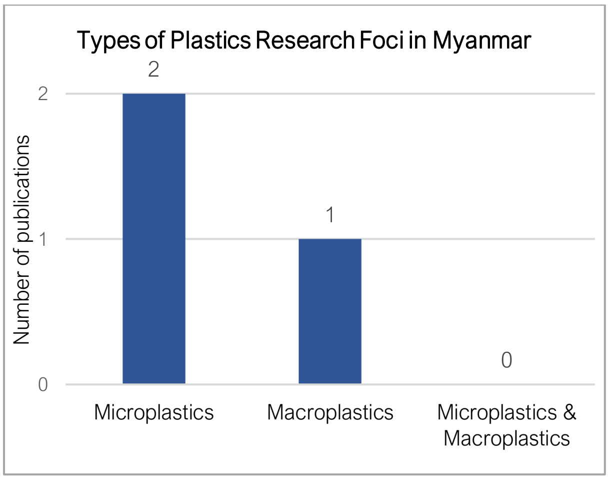



Figure 1.2.6.3. Distribution of marine micro-/macro-plastics researched in Myanmar.

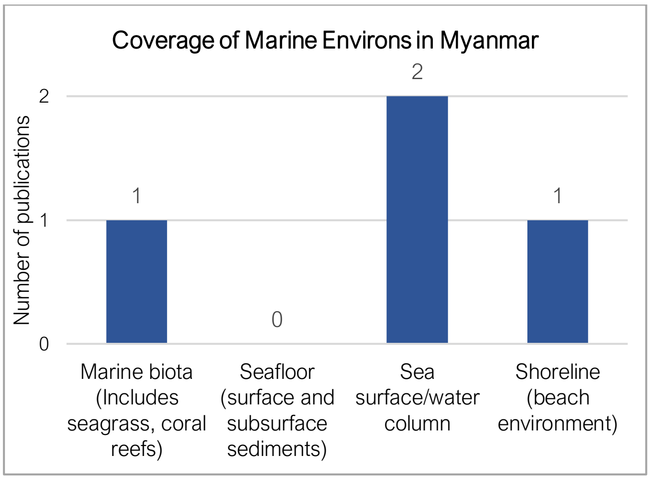



Figure 1.2.6.4. Distribution of marine environs researched in Myanmar.

## 6.2.3 Survey and monitoring

The three surveying and monitoring research articles from Myanmar provide some quantification of marine plastics in various environs.

The research led by Jeske (2019), under the FFI Myanmar Programme, investigated the abundance of floating macroplastics in various river systems in the Ayeyarwady River Basin. While this is an investigation on a riverine system, the waters of the Ayeyarwady River Basin flow into the Andaman Sea. An understanding of the movement of plastic debris in this river is therefore critical to the understanding of the status of marine plastic pollution in Myanmar. The macroplastics collected using manta trawl sampling on rivers led the researchers to conclude that there was a high contamination of 119 tonnes plastic waste entering the Irrawaddy River. The researchers also thought that urban regions were contributing more riverine plastic than non-urban regions. This study did not classify macroplastics into categories of functional use. Nevertheless, it is useful in reporting the high contamination and possible leakage of plastic into the aquatic environment.

Earlier in 2018, a month-long survey on microplastics was carried out by a Norwegian team on the research vessel 'RV Dr Fridtjof Nansen' to quantify microplastics in the water and in fish at regions in western Myanmar (i.e. Tanintharyi, Ayeyarwady and Rakhine states). This study was deployed in the context of the implementation by FAO of an initiative designed to suport the application of the ecosystems approach to fisheries management which considers climate and pollution impacts.
No information could unfortunately be found on the methodologies employed in this survey and on the specificities of the microplastics found, in terms of their sizes, polymer types or forms. Preliminary findings that were shared in a 2019 workshop on plastic pollution in Myanmar with a focus on the Ayeyarwady River revealed a high microplastic contamination reaching up to 28,000 items of

microplastics per $km^2$ along Myanmar's coastline. The Myanmar government has shown its support for the continuation of this research in the coming years.

Microplastics have also been quantified and found to be abundant on potential sea turtle nesting beaches, especially in the form of microfibres (Balasubramaniam and Phillott, 2016).

### 6.2.4 Source differentiation and pathways

There is no published peer-reviewed study on source differentiation of marine plastics.

### 6.2.5 Movement of plastics, accumulation and hotspots

There is no published peer-reviewed study on the movement, accumulation and hotspots of marine plastics other than movement on the Ayeyarwady River.

### 6.2.6 Ecological and environmental impacts

Balasubramaniam and Phillott (2016) examined the presence/absence of microplastics on coastal shores which are potential sea turtle nesting sites. Their study found microfibre contamination on Myanmar's shores, and suggested that this might be a potential threat to the health of sea turtles.

Though not formally presented in any scientific analysis, there are concerns regarding the impacts of marine plastics on marine biota along the coastline of Myanmar. Their impacts on sea turtles have been highlighted in relation to concerns over their breeding, nesting and survivability (FFI, 2019: available https://www.fauna-flora.org/news/plastic-pollution-piles-pressure-myanmars-troubled-turtles).

### 6.2.7 ALDFG

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

### 6.2.8 Social perceptions and socio-economic impacts

There is no published peer-reviewed study on social perceptions and socio-economic impacts of marine plastics.

### 6.3 Main players in marine plastic research

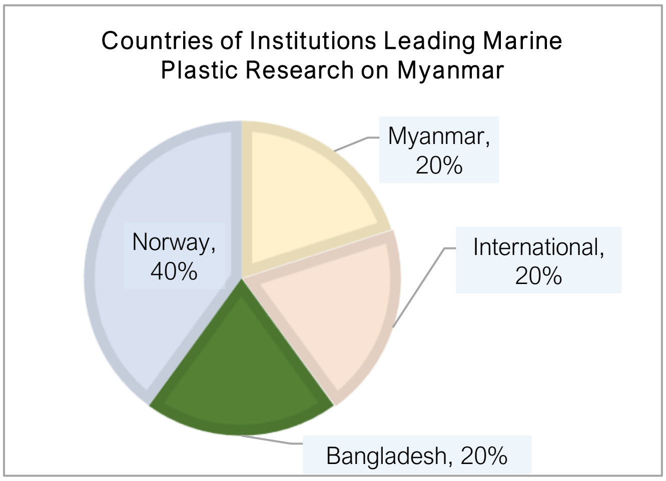



Figure 1.2.6.5. Composition of research efforts in Myanmar.

Marine plastic research appears to be not of top priority in the local scene from national organisations to universities, although researchers from the University of Yangon appear to be in a suitable position to continue marine plastic research following the 2015 seminar. Marine plastic research appears to be primarily pushed and supported by efforts from outside Myanmar (e.g. from Norway, Bangladesh, FFI and FAO).

### 6.4 Summary of understanding

There is a small number of limited studies on pollution from marine plastics in Myanmar. Not all environs have been investigated and quantification efforts are still unspecific (i.e. there is a lack of debris type, shape, polymer type, size, units of weight or number per area or volume). Survey and monitoring efforts have primarily validated the prevalence of marine plastic pollution.

More complete studies of different marine environs are necessary for a better understanding of marine plastic pollution in Myanmar. These should also include studies on degradation, fragmentation, downstream socio-economic impacts, and impacts on marine biota andecosystems in general, including from toxicity of ingestion or leaching of associated contaminants.

With respect to waste management, and to deal with increasing volumes of waste, run-offs from the accumulated landfills are potential leakages of plastic into the aquatic environment, further research is needed to examine upstream leakage of plastic including from the transport of plastic waste into water bodies and into the sea.

With its extensive coastline and marine fisheries being an important sub-sector in Myanmar, the possibility of lost gears leading to ALDFG is also a potential issue that needs further examination.

# 7. PHILIPPINES

*Summary of research topics: The majority of studies has focused on ecological and environmental impacts, followed by survey and monitoring to understand pollution status and public outreach/beach clean-up.*

*Summary of understanding at national level: Marine plastic research in the Philippines appears to be at infancy, with only 14 published studies. Though few, these studies provide some insights to the status of marine plastic pollution in the Philippines, where most of them indicate negative impacts of marine debris on numerous marine taxa groups and environments. Across these studies, varied methodologies have been used in monitoring marine litter in marine biota and environments across the Philippines, thus making it difficult to do direct cross-comparisons.*

*Keywords/research fields: National approach; solid waste; trade of plastic waste; research foci; marine environs; guidelines and standards; public outreach; beach clean-up; waste management; national research framework, coordination; surveys and monitoring; contribution from rivers accumulation zones; hotspots; fragmentation and degradation; ecological and environmental impact; ecological and environmental impact; socio-economic impact; main players*

## 7.1 Context

### 7.1.1 National approach to plastic waste and its management

The Philippines was an early mover in waste management in Southeast Asia with the Ecological Solid Waste Management Act of 2000 (Republic Act (RA) 9003), a landmark environmental legislation.

However, based on estimates from Jambeck et al. (2015), the Philippines would be the third country with the most mismanaged waste in 2010. The country produced 1.88 million tonnes of mismanaged plastic waste in 2010, where approximately 0.28–0.75 million tonnes of plastics may have leaked into the seas annually. According to reports from WWF-Philippines, the National Solid Waste Management Commission and the World Bank, 74% of plastic leakage into the waters comes from collected waste. Therefore, marine litter was ranked as top priority among coastal and marine projects for the Department of Environment and Natural Resources – Biodiversity Management Bureau (DENR-BMB). Furthermore, numerous cities and municipalities in the Philippines have initiated a ban of plastic bags, enforced regulations on utilising single-use plastics, and prepared a draft bill on the National Strategy on Marine Litter. The latter forms the basis for a Master Plan on Marine Plastics Management (Greenpeace, 2019).

### 7.1.2 Plastics as a proportion of solid waste

In 2016, the municipal solid waste (MSW) for the Philippines was estimated at 14.6 million tonnes, and with a projection of reaching 20.0 million tonnes in 2030 and 29.3 million tonnes in 2050 (Kaza et al., 2018).

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

#### 7.1.3 Illegal trade of plastic waste

The Philippines was one of the importers of global illegal plastic waste. Following China's plastic imports ban in 2018, plastic waste imports in the Philippines increased by 2.5 times, from 4,650 tonnes in early 2016 to 11,761 tonnes in end-2018 (Greenpeace, 2019). The bulk of the waste came from Japan and the United States of America. Since then, the Philippines has seized illegal plastic waste and re-exported them to their country of origin.

Of note, in May 2019, the Philippines returned 69 containers of plastic waste that had been illegally imported from Canada into the Philippines between 2013 and 2014. These measures were enacted after strong pressure by environmental activists. (Reuters, 2019: available https://www.reuters.com/article/us-philippines-canada-waste/philippines-sends-trash-back-to-canada-after-duterte-escalates-row-idUSKCN1T10BQ).

### 7.2 Research review of pollution from marine plastic

#### 7.2.1 Research overview

Research on marine plastics in the Philippines is in progress, but limited. 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. Local researcher, Abreo, N.A.S., calls for more support and work to be done on marine plastics as the country is dependent on the ecosystem services provided by the marine environment (Abreo, 2018).

The 15 studies were conducted fairly recently, between 2015 and 2020, and geographically cover subsets of each of three major regions: Luzon, Visayas, and Mindanao. The majority of research topics focuses on the ecological and environmental impact (n=9), followed by survey and monitoring to understand pollution status (n=7) and public outreach/beach clean-up (n=3).

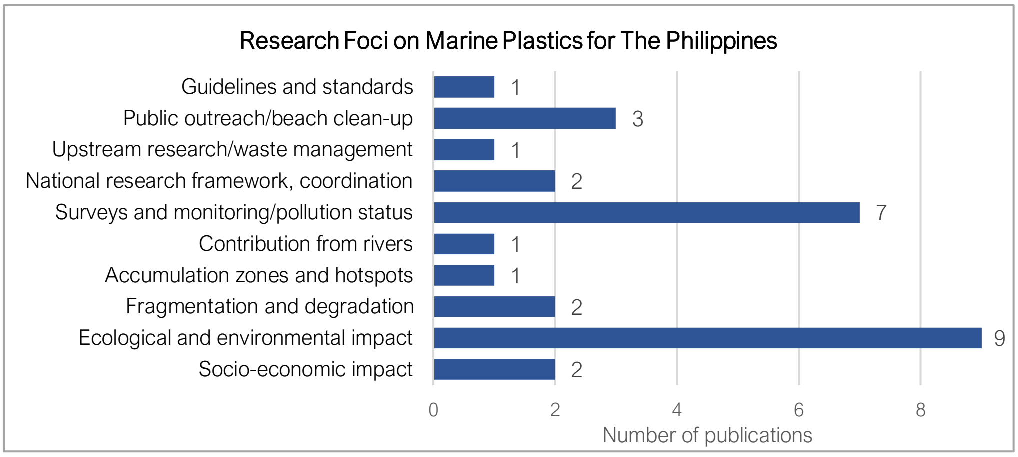



Figure 1.2.7.1. Marine plastic research conducted in The Philippines.

Table 1.2.7.2. List of published work identified and examined in this study for the Philippines.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Onda et al. (2020)<br><br>University of the Philippines | Reviews the current status and knowledge of the marine plastic-microbe association (plastic as a potential transport vector and degradation of plastic as facilitated by microbes) | N.A. |
| Bucol et al. (2020)<br><br>Negros Oriental State Uni; Siliman Uni-Angelo King Center for Research and Environmental Management; Arizona State Uni (USA) | Quantify and characterise microplastics ingested by a commercially important fish (Rabbitfish) and marine subtidal sediments in the coastal areas of Negros Oriental, central Philippines | Oct 2018 - Jan2019 (Rabbitfish) and Oct-Dec 2018 (Marine sediments) |
| Espiritu et al. (2019)<br><br>Ateneo de Manila Uni | Assess the extent of microplastic contamination in the Bombong estuary and coastal waters of Ticalan, San Juan, Batangas by sampling sediments, water, and marine organisms | Nov 2018 |
| Kalnasa et al. (2019)<br><br>Uni of Sci. and Tech. of Southern Philippines; Western Mindanao State Uni; Dept of Envt and Natural Resources Region 10; Uni of the Philippines | Determine the presence, size, colour, and shape types of microplastics and coastal litter in Macajalar Bay, Philippines | Apr 2018 |
| Paler et al. (2019)<br><br>Uni of the Philippines Los Baños; Uni of San Carlos, Optimal Laboratories, Inc. | Assess the beach plastic litter profile in a local beach in Talim Bay, Lian, Batangas, Philippines, with notes on microplastic occurrence from marine sediments | Oct 2016 |
| Deocaris et al. (2019)<br><br>Polytechnic Uni of the Philippines; Far Eastern Uni - Diliman Campus | Isolate, quantify and identify microplastic fragments from the Pasig River within the vicinity of the Polytechnic Uni of the Philippines | Aug 18, 22, 23, 2017 |
| Abueg (2019)<br><br>Uni of the Philippines Los Baños | Review and discuss the state of ocean clean-up and how is the Philippine contributing to the problem of plastic disposal globally; Discuss problems related to generation, use and disposal of single-use plastics, present recent policy formulation and implementation in addressing the problems | N.A. |
| Abreo et al. (2019)<br><br>Malayan Colleges Mindanao; Davao Oriental State College of Sci. and Tech.; Davao del Norte | Inventorise marine species adversely affected by litter and spatial distribution of these interactions by using information shared on the internet by citizen scientists and conservation groups to | 2011-2018 |

| | | |
|---|---|---|
| State College; Uni of Exeter (UK); Uni of Southwestern Philippines | assess the impacts of marine litter on megafauna | |
| Abreo et al. (2018)<br><br>Malayan Colleges Mindanao; Davao Oriental State College of Sci. and Tech.; Davao del Norte State College; Wageningen Uni & Research (The Netherlands) | Provide first quantification, characterisation, and distribution of anthropogenic marine debris (AMD) in a shallow subtidal area in Mati City, Davao Oriental | Jun 7-10, 2016 |
| Abreo (2018)<br><br>Davao Oriental State College of Sci. and Tech.; Davao del Norte State College | Open letter to the Editor of journal on the need for marine plastics research in the Philippines | N.A. |
| Palermo (2018)<br><br>Uni of the Philippines Diliman | Examine the potential threat on microplastic pollution on feeding ecology of sardines | 2014-2016 |
| Argamino and Janairo (2016)<br><br>De La Salle Uni | Assess the presence of microplastics in edible bivalves cultured in Bacoor Bay, Cavite, Philippines | Jan 2016 |
| Abreo et al. (2016b)<br><br>Davao del Norte State College; Davao Oriental State College of Sci. and Tech.; Wageningen Uni of Life (The Netherlands); D'Bone Collector Museum, Inc. | Assess impacts of plastic debris on marine turtle found in Davao Gulf, Philippines | Apr 17, 2015 |
| Abreo et al. (2016a)<br><br>Davao del Norte State College; Davao Oriental State College of Sci. and Tech.; Wageningen Uni of Life (The Netherlands); D'Bone Collector Museum, Inc. | Assess impacts of plastic debris on marine cetaceans found in Davao Gulf, Philippines | Dec 19, 2012 |
| Abreo et al. (2015)<br><br>Davao Medical School Foundation; Wageningen Uni of Life (The Netherlands); Davao Del Norte State College | Review and discuss anthropogenic impacts (where plastic pollution was one of them) on the mortality of marine organisms and damage to marine ecosystems | N.A. |

### 7.2.2 Types of research conducted

*Types of plastics research foci*

Of the 15 studies examined, microplastics appear to be of utmost concern (n=6), followed by macroplastics (n=5) (Figure 1.2.7.3). Studies examining microplastics focus on presence/absence in commercially important marine organisms (Argamino and Janairo, 2016; Palermo, 2018; Bucol et al., 2020) or in the marine environment (Deocaris et al., 2019; Espiritu et al., 2019; Kalnasa et al., 2019; Paler et al., 2019). The macroplastics studies focus primarily on items found in marine organisms such as beaked whales (Abreo et al., 2016a) and sea turtles (Abreo et al., 2016b).

No published peer-reviewed study on plastic-associated (organic or inorganic) contaminants could be found.

*Coverage of marine environs*

Most of the 14 studies that were examined had a focus on marine biota, such as the following marine organisms: beaked whale (Abreo et al., 2016a), green sea turtle (Abreo et al., 2016b), Asian green mussels (Argamino and Janairo, 2016), Bali sardines (Palermo, 2018), oysters (Espiritu et al., 2019) and rabbitfish (Bucol et al., 2020). Various fish from the families of Mugilidae, Labridae, Serranidae, Lutjanidae were also examined for microplastics in their guts (Espiritu et al., 2019). There is also a study investigating the presence of anthropogenic marine plastics in a seagrass environment (i.e. shallow coastal waters) (Abreo et al., 2018).

The other studies examined the presence/absence of marine plastics on the shoreline environment (Kalnasa et al., 2019; Paler et al., 2019) and in aquatic bodies (Deocaris et al., 2019; Espiritu et al., 2019). So far, only one recent study examined the presence/absence of microplastics in seabed sediments off an estuary in Ticalan Batangas (Espiritu et al., 2019).

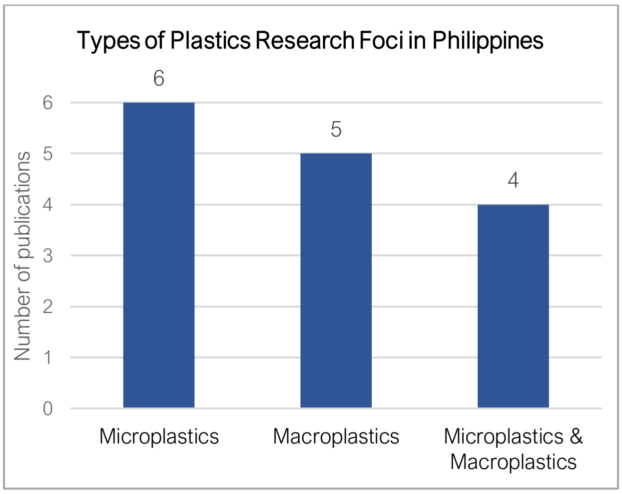



Figure 1.2.7.3. Distribution of marine micro-/macro-plastics researched in the Philippines.

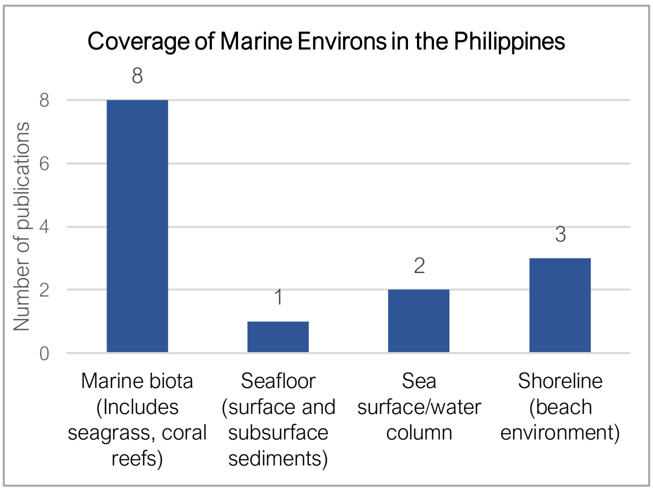



Figure 1.2.7.4. Distribution of marine environs researched in the Philippines.

## 7.2.3 Survey and monitoring

Several studies attempted to quantify marine plastics in shallow coastal waters (Abreo et al., 2018; Espiritu et al., 2019), rivers (Deocaris et al., 2019), and beaches (Paler et al., 2019; Kalnasa et al., 2019). Generally, all studies indicated the presence of either microplastics or macroplastics (e.g. plastic bags, rubber, clothing/textile, glass/ceramic, paper, metal, wood, etc.) in the environments studied. In some studies, the levels of plastic contamination were considered high (e.g. Paler et al., 2019; Kalnasa et al., 2019). These studies quantified abundance of plastics based on counts (e.g. number of items, number of items per unit area, number of items per sediment dry weight, number of microplastics per site) and weight (e.g. weight in grams per unit area, total weight of debris).

The other type of studies focused on monitoring the presence of marine debris in marine organisms. For example, a large proportion of the commercially-important species such as Bali sardines (Palermo, 2018), oysters (Espiritu et al., 2019) and rabbitfish (Bucol et al., 2020) had microplastics in their guts. In particular, rabbitfish guts are considered a delicacy in the Philippines, and therefore a clear path for exposure to humans and potential health risk. These studies quantified the abundance of plastics per individual fish (e.g. number of items of plastic per individual).

Studies of microplastics mostly adhered to the definition of size <5 mm, and the shapes of microplastics were noted (such as fibre, fragment, film, etc.). However, only three of six microplastic-focused articles had attempted to identify the types of plastic polymers, including GPPS, PE, PET, PA, PP, PVC, LDPE, PETE.

#### 7.2.4 Source differentiation and pathways

There is no published peer-reviewed study on the source differentiation and pathways of marine plastics; no study on organic and inorganic contaminants associated with marine plastics.

#### 7.2.5 Movement of plastics, accumulation and hotspots

Abreo et al. aimed to inventorise the different marine species adversely affected by litter through crowdsourcing social media posts. Based on the geographic distribution of sightings, Abreo et al. (2019) suggested that land-based sources, such as the Pasig River, are accumulation and hotspots for marine debris.

#### 7.2.6 Ecological and environmental impacts

The ecological and environmental impacts were assessed through quantifying the amounts of marine plastics (possibly) ingested by a beaked whale (Abreo et al., 2016a), green sea turtles (Abreo et al., 2016b), Bali Sardines (Palermo, 2018), oysters (Espiritu et al., 2019) and rabbitfish (Bucol et al., 2020). Most comprehensively for the Philippines, a social media-based study found that at least 17 marine species (48% cetaceans; 45% marine turtles; 7% fish) were affected by marine plastic litter through ingestion, entanglement, and/or asphyxia (Abreo et al., 2019).

#### 7.2.7 ALDFG

There is no published peer-reviewed study on ALDFG.

#### 7.2.8 Social perceptions and socio-economic impacts

There is no published peer-reviewed study on social perceptions and socio-economic impacts of marine plastics.

### 7.3 Main players in marine plastic research

Although the scope and breadth of marine plastics research is limited in the Philippines, all studies examined were conducted and led by Philippines-based researchers from different institutions. One of the most active researchers, Abreo N.A.S. from Davao Oriental State College of Science and Technology, is also socially engaged in improving the state of marine plastics in the Philippines.

## 7.4 Summary of understanding

Research on marine plastics in the Philippines is in progress but limited in scope and breadth. Despite a clear awareness of pollution from marine plastics in the scientific community, it does not appear to be a main research thrust for any marine laboratory.

Existing studies focus on the most commonly researched aspects of marine plastic pollution such as ecological and environmental impact, and surveys and monitoring. However, they do not include surveys in seabed sediments or surface water, nor research on understanding sources and pathways of marine plastics into the marine environment. There is also no research on ALDFGs.
Among the studies that seek to quantify the presence and abundance of marine plastic debris, varied methodologies have been used across the Philippines, thus making it difficult to do direct cross-comparisons. Whilst studies on microplastics in biota were able to categorise samples into various forms including those of fibres, fragments, films, only few research papers sought to identify plastic polymer types. No research has been found so far on polymer-specific research to understand differences in degradation of different polymer-types in the marine environment, or marine plastics as a pathway for pollution by other organic substances or inorganic contaminants (e.g. POPs and heavy metals).

Ecological and environmental impact is the top category of research focus, with articles showing a primary interest in the ingestion of macro- and microplastics by marine life, especially organisms of socio-economic importance and endangered migratory species (i.e. dolphins, whales, sea turtles). No investigation on plastic transfer through the food chain has been found so far.

Overall, additional research is also needed to understand leakage and movement of plastics, accumulation and hotspots of marine plastics.

## 8. SINGAPORE

*Summary of research topics: The majority of studies in Singapore focused on ecological and environmental impact, followed by survey and monitoring to understand pollution status and plastics as a transport vector.*

*Summary of understanding at national level: The body of plastic research in Singapore is still at an early stage with only a few published studies. However, the results from field studies (e.g. ICCS, Project Aware) provide insights into the status of marine plastic pollution in Singapore, with most of them indicating negative impacts of marine debris on numerous marine taxa groups and environments. To date, there is no study examining the sources, accumulation and hotspot areas of marine plastics along Singapore's coastline.*

*Keywords/research fields: National approach; solid waste; trade of plastic waste; research foci; marine environs; surveys and monitoring; ecological and environmental impact; plastic as transport vector; main players*

### 8.1 Context

#### 8.1.1 National approach to plastic waste and its management

Singapore generated almost 949,300 tonnes of plastic waste in 2018, but only 4% of these were recycled (MEWR, 2019). The remainder (possibly non-recyclables) became incinerated, where the ashes were deposited in the country's only landfill on Semakau Island. This landfill is planned to reach full capacity by 2035, although waste reduction and recycling could change this projection.

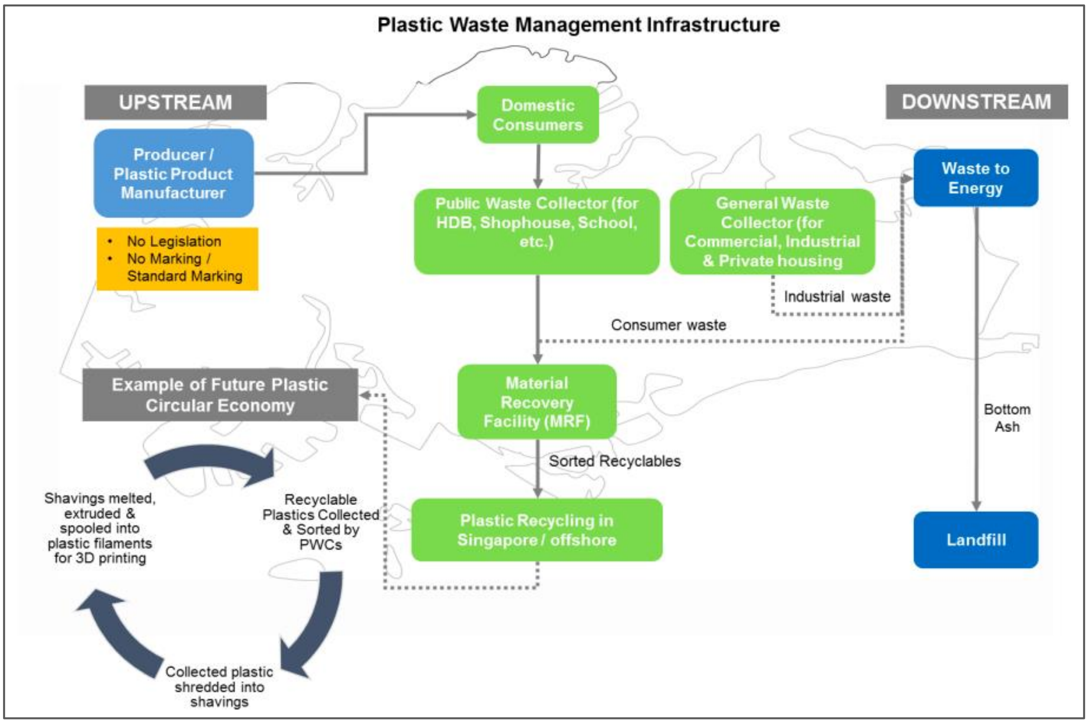



Figure 1.2.8.1. The plastic ecosystem and life cycle in Singapore (source: Singapore Environment Council).

Under the National Recycling Programme (NRP) led by National Environment Agency (NEA), several initiatives have been launched to encourage recycling habits. These include the blue recycling bins for commingled recyclables at every block in public housing estates, and the dual chutes for refuse and recyclables fitted in public housing developments since 2014. While the amount of recyclables collected under NRP has been steadily rising, perception surveys conducted by the Singapore Environment Council (SEC) found that close to 70% of respondents are not fully aware of what can be recycled and the know-hows of recycling in Singapore (SEC, 2018; Figure 1.2.8.1).

In a bid to further reduce plastic waste, Singapore has adopted the Singapore Packaging Agreement and the 2019 Zero Waste Master Plan, which include a new mandatory packaging reporting framework set to take effect latest by 2025 (Zero Waste Master Plan, 2019). After Singapore marked its Year Towards Zero Waste in 2019, there appears to be more awareness among businesses of the pressure of consumption on the planet, and they are taking steps to reduce waste (The Straits Times, 2020: available https://www.straitstimes.com/singapore/environment/byoc-thats-bring-your-own-container).

## 8.1.2 Plastics as a proportion of solid waste

In 2016, MSW for Singapore was estimated at 7.6 million tonnes, and with a projection of reaching 9.3 million tonnes in 2030 and 10.0 million tonnes in 2050 (Kaza et al., 2018). The Ministry of the Environment and Water Resources (MEWR) of Singapore reported that 7.70 million tonnes of solid waste was generated in 2018, which is approximately 9,000 tonnes less than that produced in 2017 (MEWR, 2019: available https://www.nea.gov.sg/our-services/waste-management/waste-statistics-and-overall-recycling).

In 2012, the World Bank estimated that the plastic composition in solid waste for Singapore was at 12% (Hoornweg and Perinaz, 2012). However, local statistics suggest a much lower part of 3% (National Environmental Agency: available https://www.nea.gov.sg/our-services/waste-management/waste-statistics-and-overall-recycling).

It was also estimated that people in Singapore use 467 million PET plastic bottles, 820 million supermarket plastic bags and 473 million polypropylene plastics annually (SEC, 2018).

## 8.1.3 Illegal trade of plastic waste

Based on Greenpeace (2019), plastic waste imports almost tripled between 2016 and 2018 for Singapore, where it increased from 3,354 tonnes in 2016 to 9,018 tonnes in 2018. Singapore would also have been one of the countries illegally sending plastic scrap into Malaysia and Indonesia, without the correct permits.

New regulation on hazardous waste (on control of export, import and transit) is in the process of adoption in Singapore. It is designed to govern plastic waste exports and avoid plastic exporters in Singapore to ship out plastic waste that is contaminated, difficult to recycle or mixed with other materials. This new act is designed to implement in Singapore the new amendment to the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.

(Parliament session on the draft bill on 2 February 2020 - Singapore Law Watch: available https://www.singaporelawwatch.sg/Headlines/Singapore-passes-law-in-line-with-global-pact-to-restrict-export-of-plastic-that-is-contaminated-difficult-to-recycle).

## 8.2 Research review of pollution from marine plastic

### 8.2.1 Research overview

Research on pollution in marine plastics in Singapore is generally limited to particular research foci, with a total of nine publications. These nine studies found for this study were conducted in different decades: one study in 2006, and eight studies between 2014 and 2020. Geographically, they cover both the coastline and shallow coastal waters of Singapore (Table 1.2.8.3). The majority of studies had research topics focused on the ecological and environmental impact (n=9), followed by survey and monitoring to understand pollution status (n=7), and plastics as transport medium (n=1) (Figure 1.2.8.2).

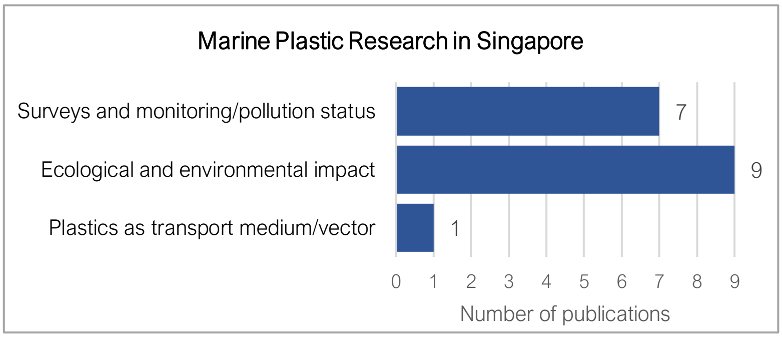



Figure 1.2.8.2. Research foci of marine plastic research conducted in Singapore.

Table 1.2.8.3. List of published work identified and examined in this study for Singapore.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Seng et al. (2020)<br><br>National University of Singapore; National Parks Board | Quantify and characterise microplastics found on the surfaces of three species of intertidal seagrasses and two species of subtidal macroalgae | Sep 2018 |
| Curren and Leong (2019)<br><br>National University of Singapore; St John's Island National Marine Laboratory | Understand the distribution of microplastics in the marine environment, coupled with profiling of bacterial communities on surfaces of microplastics | Apr-Jul 2018 |
| Bhargava et al. (2018)<br><br>National University of Singapore; St John's Island National Marine Laboratory | Investigate the potential toxicity of PMMA particles on the larvae and microalgae feed, ingestion, egestion, retention and translocation of nanoparticles through various larval stages of acorn barnacle | N.A. |
| Chim et al. (2015)<br><br>National University of Singapore | Document the impacts of trammel nets on marine life in Singapore | Aug 16, 2015 |
| Chim and Lim (2014b)<br><br>National University of Singapore | Document the presence of coral cat-shark, reporting impacts of fish traps on marine life in Singapore | Apr 20, 2011 |
| Chim and Lim (2014a)<br><br>National University of Singapore | Document the presence of blackspot shark, reporting impacts of gill nets on marine life in Singapore | Jul 6, 2012 |

| | | |
|---|---|---|
| Yeo (2014)<br><br>Citizen science | Document the presence of black-tipped reef shark, reporting impacts of gill nets on marine life in Singapore | May 29, 2010 |
| Mohamed Nor and Obbard (2014)<br><br>National University of Singapore | Document the presence and abundance of microplastics from mangrove sediments | Aug-Nov 2012 |
| Ng and Obbard (2006)<br><br>National University of Singapore | Document the presence and abundance of microplastics in Singapore's coastal environment | Aug-Dec 2004 |

There is clear awareness of pollution from marine plastics in the scientific community, but it is not a main research thrust for any research group focusing on marine environmental sciences currently. In addition to two earlier studies (Ng et al., 2006; Mohamed Nor et al., 2014), preliminary research had been conducted by the National Parks Board (NParks) and National University of Singapore (NUS) from 2017 to 2019 in an attempt to investigate the baseline occurrence of microplastics in Singapore and its potential sources (ICCS: available https://coastalcleanup.wordpress.com/nus%E2%80%92nparks-marine-debris-monitoring-programme/).

Since 2016, there have also been efforts (such as symposiums, workshops and conferences) to bring local and regional scientists together to discuss scientific and societal issues raised by marine plastics and microplastics.

### 8.2.2 Types of research conducted

*Types of plastics research foci*

Of the nine studies examined, the emphasis on either microplastics (n=5) or macroplastics (n=4) appear to be of almost similar concern. One of the studies even investigated the impacts of nanoplastics (ca. < 200 nm in diameter) on marine larvae (Bhargava et al., 2018); this study is categorised under 'microplastic' work. Four studies were also published on the impacts of trammel nets (i.e. macroplastics) on marine life (see Part 1, Section 2.8.2.7). The remaining studies investigated the presence/absence of microplastics in marine biota, such as seagrass, mangrove, seaweed, and sea surface waters.

Although there are few published papers on macroplastics, volunteer groups such as the International Coastal Cleanup Singapore (ICCS) and Our Singapore Reefs (OSR) run clean-up events and collect debris data. These groups cover different habitats in Singapore: ICCS on mangroves and beaches and OSR on subtidal reefs.

No published peer-reviewed study on plastic associated organic or inorganic contaminants.

*Coverage of marine environs*

Of the nine studies examined, two of them focused on shoreline environments, specifically sandy beaches (Ng et al., 2006; Curren and Leong, 2019), while one focused on sediments found in mangroves (Mohamed Nor et al., 2014). All studies examined the presence/absence of marine plastics in the environment, but only Curren and Leong (2019) further analysed the presence/absence and composition of bacterial assemblages found on marine plastics. Ng et al. (2006) also further analysed the presence/absence of microplastics in subsurface water samples.

One study looked at the long-term effects of nanoplastics on marine larvae life cycle, under an experimental setting (Bhargava et al., 2018), while the other studies looked at the impacts of abandoned fishing nets and cages on marine life (Chim and Lim, 2014a, 2014b; Yeo, 2014; Chim et al., 2015). The most recent study by Seng et al. (2020) provided early evidence of the presence of microplastics in three intertidal seagrasses (*Cymodocea rotundata*, *Cymodocea serrulata* and *Thalassia hemprichii*) and two subtidal seaweeds (*Padina* sp. and *Sargassum ilicifolium*) in coastal environments.

There is no published peer-reviewed study on marine plastics in the seabed or subsoil.

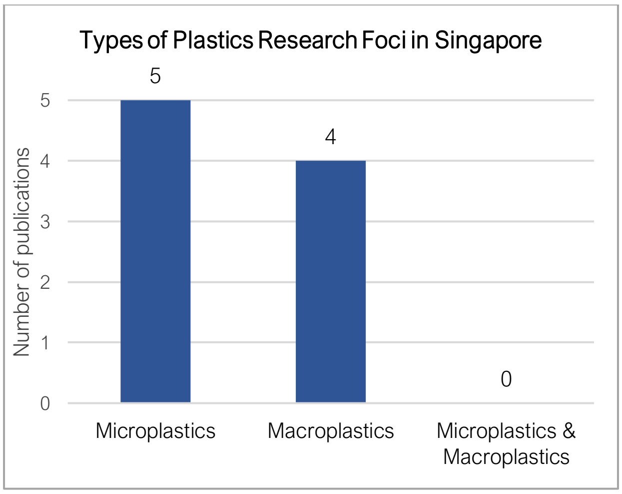



Figure 1.2.8.4. Distribution of marine micro-/macro-Plastics researched in Singapore.

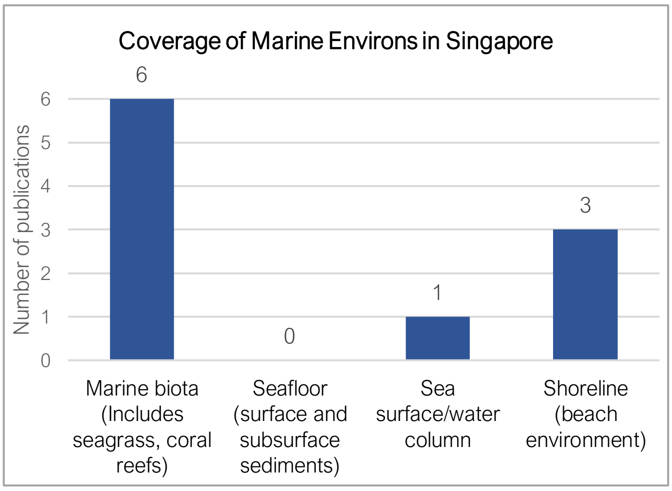



Figure 1.2.8.5. Distribution of marine environs researched in Singapore.

## 8.2.3 Survey and monitoring

Two out of nine published articles sought to quantify the presence and abundance of microplastics in mangroves and other coastal areas. As these studies were led by the same research leader (Obbard, J.), the methodologies used are similar and comparable, though the environs studied were different.

Of the five studies focused on microplastics, two focused on microplastics found in shallow coastal habitats (Ng et al., 2006; Mohamed Nor et al., 2014). Microplastic-focused studies quantified the abundance of plastics based on counts (i.e. number of microplastic particles, number of particles per 250g dry sediments, density of microplastics per unit area of blade), but none measured weight of debris. Studies of microplastics adhered to the definition of size <5 mm, but only 2 articles noted the shapes of microplastics (such as fibre, fragment, granule). Two studies (Ng et al., 2006; Mohamed Nor et al., 2014) attempted to identify the types of plastic polymers including PE, PP, PVC, PVA and nylon.

Four studies on macroplastics identified fishing gear (i.e. trammel nets, cage fish traps) as part of the ALDFG debris (see Part 1, Section 2.8.2.7 below), with no mention of the plastic polymer of the nets.

Though the data has not been formally published, groups based in Singapore contribute annually to large international surveys, namely: ICCS and Project AWARE's Dive Against Debris. The ICCS is coordinated by Toddycats, who are volunteers of the Lee Kong Chian Natural History Museum, NUS. Using the protocol from Ocean Conservancy, 14,566 kg of trash (195,706 items) was collected across 62 km of coastline (Ocean Conservancy, 2018).

Enumerated marine plastics include:

- 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, and
- 2,454 foam take out/away containers.

Several independent groups, all led by volunteers, have been conducting underwater clean-ups in Singapore. These groups include OSR, Small Change, The Submersibles, Zen Freediving, DHI Water & Environment (S) Pte Ltd, Resorts World Sentosa, Marlin Divers, and Asia Dive Academy. They collect the data and upload it to the global database, Project AWARE's Dive Against Debris. As of April 2019, Singapore has collected 9,881 pieces of underwater marine debris under Project AWARE's Dive Against Debris (Project AWARE, 2019).

#### 8.2.4 Source differentiation and pathways

There is no published peer-reviewed study on source differentiation and pathways of marine plastics.

#### 8.2.5 Movement of plastics, accumulation and hotspots

There is no published peer-reviewed study on the movement, accumulation and hotspots of marine plastics.

#### 8.2.6 Ecological and environmental impacts

A study by Bhargava et al. (2018) demonstrated the impacts of nanoplastics on early life larvae of the acorn barnacles (*Amphibalanus amphitrite*) under two exposure periods: acute and chronic conditions. For both exposures, the barnacle larvae had ingested and egested the nanoplastics, but the nanoplastics had also translocated and became assimilated by the larvae. Overall, the study found that the barnacle larvae bioaccumulate low concentrations of nanoplastics throughout its life cycle.

Another study by Curren and Leong (2019) analysed the assemblages of bacteria found on the surfaces of microplastics collected from three beaches in Singapore. Of the bacteria identified, the study found several notable bacterial strains, namely: one that is commonly associated with coral bleaching, one that has harmful effects on humans (e.g., gastroenteritis and wound infection), one that is capable of degrading plastic, and one that have been used to clean up oil spill.

The most recent study by Seng et al. (2020) provided early evidence of the presence of microplastics, specifically microfibres and micro-fragments, on the surfaces of macrophytes collected from the wild. They also found significantly higher microplastic densities on seagrasses than seaweed, proposing that epibionts (i.e. animal and plant attached to the surfaces) could increase entrapment of microplastics. However, they found no correlation between microplastic density and epibiont cover found on either seagrass or seaweed.

There have been several informal accounts of ingestion, entanglement, and asphyxiation of marine animals. They include hawksbill sea turtles, dugongs, as well as a female sperm whale (*Physeter macrocephalus*). The latter was found floating off Jurong Island in 2015, and the autopsy revealed the presence of marine plastic waste in the gut (Chua et al., 2019).

#### 8.2.7 ALDFG

Four scientific peer-reviewed articles have been published on impacts of ALDFG on marine organisms (Chim and Lim, 2014a, 2014b; Yeo, 2014; Chim et al., 2015). Notably, all studies had reported different shark species (coral cat-shark, blackspot shark, black-tipped reef shark) as casualties of abandoned fishing gear, with the most severe case of 13 juvenile blacktip reef sharks (*Carcharhinus melanopterus*) and other myriad of marine life found dead in three trammel nets set in a lagoon (Chim et al., 2015). Observations on the impacts of ALDFG were noted, such as entanglement, lacerations, and suffocation.

There have also been several informal accounts of impacts of ALDFG on marine organisms that have been documented on the Facebook page of Project Driftnet Singapore (https://www.facebook.com/Project-Driftnet-Singapore-114400678619886/). This page displays informal accounts of impacts of abandoned fishing gear on marine life. In addition, a study led by undergraduate students from NUS also assessed the impacts of ALDFG on local marine life in 2018 (pers. comms., Anya). The data is presently unpublished.

#### 8.2.8 Social perceptions and socio-economic impacts

There is no published peer-reviewed study on social perceptions and socio-economic impacts of marine plastics in Singapore.

The Singapore Environment Council (SEC) is a major non-profit organisation in Singapore that facilitates and coordinates environmental causes in Singapore. In 2018, they addressed the plastic issue in Singapore through producing a position paper: Consumer Plastic and Plastic Resource Ecosystem in Singapore. The study was motivated by the increased concerns of plastic usage, coupled with the low recycling rates in Singapore. In this study, SEC conducted literature reviews and surveys to understand Singapore's plastic ecosystem and plastic lifecycle. Results found that people had diverging views on introducing financial penalties for using plastic bags, as well as low awareness of the know-how of recycling plastics. Finally, the paper presented recommendations to help improve

Singapore's plastic ecosystem. (SEC, 2019: available http://sec.org.sg/wp-content/uploads/2019/07/DT_PlasticResourceResearch_28Aug2018-FINAL_with-Addendum-19.pdf)

### 8.3 Main players in marine plastic research

Based on the published articles found and examined for this study, marine plastics research in ASEAN+3 is limited in Singapore. The publications that were found related to studies conducted and led by Singapore-based researchers from NUS. Whilst the authors are aware of relevant expertise held by several local colleagues in other research institutions in Singapore, they could not be identified from the published literature. Related works on pollution from marine plastics have been carried out by the Singapore Centre for Environmental Life Sciences Engineering (SCELSE) from the Nanyang Technological University (NTU) but published studies are not focused on Singapore or the rest of ASEAN+3. Other institutions such as NUS Department of Mechanical Engineering and Agency for Science, Technology and Research (A*STAR) are carrying out plastics research on polymer materials which is not specific to marine plastics.

The National Parks Board (a government agency) has played an active role in leading preliminary studies of macro-and microplastics on Singapore beaches (together with NUS researchers), as well as local stakeholder discussions and outreach and education campaigns.

### 8.4 Summary of understanding

There is a good understanding of the status of marine plastic pollution in Singapore, though not all information has been formally published. A 15-month long nationwide study between 2017 and 2019 on microplastics on beaches revealed the presence of microplastics in beach sediments, with data currently being analysed. Combining this study with quantitative sampling of ICCS marine debris data (of >20 years of annual September data since 2000), the combined data will provide an overall assessment of temporal and seasonal variations of macro- and microplastics in Singapore.

Microplastic studies were able to categorise samples into various forms including those of fibres, fragments, granules, and identify plastic polymer types. Notably, there was one study investigating the transfer of nanoplastics between the life stages of an acorn barnacle larvae, thus implying marine plastics as a pathway for pollution by other organic substances, polymers or inorganic contaminants (e.g. POPs and heavy metals).

The research focus of published articles is dominated by ecological and environmental impacts from marine plastics, especially through marine plastic being a transport vector or pathway. These articles also include investigations in the ingestion of microplastics by marine life, trophic transfer of plastics and changes in microbial assemblages. In particular, Bhargava et al. (2018) demonstrated the potential for marine species to retain and adsorb nanoplastics in their bodies, which suggest potential effects on human health. However, more research is needed to verify this pathway of plastics to human bodies and understand their possible impact.

Three out of four environs were investigated, lacking studies looking at the seafloor.

Although there is no peer-reviewed article on ingestion of macroplastic by wild animals, informal accounts of endangered marine species (i.e. sea turtles, dugongs, a sperm whale) have been reported. Four studies also correlated the physical impact of plastics on marine life, specifically ALDFG.

No research has been found so far on polymer-specific research to understand differences in degradation of different polymer-types in the marine environment.

There is also an increasing awareness of the topic among the scientific community, especially with the recent UK-SG (NERC-NRF) joint grant call on Understanding the impact of plastic pollution on marine ecosystems in Southeast Asia (Southeast Asia Plastics). See NERC, available: https://nerc.ukri.org/research/funded/programmes/seap/news/ao-singapore-plastics/.

## 9. THAILAND

***Summary of research topics:*** *Research on marine plastics in Thailand does not appear to be a main research thrust of any marine laboratory currently. Seven of the eight studies found for this report were conducted since 2016. They focus primarily on survey and monitoring to understand pollution status and on ecological and environmental impact, followed by socio-economic impact.*

***Summary of understanding at national level:*** *Published articles and reports on pollution from marine plastics may not reflect the understanding of the issue at national level due to unpublished work (in English) by the Department of Marine and Coastal Resources (DMCR), under the Ministry of Natural Resources and Environment, including by international coastal cleanups since 2009. Published articles highlight negative impacts of marine plastic debris on several marine taxa groups and all habitats sampled. However, varied methodologies and technologies have been used in monitoring marine litter that only allow a limited understanding of issues. Furthermore, studies of seabed sediments and surface waters are missing, as well as of source differentiation.*

***Keywords/research fields:*** *National approach; solid waste; trade of plastic waste; research foci; marine environs; surveys and monitoring; source differentiation; contribution from fisheries; ALDFG; accumulation zones; hotspots; ecological and environmental impact; socio-economic impact; main players*

### 9.1 Context

#### 9.1.1 National approach to plastic waste and its management

In 2017, the Thai government made a commitment to reducing plastic use and included waste management in its 20-year national strategy. Two programmes were established: a five-year programme, National Waste Management Master Plan for 2016–2021, and a four-year Plastic Debris Management Plan for 2017–2021. Thailand also partners with the IUCN, which has several projects aimed at helping achieve integrated coastal and marine resources management, such as the 'Tackling Marine Plastics in Thailand: from community-based actions to policies' project, which had a case study in the Koh Yao Yai sub-district.

As the ASEAN Chair in 2019, Thailand placed a particular emphasis on pollution from marine plastics, and helped to advance the issue within ASEAN. Its initiatives included the launch of the Bangkok Declaration on Combating Marine Debris in ASEAN Region at the 34th ASEAN summit in June 2019, which was adopted by the ASEAN Leaders. A Framework of Action on Marine Debris was subsequently adopted. See Part 1, Section 4.2.2.1 and https://asean.org/storage/2019/06/2.-Bangkok-Declaration-on-Combating-Marine-Debris-in-ASEAN-Region-FINAL.pdf.

In January 2020, Thailand placed a ban on single-use plastic bags at major stores, continuing a campaign launched by the government and retailers towards a complete country-wide ban in 2021. In response to this ban, some Thais have interestingly taken out-of-the-box approaches in place of using plastic bags when shopping. They have used vases, suitcases, hampers and even wheelbarrows, apart from the conventional tote or recyclable bags, in place of single-use plastic bags (NBC News, 2019: available https://www.nbcnews.com/pop-culture/pop-culture-news/after-plastic-bag-ban-thai-shoppers-use-wheelbarrows-hampers-tote-n1111151).

### 9.1.2 Plastics as a proportion of solid waste

In 2016, the MSW for Thailand was estimated at 27.3 million tonnes, with a projection of reaching 32.5 million tonnes in 2030 and 37.3 million tonnes in 2050 (Kaza et al., 2018). Of the waste generated in 2016, 4.2 million tonnes would have been generated in Bangkok.

Thais are assessed to be using 70 billion plastic bags annually. Based on Jambeck et al. (2015) estimates, Thailand produced 1.03 million tonnes of mismanaged plastic waste in 2010, with approximately 0.15-0.41 million tonnes of plastics that may be entering the marine environment annually. 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% of plastic waste (ca. 51,000 tonnes) is estimated to be mismanaged and pass through the Thai waters into the oceans each year.

### 9.1.3 Illegal trade of plastic waste

According to Greenpeace (2019), Thailand's plastic waste imports rose from 69,500 tonnes in 2016 to 481,000 tonnes by 2018, with top exporters being the US and Japan. In response to this, Thailand adopted a temporary three-month prohibition on importing plastic waste, and is seeking to ban these imports by 2021 (Telegraph UK, 2018: available https://www.telegraph.co.uk/news/2018/10/15/thailand-ban-foreign-plastic-waste-2021-south-east-asia-buckles/).

## 9.2 Research review of pollution from marine plastic

### 9.2.1 Research overview

Research on marine plastics in Thailand is in progress. The nine studies found were conducted in different decades: one in 2009 and seven between 2016–2020. They geographically cover much of the country's coastline and one offshore island (Koh Tao). A majority focused on survey and monitoring to understand pollution status and on ecological and environmental impact and socio-economic impact.

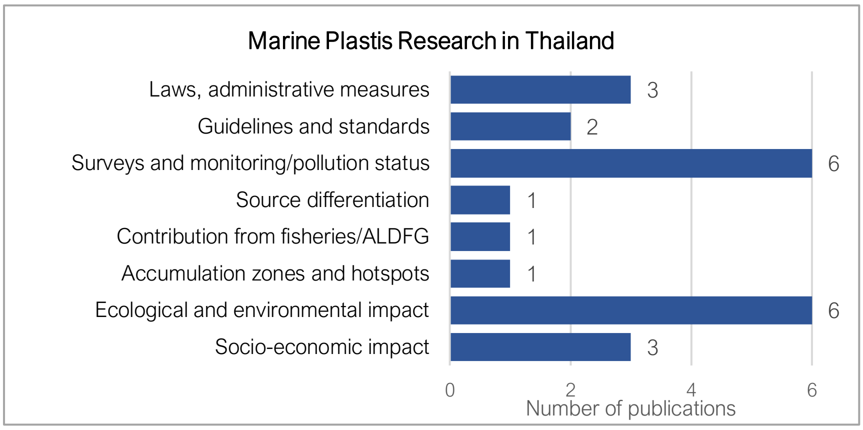



Figure 1.2.9.1. Research foci of marine plastic research conducted in Thailand.

Table 1.2.9.2. List of published work identified and examined in this study for Thailand.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Marks et al. (2020)<br>Uni of Hong Kong (China), National Uni of Singapore, Chualongkorn Uni | Assess the challenges to addressing marine plastic pollution in Thailand | N.A. |
| Wichai-utcha and Chavalparit (2019)<br>Chulalongkorn Uni | Review of 3Rs policy, plastic waste management and its governing laws (i.e. Plastic Debris Management Plan 2017-2021) in Thailand | N.A. |
| Azad et al. (2018)<br>Prince of Songkla Uni; Vietnam National Uni (Vietnam) | Quantify plastic debris (micro-, meso, macro-) in stomach of economically important fish in the lower Gulf of Thailand | Jan-Apr 2015 |
| Ballesteros et al. (2018)<br>Naturalis Biodiversity Center (Netherlands); Big Blue Dive Resort; Leiden Uni (Netherlands) | Understanding ALDFG (nets, ropes, cages, lines) impacts on six stony coral growth forms; Inventorise ALDFG on reefs | Feb 8-May 2, 2011 |
| Kungskulniti et al. (2018)<br>Mahidol Uni; Center of Excellence on Envtal Health and Toxicology; Tobacco Control Research and Knowledge Management Center; Insight Analysis Group (USA) | Investigate the level of tobacco product waste (TPW) on Thailand's public beaches, and discuss actions to be undertaken to mitigate problem | N.A. |
| Thushari et al. (2017b)<br>Uva Wellassa Uni (Sri Lanka); Asian Institute of Technology; Chulalongkorn Uni | Quantify abundance and types of coastal debris along 3 beaches in eastern coast of Thailand | mid-Feb-mid-May, mid-May - mid-Oct 2015 |
| Thushari et al. (2017a)<br>Uva Wellassa Uni (Sri Lanka); Asian Institute of Technology; Chulalongkorn Uni | Determine microplastic contamination in three abundant sessile and intertidal invertebrates along 3 beaches of eastern Thailand | Mar-May 2015 |
| Tharamon et al. (2016)<br>Burapha Uni Chanthaburi Campus; Dept of Marine and Coastal Resources Bangkok | Determine microplastic contamination in two species of bivalves at two beaches in Chanthaburi province | Aug-Sep 2014 |
| Thanida et al. (2009)<br>Chulalongkorn Uni; Ministry of Natural Resources & Envt | Quantifying plastic debris present in stomach necropsy of whale shark (*Rhincodon typus*) | Oct 17, 2005 |

Despite a clear awareness of marine plastic pollution by the scientific community, this topic does not appear to be a main research thrust of any marine laboratory currently. With support from IOC-WESTPAC, Thailand hosted the first regional workshop on microplastic research and monitoring, in Phuket in 2017. (For more details see Part 1, Section 4.8.)

### 9.2.2 Types of research conducted

*Types of plastics research foci*

Research in micro- and macro- plastics is roughly equivalent and not very detailed. Studies examining microplastics focused on presence/absence in marine organisms, especially sessile organisms and fish (Tharamon et al., 2016; Thushari et al., 2017a; Azad et al., 2018) and on beaches (Thushari et al., 2017b; Kungskulniti et al., 2018). Studies of macroplastics focused on items found on beaches, in a whale shark (Thanida et al., 2009) and on abandoned fishing gear (Ballesteros et al., 2018).

No peer-reviewed study was found on organic or inorganic contaminants associated with marine plastics.

*Coverage of marine environs*

Of the nine studies examined, the most commonly studied environ is marine organisms, such as invertebrates (Tharamon et al., 2016; Thushari et al., 2017a; Azad et al., 2018), a whale shark (*Rhincodon typus*) (Thanida et al., 2009), and coral reefs (Ballesteros et al., 2018). The other studies examined the presence/absence of marine plastics on beaches (Thushari et al., 2017b; Kungskulniti et al., 2018).

There is no published study on marine plastics on or in the seafloor and water column.

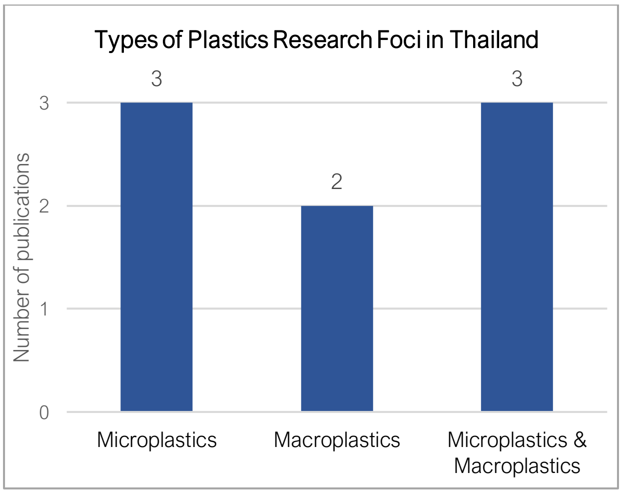



Figure 1.2.9.3. Distribution of marine micro-/macro-plastics researched in Thailand.

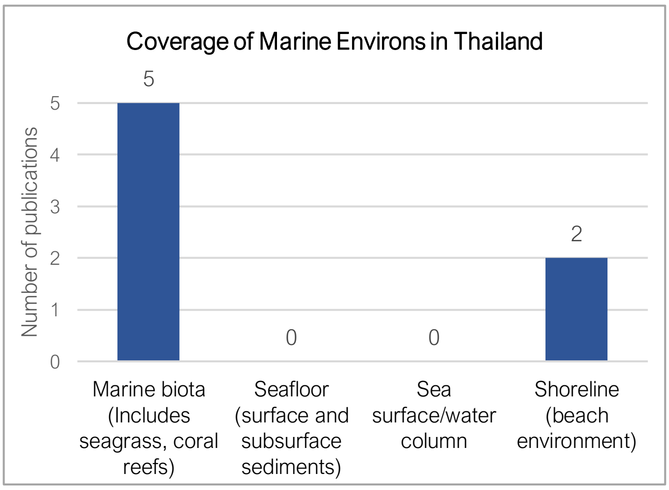



Figure 1.2.9.4. Distribution of marine environs researched in Thailand.

Two studies were not categorised for the purpose of this report as they are reviews on plastic waste management in Thailand (Marks et al., 2020; Wichai-utcha and Chavalparit, 2019).

### 9.2.3 Survey and monitoring

Most studies have attempted to quantify the status of marine plastics in the marine environment. Several studies examined the distribution and abundance of macroplastics in marine environs such as the shoreline (Thushari et al., 2017a; Kungskulniti et al., 2018), coral reefs (Ballesteros et al., 2018) and the stomach of a whale shark (Thanida et al., 2009). These studies identified macroplastic plastic debris in the following categories: cigarette butts, general plastic, EPS (styrofoam), glass, metal, paper, rubber, wood, cloth, fishing gear, etc. However, none of them noted the types of plastic polymer. Generally, these studies quantified the abundance of plastics based on counts (i.e. number of cigarette butts, number of debris per transect area, number of derelict gear) and weight per area (i.e. wet weight of debris per transect area, volume of debris per transect area).

All of the microplastic-focused studies have investigated the presence/absence and abundance of microplastics in marine biota (Thushari et al., 2017b), especially commercially-important species (Azad et al., 2018; Tharamon et al., 2016). These studies quantified the abundance of plastics based on counts (i.e. number of fish with microplastics, number of plastic debris per stomach of fishes, number of plastic debris per gram of fish stomach, number of microplastics per individual). Studies of microplastics all adhered to the definition of size <5 mm, and the shapes of microplastics were noted (such as fibre, fragment, film, rod, etc.). However, only 1 of 3 microplastic-focused articles have identified the types of plastic polymers including PS, PET, PA.

Though the data has not been formally published, the Department of Marine and Coastal Resources (DMCR) under the Ministry of Natural Resources and Environment has been leading clean-ups under International Coastal Clean-up Thailand between 2009 and 2015. Plastic disposables were their top marine debris. DMCR has since expanded its work to sampling and quantifying microplastics. This information is not accessible in the English language, but it might be in Thai.

Several independent groups, all led by volunteers, have also been conducting underwater clean-ups in Thailand. These groups mainly comprise recreational divers who collect data and upload them to the global database of Project AWARE's Dive Against Debris.

#### 9.2.4 Source differentiation and pathways

There is no published peer-reviewed study on source differentiation and pathways of marine plastics.

#### 9.2.5 Movement of plastics, accumulation and hotspots

There is no published peer-reviewed study on marine transport accumulation and hotspots of marine plastics.

#### 9.2.6 Ecological and environmental impacts

Studies on the impact of marine plastics on marine organisms are varied. Thanida et al. (2009) reported a case where a single plastic straw was found in the stomach of a whale shark, while subsequent studies reported the presence/absence of microplastics in sessile marine invertebrates (Tharamon et al., 2016; Thushari et al., 2017b). The latter studies indicated that filter-feeding organisms showed comparatively higher accumulation rates of microplastics. This implies that contaminated invertebrates would be ingested by seafood consumers.

One study on ALDFG around Koh Tao found that lost fishing gear caused tissue loss and fragmentation in coral reefs (Ballesteros et al., 2018; see Section 9.2.6).

### 9.2.7 ALDFG

Ballesteros et al. (2018), a team of researchers from The Netherlands, conducted a reef survey to understand the impact of lost fishing gear (e.g. nets, ropes, cages, lines) on six stony coral growth forms. They inventorised types of fishing gear lost on these reefs to identify and quantify damage caused to corals and concluded that abandoned fishing gear is a major component of marine litter on coral reefs around Koh Tao. They also considered that these ALDFGs affect coral reefs.

### 9.2.8 Social perceptions and socio-economic impacts

In 2019, a study led by researchers at the Chulalongkorn University reviewed the current status of Thailand's 3Rs policy and plastic waste management, discussed the approaches of Thailand's Plastic Debris Management Plan 2017–2021 and reviewed measures aimed to create more effective plastic waste management strategies (Wichai-utcha and Chavalparit, 2019). In a new 2020 study, Marks et al. also explored challenges met in addressing marine litter pollution in Thailand through particular consideration of the importance of a multi-sectoral and stakeholder engagement in this context.

On another topic, a study highlighted the potential socio-economic impacts of tobacco cigarette pollution on both tourism and human health in Thailand (Kungskulniti et al. 2018). The accumulation of tobacco cigarettes as beach litter is seen to potentially affect visitorship at popular tourist beaches. Additionally, when strewn tobacco cigarettes are leaked and carried into marine environs, they are also expected to fragment into microplastics and release harmful toxic substances.

## 9.3 Main players in marine plastic research

Although marine plastics research is limited in Thailand, the studies assessed were conducted and led by a varied group of researchers, both local (i.e. First Chulalongkorn University, with four publications, followed by Burapha University Chanthaburi Campus, Prince of Songkla University, Mahidol University) and international (e.g. Uva Wellassa University – Sri Lanka; Vietnam National University – Vietnam; Insight Analysis Group – Corte Maderal, USA; and University of Hong Kong –HK SAR, China).

The Department of Coastal and Marine Resources (DCMR) also plays an active role in leading marine plastics research across Thailand.

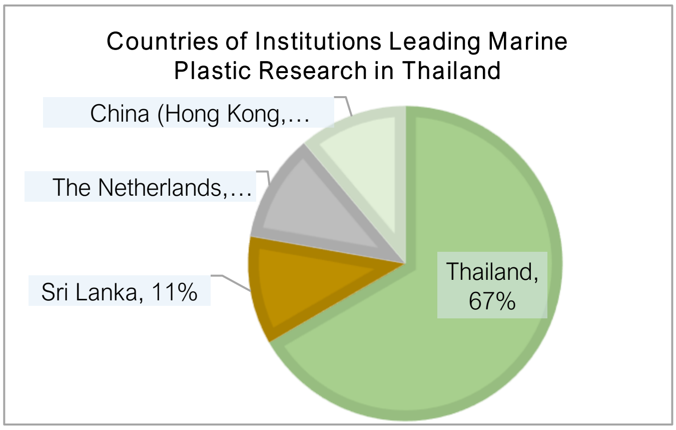



Figure 1.2.9.5. Composition of research efforts in Thailand.

## 9.4 Summary of understanding

There is a growing awareness of proven and potential issues resulting from pollution from marine plastics in Thailand, among the scientific community and beyond. Existing studies covered common research aspects of marine plastic pollution, such as ecological and environmental impact, and surveys and monitoring. However, there appears to be a lack of understanding of sources and pathways of marine plastics into the marine environment.

Two out of four environs were investigated, of which, the dominant group is marine biota. This suggests that data is lacking to understand pollution from marine plastics in surface waters, the water column and the seabed.

Seven studies sought to quantify the presence and abundance of marine plastic debris. Across the studies, varied approaches and methodologies have been used in monitoring marine litter in Thailand, despite most studies being conducted in marine biota. The types of marine biota were also varied, and the studies used different measures for quantification, making it difficult for direct comparisons. The articles on ecological and environmental impact showed a particular interest in the ingestion of microplastics by marine life, including the endangered migratory whale shark, as well as the entanglement of corals by plastics in the wild, specifically by ALDFG. There are no studies on the physical impacts of marine plastics on endangered migratory species (i.e. dolphins, whales, sea turtles). No investigation on plastic transfer through the food chain has been found so far.

While most of the studies on microplastics were able to categorise samples into various forms including those of fibres, fragments, rods, films, only one study sought to identify plastic polymer types. No research has been found on differences in degradation of different polymer-types in the marine environment or on marine plastics as a pathway for pollution by other organic or inorganic contaminants (e.g. POPs and heavy metals).

Additional work is needed to understand leakage and movement, accumulation and hotspots of marine plastics.

## 10. VIETNAM

***Summary of research topics:*** *Publications on pollution from marine plastics in Vietnam show that the country is at an early stage of research on this topic. The four articles found were published since 2016 and all involved foreign research partners together with local institutions. Despite the relatively small number of publications, these publications cover a large number of research topics, ranging from laws and other national measures to POPs transported and released by marine plastics.*

***Summary of understanding at national level:*** *Two of the studies focused on the Saigon River and suggested that it would contribute four times more plastic debris to the marine environment than had been estimated in 2017. Resin pellets were also identified as a pathway for POPs. A review also suggested that vessels and fishing gear would be a substantial source of marine debris. However, there is no clear evidence of this. Furthermore, there is no analysis of polymers that compose marine plastic debris, nor of the presence or impact of marine plastics on marine biota, or on the seabed and in seabed sediments.*

***Keywords/research fields:*** *National approach; solid waste; trade of plastic waste; research foci; marine environs; surveys and monitoring; methodology for the monitoring and assessment of marine litter; source differentiation; contribution from rivers; accumulation zones; hotspots; fragmentation and degradation; ecological and environmental impact; socio-economic impact; movement of plastics; adsorption-desorption of contaminants; organic contaminants; inorganic contaminants; plastic as transport vector; main players*

### 10.1 Context

#### 10.1.1 National approach to plastic waste and its management

Based on Jambeck et al. (2015) estimates, Vietnam would have been the fourth country with the most mismanaged waste in 2010. Of the plastic flows through Vietnam, 0.7-1.0 million tonnes are recycled back into production, and another 1.3 million tonnes are sent for waste treatment and disposal facilities. While there is no specific policy on plastic waste management, Vietnam's Law on Environmental Protection 1993 regulates the general provisions on environmental protection and waste management. However, the 3Rs policy does not appear to have been emphasised. Most waste would also be disposed of in an insufficient number of often inadequate landfills that are thus subject to significant leakages.

On 4 November 2019, Vietnam officially took over ASEAN's rotating Chairmanship for 2020 from Thailand. Under ASEAN's socio-cultural agenda, the ASEAN Leaders adopted the Bangkok Declaration on Combating Marine Debris in ASEAN Region at the 34th ASEAN summit in June 2019. Whilst Vietnam considers the handling of plastics and ocean plastic waste a priority to be implemented, it is unclear how Vietnam plans to encourage the ASEAN Leaders to cooperate further to combat pollution from marine plastics (S. Rajaratnam School of International Studies, NTU: available https://www.rsis.edu.sg/rsis-publication/cms/next-asean-summit-how-will-vietnam-lead/#.XjQFExMzb_Q). There has been mentions of Japan's support for ASEAN in dealing with plastic waste and ocean plastic by working closely with Vietnam during its Chairmanship (Nhân Dân: available https://en.nhandan.org.vn/politics/item/8003202-japan-backs-environment-priorities-during-vietnam%E2%80%99s-assumption-of-asean-chair.html).

### 10.1.2 Plastics as a proportion of solid waste

In 2016, municipal solid waste (MSW) for Vietnam was estimated at 11.6 million tonnes with a projection of 15.9 million tonnes in 2030 and 22 million tonnes in 2050 (Kaza et al., 2018). In Ho Chi Minh City alone, about 8,175 tonnes of solid waste may have been generated per day in 2014, with 1.02 kg/capita/day generation of waste (Verma et al., 2016).

Of the MSW, plastic waste ranked second after food waste (Verma et al., 2016). The composition of plastics in solid waste was estimated at 16% for Vietnam (Hoornweg and Perinaz, 2012).

### 10.1.3 Illegal trade of plastic waste

Vietnam became one of the top importers of global illegal plastic waste after China's ban on plastic waste import in 2018. Plastic waste imports increased from 348,000 tonnes in early 2016 to 492,000 tonnes in end-2018. The bulk of the waste came from Japan and Thailand (Greenpeace, 2019). Vietnam has since stopped issuing new permits to import plastic waste, increased customs inspections of illegal shipments, and adopted a target to ban plastic scrap imports by 2025 (Waste Management Review: available https://wastemanagementreview.com.au/battling-sovereign-risk/). Moving forward, Vietnam plans to look into the 21,600 containers of plastic scrap that would have remained stuck in ports since February 2019. See Greenpeace, 2019 and Unearthed Greenpeace, 2018: available https://unearthed.greenpeace.org/2018/10/05/plastic-waste-china-ban-united-states-america/.

## 10.2 Research review of pollution from marine plastic

### 10.2.1 Research overview

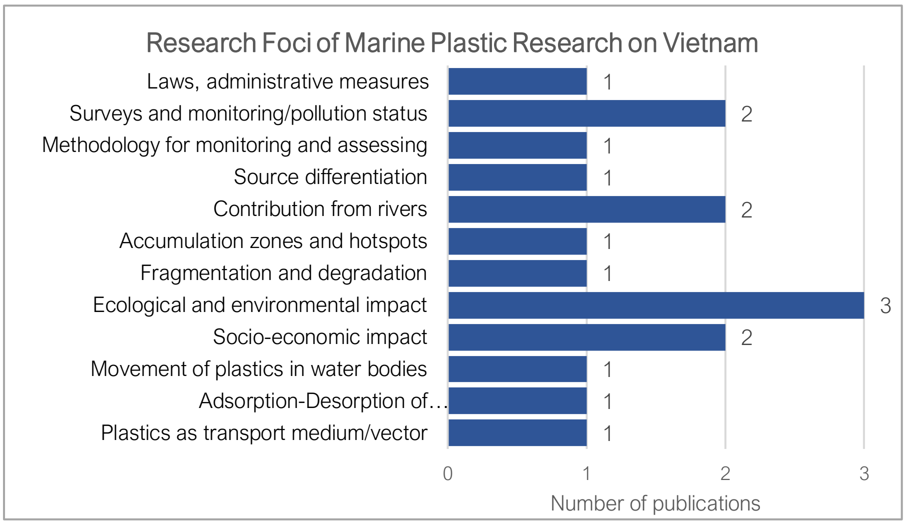
Publications of on pollution from marine plastics in Vietnam show that the country is at an early stage of research on this topic. No local scientific research institution has yet to publish articles in English on this topic without the support of external partners.

Notably, in 2017, country representatives from Vietnam attended the inaugural 'Workshop on Distribution, Source, Fate and Impacts of Marine Microplastics in Asia and the Pacific' in Phuket, Thailand, which was supported by IOC-WESTPAC. The Workshop's Report mentioned the country's limited understanding of marine plastics, as well as the lack of priorities for related research, monitoring, and management.

The four studies that were examined for this report were conducted within the last five years (2016–2019) within a limited geographic coverage of the country (i.e. Saigon River, Minh Chau Island, Ba Lat estuary). However, they cover a large number of research topics, ranging from laws and other national measures to POPs associated with marine plastics. This shows a general understanding of the issues and determination to assess them all. It also suggests that more specific and detailed research projects should be expected.

Most of the studies focused on ecology and environmental impact (n=3), followed by survey and monitoring to understand pollution status (n=2), contribution from rivers (n=2), and socio-economic impact (n=2).

Figure 1.2.10.1. Research foci of marine plastic research conducted in Vietnam.




## 10.2.2 Types of research conducted

*Types of plastics research foci*

The four studies examined suggest an equivalent interest in micro- and macro-plastics. The studies that examined microplastics were varied: one assessed the presence of persistent organic pollutants (POPs) on resin pellets (Le et al., 2016), one assessed presence/absence of microplastics (and macroplastics) in the Saigon River (Lahens et al., 2018), and the last one is a review providing the status of marine plastics status in Vietnam that included a microplastics discussion (Van Truong and Chu, 2019). The macroplastics study looked at assessing the spatiotemporal variation of plastic debris through hydrodynamic modelling on Saigon River (Van Emmerik et al., 2018).

No published study on plastic additives was found. However, of note is the article by Le et al. (2016) which identifies three POPs (DDTs, PCBS and HCHs) carried by resin plastic pellets as collected from Vietnamese coastal waters. This study was carried out as part of the programme, International Pellet Watch, for monitoring the global POPs distribution on contaminated resin pellets in the marine environ.

Table 1.2.10.2. List of published work identified and examined in this study for Vietnam.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Van Truong and Chu (2019)<br><br>Dalian Maritime Uni (China) | Provide a general review of marine plastics, and a brief account of marine plastic waste on coastal Vietnam; Review International Conventions and Vietnam's regulations related to the prevention and control of plastic waste from ships; Categorise sources of plastic waste in the marine environment; Quantify amount of plastic waste in the marine environment of Vietnam's coastal area | N.A. |
| Lahens et al. (2018)<br><br>Uni Paris-Est (France); Uni Grenoble Alpes (France); Ho Chi Minh City Uni of Technology; Ifremer (France) | Assess macroplastic and microplastic contamination levels in a tropical river estuary system, Saigon River | Dec 2015; Apr 2016 |
| van Emmerik et al. (2018)<br><br>The Ocean Cleanup (The Netherlands); Ho Chi Minh City Uni of Technology; Uni of Grenoble Alpes (France); Uni Paris-Est (France); The Modelling House Limited (New Zealand) | Assess spatiotemporal variation in river plastic quantities and composition using new sampling methods and hydrodynamic modelling on Saigon River | Feb 28-Mar 13, 2018 |
| Le et al. (2016)<br><br>Uni Malaysia Terengganu (Malaysia); Tokyo Uni of Agriculture and Technology (Japan); Vietnam National Uni HCM; Vietnamese Academy of Sci. and Tech. | Assess the presence of DDTs, PCBs and HCHs on plastic resin pellets collected in Vietnam; Study carried out as part of the International Pellet Watch Programme for monitoring the global distribution of POPs | 2007-2014 |

*Coverage of marine environs*

The four studies examined focused primarily on the presence/absence of marine plastics at water surface and in the water column (specifically in the Saigon River, in Lahens et al., 2018; Van Emmerik et al., 2018). Only one examined the beaches of Minh Chau Island and Ba Lat estuary to collect resin plastic pellets (Le et al., 2016).

No published peer-reviewed study was found on marine plastics in marine biota or the seafloor (surface and sediments).

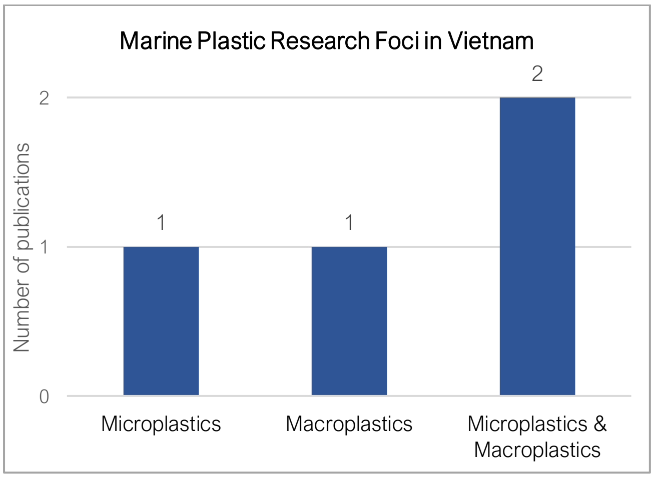



Figure 1.2.10.3. Distribution of marine micro-/macro-plastics researched in Vietnam

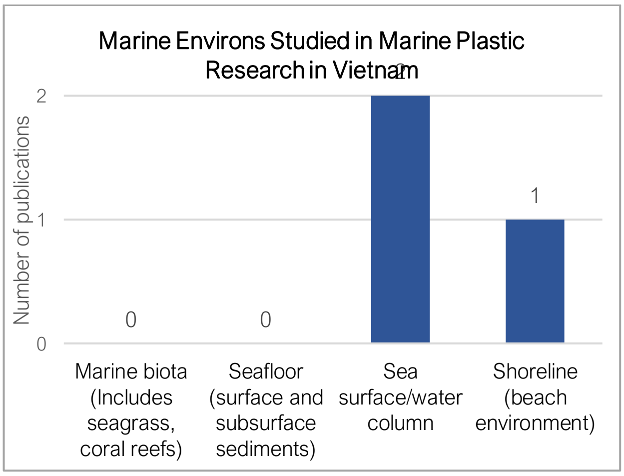



Figure 1.2.10.4. Distribution of marine environs researched in Vietnam

#### 10.2.3 Survey and monitoring

Le et al. (2016)'s article is focused on assessing the presence of POPs on plastic resin pellets collected from the Vietnamese coastal waters. The pellets were analysed for three POPs: dichloro-diphenyl-trichloroethanes (DDTs), polychlorinated biphenyls (PCBs) and hexachlorocyclohexanes (HCHs). Presence and concentration of POPs on plastic pellets provide an indication that may be useful to trace where the plastics could come from in the region. The authors indicated that higher levels of DDTs compared to PCBs suggest agricultural inputs rather than industrial discharges. Plastic pellets, serving as a transport vehicle for POPs, could therefore be used to track temporal and spatial patterns of POP levels in the marine environment.

Van Emmerik et al. (2018) briefly examined the amount of plastics found on the water surface of the Saigon River, though they did not identify the type of macroplastics found. Microplastics were defined in the article as <5 mm; their shape was also described (e.g. fibre, fragment). Abundance was quantified as number of fibres per size class, wet weight in percentage, and fibre concentration per $m_3$. The types of plastic polymer in this study were identified as PE, PP, Polyester, PET, rayon, PP-vistalon, viscose, acrylic. Van Emmerik et al. (2018) collected this data to test a new methodology on characterising riverine macroplastics leakages into the oceans.

#### 10.2.4 Source differentiation and pathways

There is no published peer-reviewed study on source differentiation and pathways on marine plastics.

Whilst the article by Van Emmerik et al. (2018) identifies the Saigon River as an important source of marine plastic, no quantitative contribution was offered. In their review, Van Truong and Chu (2019) mentioned that the GreenHub organisation indicated that 62% of waste is discharged from major rivers in Vietnam, such as the Red River Delta, the Mekong Delta, the East, the Southern and Central coast, and that 71% of these marine debris are plastics.

#### 10.2.5 Movement of plastics, accumulation and hotspots

The study by Van Emmerik et al. (2018) included the testing of a new method in characterising riverine macroplastic flux dynamics, i.e. the transport of macroplastic in rivers. This new methodology can be simplified in four steps: (i) determine the cross-sectional profiles of plastic flux; (ii) obtain plastic debris statistics; (iii) combine plastic flux to hydrology; and (iv) extrapolate observations. Using real-time data collected from the Saigon River, the study found that macroplastics transported by the river into the marine environment would be four times higher than previously estimated by Lebreton et al. (2017).

#### 10.2.6 Ecological and environmental impacts

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

Several studies (Le et al., 2016; Lahens et al., 2018; Van Truong and Chu, 2019) strongly imply ecological and environmental impacts, but they are not discussed in the articles in the context of

Vietnam. For example, Le et al. (2016) suggest that DDT could have an impact on marine life such as sea birds, but do not discuss it further.

### 10.2.7 ALDFG

There is no published peer-reviewed study on ALDFG.

### 10.2.8 Social perceptions and socio-economic impacts

There is no published peer-reviewed study on social perceptions and socio-economic impacts of pollution from marine plastics in Vietnam.

## 10.3 Main players in marine plastic research

All four studies examined have been conducted by a diverse group of researchers, coming in majority from foreign research institutions (including Universiti Malaysia Terengganu-Malaysia, French universities, The Ocean Cleanup – The Netherlands, Tokyo University of Agriculture and Technology, and Dalian Maritime University – China). However, they also involved local partners, primarily Ho Chi Minh City University of Technology. No government agency or department could be identified.

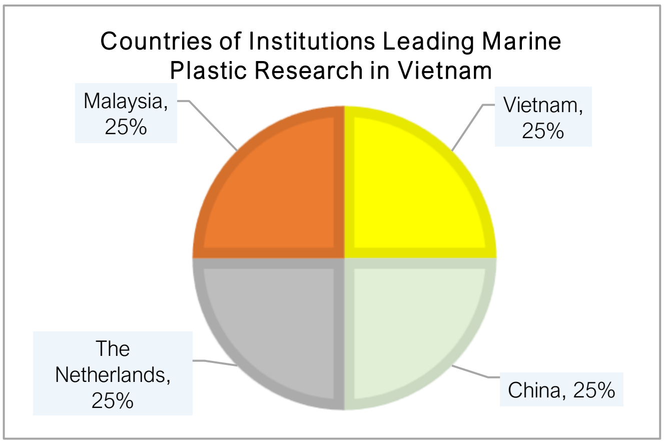



Figure 1.2.10.5. Composition of research efforts seen in Vietnam.

## 10.4 Summary of understanding

Despite their small number, the articles published in English cover a wide range of research aspects of marine plastic pollution in Vietnam, including the common ecological and environmental impacts, survey and monitoring, as well as movement of plastic debris in water bodies and adsorption-desorption of chemicals/pollutants. Two out of four environs were investigated.

Three out of four published articles seek to quantify the presence and abundance of marine plastic debris. Across the studies, varied methodologies (i.e. counting plastic debris versus simulation modelling) were used in monitoring marine litter in the marine environment, thus making it difficult to do direct comparisons. They nevertheless provide a more comprehensive picture of baselines on which further research can be based.

The two articles on microplastics categorised samples into various forms including those of fibres, fragments, pellets. They also identified plastic polymer types. Notably, one article investigated the presence of POPs on plastic resin pellets located in the coastal environment of Vietnam and demonstrated that marine plastics are a pathway for pollution by POPs, specifically DDTs, PCBs, and HCHs. However, none of the studies focused on the degradation of any type of polymer in the marine environment.

Whilst most articles are concerned with ecological and environmental impacts, no studies could be found on marine biota, including ingestion or physical impacts of marine plastics on organisms of either socio-economic importance or endangered migratory species. There seems to have also been no investigation on plastic transfer through the food chain so far.

In their review of marine plastic pollution in coastal Vietnam, Van Truong and Chu (2019) suggested that merchant ships and fishing vessels would be one of the major sources of marine plastics pollution into the ocean. The review also analysed Vietnam's international and local regulations and measures on the management of marine plastics, and found that current local provisions are not sufficient to prevent pollution of the marine environment by plastic waste.

Further research on quantification and monitoring of marine plastics, as well as hotspots, would be useful. In addition, further improvement of understanding on sources and pathways, as well as the ecological, environmental, and socio-economic impacts within the country, could support decision-making in the adoption of adequate management measures. Whilst all four of the articles examined involved foreign researchers, involvement of local partners is expected to have contributed to building some of the research capacity needed for this purpose.

## 11. CHINA

***Summary of research topics:*** *China leads the region in terms of number of research papers on marine plastics (128 peer-reviewed papers published since 2015), which are focused on several topics of interest. There is a particular emphasis on monitoring surveys for microplastics, focused on quantification of microplastics spanning all marine environs including a variety of different habitat types and marine biota. Similarly, studies of ecological and environmental impacts have a particular focus on presence of microplastics, rather than intake/absorption mechanisms and food chain transfer. By contrast, there seems to be little research on macroplastics and their degradation, source differentiation, movement of plastics, accumulation and hotspots, ALDFGs, social perception and socio-economic impacts. Published articles and the number of institutions involved show China's leading research capacity in plastic research.*

***Summary of understanding at national level:*** *There appears to have been a near country-wide sampling for marine microplastics abundance in a number of abiotic and biotic environments. These studies include polymer identification as well as associated contaminants. Much of the research is conducted at relatively high levels of technology, particularly evident in the frequent use of spectroscopy and the studies of sorption dynamics of specific chemicals. However, there is still a lack of standardised protocols for detection, sampling and extraction of plastics. The plastic classification system proposed by Wang et al. (2019) may be useful on this path of harmonisation or consistency in preferred sampling protocols.*

***Keywords/research fields:*** *National approach; solid waste; trade of plastic waste; research foci; marine environs; upstream research; waste management; surveys and monitoring; methodology for the monitoring and assessment of marine litter; source differentiation; contribution from fisheries; ALDFG; accumulation zones; hotspots; ecological and environmental impact; socio-economic impact; adsorption-desorption of contaminants; organic contaminants; inorganic contaminants; plastics as transport vector; plastic additives; heavy metals; main players*

### 11.1 Context

#### 11.1.1 National approach to plastic waste and its management

China's decision to ban the import of plastic waste in 2017 (effective in January 2018) shows the country's realisation of plastic issues raised by its management and pollution impacts. Despite new initiatives being implemented on the reduction of plastic consumption and waste, China does not seem to place plastic waste management as a top priority in their environmental policy agenda (Garcia et al., 2019). In contrast, there are varying extents of plastic waste management being carried out at sub-national levels, which is especially evident in coastal provinces and cities due to their proximity to seas.

According to data from the National Bureau of Statistics, China disposes of most of their waste at landfills, while only a small proportion is incinerated (BBC, 2019: available https://www.bbc.com

/news/world-asia-50429119). However, an increase in the amount of waste produced by population growth could threaten the capacity of their landfills. For example, the Jiangcungou landfill in Shaanxi Province, the largest landfill in the country, appears to be already filled when it would have been expected to last for another 25 years (BBC, 2019: available https://www.bbc.com/news/world-asia-50429119).

On 19 January 2020, the National Development and Reform Commission and the Ministry of Ecology and Environment announced a new policy to reduce the production, sale and use of single-use plastic products, including banning plastic bags in all of China's major cities by the end of 2020, extending the ban in all cities and towns by 2022, and banning single-use straws in the restaurant industry by the end of 2020. (China Daily, 2020: available http://www.chinadaily.com.cn/a/202001/20/WS5e24181da310128217272097_2.html).

This phased approach is expected to provide the time for the development of manufacturing of biodegradable and alternative products to replace single-use plastics (Forbes, 2020: available https://www.forbes.com/sites/trevornace/2020/01/20/china-to-ban-all-single-use-plastics/).

### 11.1.2 Plastics as a proportion of solid waste

The 2016 MSW for China was estimated at 220 million tonnes and is projected to reach 295 million tonnes in 2030 and 336 million tonnes in 2050 (Kaza et al., 2018). Meanwhile for Hong Kong SAR, the 2016 MSW was estimated at 5.7 million tonnes, and is projected to reach 6.9 million tonnes in 2030 and 7.6 million tonnes in 2050.

Estimates of the proportion of plastic in MSW in 1996 varied between 2 to 14% in different cities, where Shenzhen, a major city in the Guangdong Province scored the highest (Wang and Nie, 2001). Jambeck et al. (2015) estimated that about 11% of the national MSW was composed of plastics.

### 11.1.3 Illegal trade of plastic waste

The government first introduced 'Operation Green Fence' in 2013 in an attempt to increase the quality of plastic waste being imported into China and to reduce the illegal trade of plastic waste into China. Under this operation, plastic imports were accepted under the caveat that there was little or no contamination and to that, customs inspects were enhanced (Velis, 2014). Whilst this operation was successful to improve the control of legally imported plastic waste, it seemed to have been unable to sufficiently curb the illegal trade of plastic waste that was still happening. In 2017, China announced a new import policy known as the 'National Sword Policy' to permanently ban the imports of non-industrial plastic waste, among the 23 other types of waste (Chinese Ministry of Environmental Protection, 2017: available http://www.mee.gov.cn/gkml/hbb/bgg/201708/t20170817_419811.htm?COLLCC=3069001657&).

This ban took effect in 2018 and China seems to have seen results, with the amount of plastic received being halved in 2018. In 2016, it had received 7.35 million tonnes of plastic waste from 43 countries, accounting for 52% of global plastic exports in that year. Since reporting began in 1992, China and Hong Kong cumulatively received 72.4% of all plastic waste (Brooks et al., 2018).

This policy is widely considered to have caused a global crisis in the trade and recycling of plastic waste trade which resulted in the re-routing of illegal trade of plastic waste to alternatives countries, particularly those in Southeast Asia (Greenpeace, 2019).

## 11.2 Research review of pollution from marine plastic

### 11.2.1 Research overview

There has been an extensive amount of research on marine plastics in China, especially in recent years. It appears to be a nation-wide effort, as numerous research institutions are involved, covering a wide geographic range from its coastal provinces along the eastern and southern coastlines of China, to the major inland rivers that lead out to the open ocean (i.e. Pearl River and Yangtze River), as well as to the waters around the Paracel and Spratly Islands (i.e. South China Sea basin).

Marine plastics research in China had the largest amount of published peer-reviewed articles among the ASEAN+3 member states (n=129). For the scope of this study, we limited our review to English-language peer-reviewed published articles between 2015 and 2019. It is expected that the number of articles on marine plastics published in China and in Chinese-language in peer-reviewed journals will be much higher, as well as institutional reports and grey literature, which could not be covered in this report. The decision to select 2015 as the start date for inclusion of studies in this report is based on the observation that 90-95% of articles were published from 2015 onwards. This time frame is therefore expected to better reflect current trends in marine plastics research in China.

Around 76% of this research effort was published between 2018 and 2019. The research covers a wide range of topics across 14 different research foci (Figure 1.2.11.1). Of these, there is an emphasis on the understanding of the pollution status through surveying and monitoring (n=76), on assessing the ecological and environmental impacts of plastics (n=38) and on understanding the sorption mechanism of contaminants on plastics (n=32).

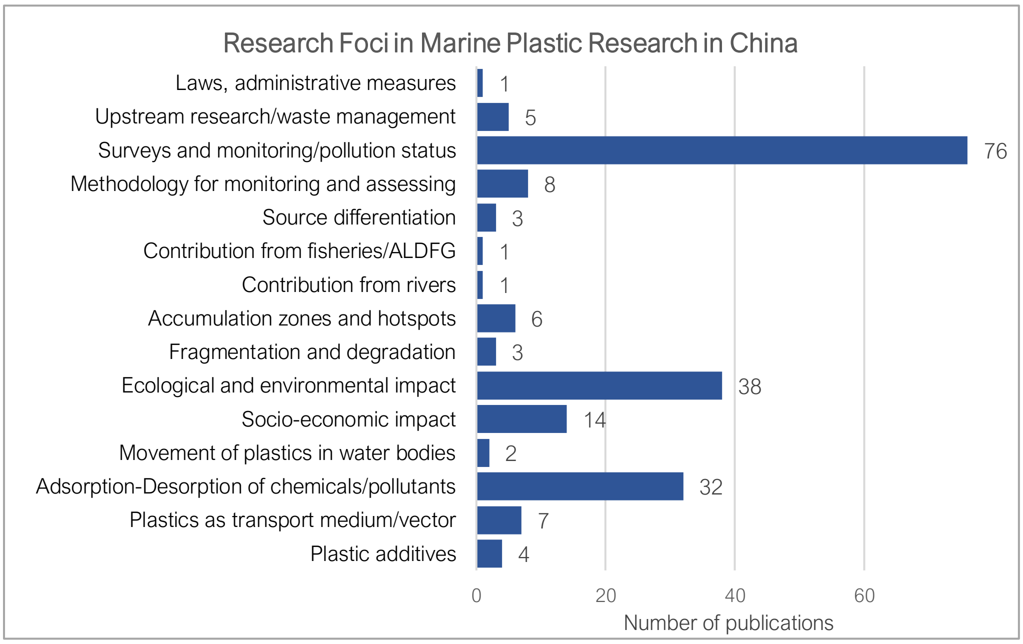



Figure 1.2.11.1. Research foci of marine plastic research conducted in China.

### 11.2.2 Types of research conducted

*Types of plastics research foci*

Of the 129 studies examined, microplastics appear to be of greatest concern with the highest number of published articles (n=113). By contrast, only four articles are solely focused on macroplastics and 11 studies examined both macro- and microplastics.

Articles concerning microplastics focused mostly on surveying and monitoring presence, abundance, and polymer types in various marine environs. Other articles focused on plastic litter as a pathway or vector for contaminants and its related sorption mechanisms, on hydrodynamic modelling of movement microplastic debris and on originating sources based on different hypotheses (i.e. personal care products).

There have been some attempts to examine polymer-specific plastic contaminants, both as plastic additives and non-additives (i.e. sorbed contaminants), mostly done in a laboratory setting. The polymers selected in these studies were those that can be found on some of the polymers already observed in the natural environment.

*Coverage of marine environs*

There is a balanced number of studies in the four marine environs (Figure 1.2.11.3), with a greater emphasis on sea surface waters (n=44) and in selected marine biota (n=44), followed by the shoreline (n=30) and finally, the surface and subsurface sediments of the seafloor (n=23).

Of note, there were a number of studies realised in laboratory settings that focused on potential mechanisms of impacts, movement or pathways of microplastics in the natural environment.

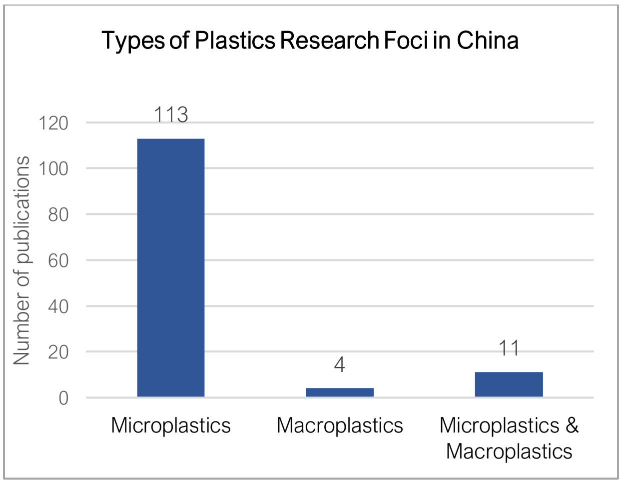



Figure 1.2.11.2. Distribution of marine micro-/macro-plastics researched in China.

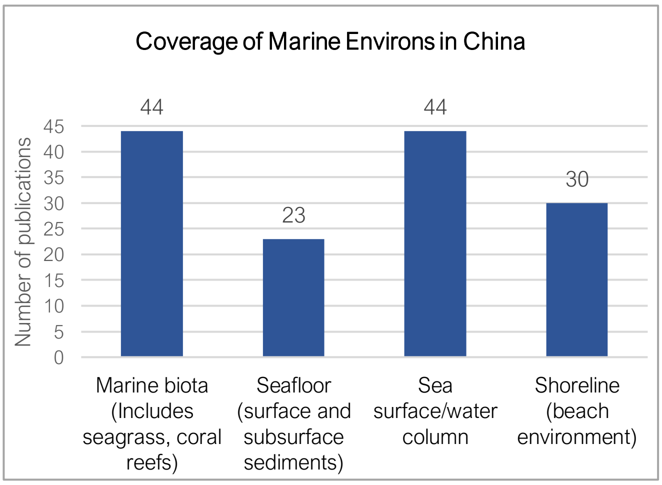



Figure 1.2.11.3. Distribution of marine environs researched in China.

Of the studies in sea surface waters, 22 papers were surveys in near-shore environments, 11 papers were in open seas, while the remainder were general literature reviews. None of the papers sampled from deeper sections of the water column.

With respect to the 44 papers on plastics in marine biota, 12 focused on surveying the presence/ absence of plastics in commercial species and 10 were laboratory based.

Of the 30 papers on shoreline, 20 were surveys of different habitats: mangroves, mudflats, sandy beaches as well as papers on multiple habitats.

Of the 23 papers on seafloor environs, 13 were monitoring surveys and the remainder were general literature reviews or methodology papers. Nine survey and monitoring papers examined near-coastal benthic sediments within estuaries or bays, while four papers examined sediments in deeper waters, in the Yellow Sea and in the East China Sea.

Three recent papers deserve particular attention. One paper assessed sorption mechanisms of antibiotics on microplastics collected from sediments (Guo & Wang, 2019) and two papers assessed pollutants such as hydrophobic compounds (Lo et al., 2019) and heavy metals (Mohsen et al., 2019) carried by microplastics found in sediments.

### 11.2.3 Survey and monitoring

Surveying and monitoring counted for more than half of marine plastic research in China with a focus on microplastics and in various marine environs, reporting the extent of plastic contamination.

*Microplastics*

Microplastics are found to be prevalent in a wide array of environments although the distribution and reported abundance is varied. In addition to the four environs focused on for this study, other studies focused on other commercial food items such as common table salt (Yang et al., 2015).

Some studies have focused on presence/absence and quantification of microplastics in marine biota. These include marine biota in the wild (Chan et al., 2015; Ding et al., 2019; Jabeen et al., 2017; Li et al., 2015, 2016, 2018; Su et al., 2019; Sun et al., 2017, 2019; Zhang et al., 2019), farmed marine biota (Feng et al., 2019; Teng et al., 2015; Wang et al., 2018, 2019), and those in both wild and farmed conditions (Cheung et al., 2018). One study conducted by Zhu et al. (2019) examined deep-sea fish from depths of 200 to 209 m and 453 to 478 m and reported a uniformity of microplastics ingestion in fish collected from different depths. The dominant microplastics found were of cellophanes in film structures. The contamination of microplastics however, were examined to be seemingly low.

Quantification of microplastic in the three abiotic marine environments was also conducted. Most of the studies examined microplastics in the sea surface or water column (Cai et al., 2018; Cheung et al., 2018; Cheung & Fok, 2016; Huang et al., 2019; Li et al., 2018; Luo et al., 2019; Mai et al., 2018; Pan et al., 2019; So et al., 2018; Wang et al., 2019; Xu et al., 2018; Yan et al., 2019; Zhang et al., 2019; Zhao et al., 2015). Microplastics on the shoreline was also an area of interest where there was surveying in different ecological habitats. These ecological habitats include those of coastal beaches (Cheung et al., 2016; Fok et al., 2017; Fok & Cheung, 2015; Qiu et al., 2015; Yu et al., 2016; Zhou et al., 2015, 2018; Zhang et al., 2015), mangrove ecosystems (Li et al., 2019) and saltmarshes (Yao et al., 2019). A mix of different ecological habitats on the shoreline has also been examined in several studies (Lo et al., 2018; Li et al., 2018; Zhou et al., 2016).

Surface and subsurface sediments of the seafloor were less studied but still common in several studies (Cheang et al., 2018; Peng et al., 2017; Zhao et al., 2018; Zhang et al., 2019). In a number of studies, microplastic quantification was not done in a single isolated environment but as a combination (Chen et al., 2019; Ho & Not, 2019; Tsang et al., 2017; Wang et al., 2018; Zhu et al., 2018; Zheng et al., 2019).

In attempts to draw meaningful comparisons of microplastic contamination in marine biota with the surrounding abiotic environments, some studies quantified microplastics in both marine biota and the physical environment (Ding et al., 2019; Mohsen et al., 2019; Nie et al., 2019; Sun et al., 2018; Qu et al., 2018; Wang et al., 2019; Zhu et al., 2019).

Microplastics in these studies, where defined, were generally denoted as being <5 mm, with some studies showing a further classification into finer size classes. There is a good proportion (92%) of studies that further examined plastics into its specific polymer types. Microplastics found in the natural environment appears to be commonly of polymer types PE, PP, PS, PET and PVC as well as less commonly found polymers such as PA, LDPE, CP and nylon. The majority of studies (94%) also identified the morphology of microplastics sampled, and most commonly found fibres, fragments, and films.

The reported quantification from these studies were often in a diversity of units but may be comparable when converted to the same standard (with the caveat that different methodologies can lead to less comparable results):

- In marine biota studies, microplastics examined are from various body parts of marine biota (e.g. entire gastrointestinal tract, stomach, intestines, gills, liver, muscles, etc.) and are generally measured for abundance (number of items per individual; gram of tissue wet weight; gill).
- In sea water and surface columns, microplastics could be examined from different depths or volume and were mostly measurement of abundance (number of items per $m^3$; $100m^3$; $km^2$; litre).
- On the shoreline and along the seafloor, microplastics could be examined from different ecological habitats and niches, and were measured for abundance in terms of number of items (per kg dry sediment; 50g dry sediment; 100g dry sediment; kg sediment; kg sand; $m^2$; $m^3$) and in weight or volume (g or mg per $m^2$; $m^3$; $100m^3$).

Much of the research was conducted at relatively high levels of technology. Spectroscopy techniques were used in the majority of survey and monitoring papers to analyse polymers sampled, and several additionally used SEM to describe the surface morphology of weathered microplastics sampled.

*Macroplastics*

There was only one surveying attempt on macroplastics in Zhou et al. (2016). In this research, the team examined macroplastic debris on 23 sites on beaches of coastal mainland China and in their adjacent waters). They reported that plastic was the most common debris type.

### 11.2.4 Source differentiation and pathways

Many papers which surveyed marine plastic debris in the natural environment suggested mariculture and industrial activities as likely sources. Several studies conducted in Hong Kong and Guangzhou suggested that the Pearl River was a major contributor to marine plastic debris in the area (e.g. Fok & Cheung, 2015, Li et al., 2018), while a later paper refuted this suggestion (Cheung et al., 2018; notably by the same authors who first suggested that the Pearl River was a major source of marine debris).

However, few papers aimed to directly identify the sources of marine plastic debris. Cheung & Fok (2016) and So et al. (2018) both investigated microbeads that had been sampled from coastal waters around Hong Kong and found their appearance and composition had matched those found in cosmetic products sold in Hong Kong.

A 2019 study by Wang et al. explored the possibility of typhoons as a major factor influencing an increase in marine plastic following high rainfall run-off. It discussed the role of infrequent natural phenomena in the pathways of microplastic distribution.

In the context of plastic as a pathway for pollutants other than plastics polymers, its associated contaminants (either plastic additives or other potential pollutants that are sorbed on the plastics), are important in understanding pollution from marine plastics. China has shown notable research interest on this topic of plastic as a pathway. Most of these studies examined the sorption mechanism and behaviours of contaminants to specific plastic polymers in laboratory settings (n=32). There were also studies examining the toxicity impacts of selected polymers on certain marine biota (n=4) and the potential of plastic as a transport vector of contaminants in the natural environment (n=3). Specific polymers used in these studies notably coincided with those found in the natural environment as previously mentioned. Contaminants that have been studied include various organic pollutants of antibiotics, lubricating oil, organic filters, polyhalogenated carbazoles, phthalate esters, BFRs, PAHs, OCPs, OPEs, BPAs, and HBCDD. Several studies also examined inorganic heavy metals including those of lead, copper, cadmium, strontium, zinc, manganese, chromium, nickel and arsenic.

### 11.2.5 Movement of plastics, accumulation and hotspots

There is little research studying movement of plastics in the marine environment except in literature reviews (Wang et al., 2016 and Zhang 2017). Zhang (2017) provides an in-depth literature review discussing processes of behaviour of plastic particles and challenges encountered in its study. Some surveys also discuss distribution and areas of accumulation of higher concentration (e.g. in saltmarsh, Yao et al., 2019).

### 11.2.6 Ecological and environmental impacts

There is a strong and diverse research interest in the environmental impacts of marine plastic pollution. 26 articles discuss studies of *in situ* uptake of microplastic in marine organisms, predominantly in fish (Cong et al., 2019, Chan et al., 2019, Nie et al., 2019; Su et al., 2019; Sun et al., 2019; Zhang et al., 2019; Zhu et al., 2019a) and bivalves (Luo et al., 2019; Li et al., 2018; Li et al., 2016; Li et al., 2015), as well as marine mammals (Xiong et al., 2018, Zhu et al., 2019b), seabirds (Zhu et al., 2019c), zooplankton (Sun et al., 2017, Sun et al., 2018), and less commonly studied taxa such as sea cucumbers (Mohsen et al., 2019), starfish (Wang et al., 2019), jellyfish (Sun et al., 2017) and crustaceans (Zhang et al., 2019). 12 of these studies were conducted on commercial species, either farmed or caught in mariculture areas.

These papers were able to use advanced methods of spectroscopy to characterise and identify the polymers found, primarily FTIR spectroscopy. A few papers used Raman spectroscopy, infrared spectroscopy, or even scanning electron microscopy. They tended to find fragments and fibres, consisting of a wide variety of polymers such as PP, PE, PVC, PET, polyester, nylon, and more. Units were typically expressed in item counts, though they were split in whether individuals or tissue wet weight were used. Notably, two papers (Su et al., 2019, Zhang et al., 2019) specifically examined microplastic in fish gills in addition to their digestive tracts, which was not investigated in papers from any other country in the region which typically either did not distinguish between organs or sampled only the digestive tract.

There are no papers quantifying macroplastic ingestion, or entanglement records.

China leads the region in laboratory studies investigating the physio-chemical impacts of plastic exposure to marine organisms (n=12). These studies span diverse taxa, such as marine microalgae, bivalves, polychaetes, and fishes, and primarily focus on effects such as mortality, development, and reproduction. Both direct ingestion and exposure to plastic leachates were investigated, originating from different polymers, including PS, PE, PP, and PVC, though most studies focused on the effects of one type among these.

Zhang et al. (2019) suggested that trophic transfer of plastic debris occurs in the wild, finding a correlation between higher microplastic abundance and species of a higher trophic level. However, this paper compared microplastics per individual and did not consider the influence of size and varying food intake rates. More research is needed for understanding trophic transfer of plastic in the wild.

#### 11.2.7 ALDFG

There is only one published peer-reviewed study on ALDFG. Chen et al. (2018) quantified microplastics in the surface waters, intertidal sediments, and benthic sediments of Xiangshan Bay, Zhejiang, while attempting to distinguish their likely sources based on polymer types. The most common polymers found were PE, synthetic cellulose, and PP. They estimated that about 55.7% of seawater microplastics and 36.8% of sediment microplastics originated from mariculture activities.

#### 11.2.8 Social perceptions and socio-economic impacts

There were no peer-reviewed studies published by Chinese authors which directly studied social perceptions regarding plastic pollution, or economic and monetary impacts.

However, there is a strong interest in the potential impact of microplastics on human health and food safety in China (n=13). Microplastics have been quantified in seafood either obtained from fish markets or caught from mariculture areas, primarily fishes (n=7 papers) and bivalves (n=6 papers), with one paper on sea cucumbers (Mohsen et al. 2019). All the papers found microplastic fibres and fragments in at least half of their samples. The most commonly found polymers were PE, PET, and cellophane, and some papers also mentioned high levels of PVC, PP, and rayon. In addition, Yang et al. (2015) measured microplastics in commercial table salt sold in China, which was among the first papers to look for microplastics in a sea-derived, non-biotic product. They found abundant levels of microplastics in all brands of salt they had sampled, particularly in sea salts, with the most common polymers being PET and PE fragments and fibres.

Brook et al. (2018) investigated the impact of China's ban on the import of plastic waste on the displacement of the plastic waste trade, and described current global patterns of the plastic scrap and waste trade. They estimated that about 111 million metric tons of plastic waste would be displaced by 2030 due to China's import ban.

### 11.3 Main players in marine plastic research

Majority of authors are local researchers working in Chinese research institutions, with 3 papers headed or co-authored by researchers from the United States. Many institutes are involved in marine plastic pollution research, mainly from coastal areas.


Figure 1.2.11.4. Composition of research efforts in China.

Across over a hundred different institutions, the most prolific include East China Normal University (ECNU), the Chinese Academy of Sciences (Yantai, Qingdao, Wuhan, Guangzhou), the University of the Chinese Academy of Sciences, Qingdao National Laboratory for Marine Science and Technology, Xiamen University, the Education University of Hong Kong, and the University of Hong Kong.

Out of over 80 corresponding authors on these papers, two researchers stand out as particularly prolific. Lincoln Fok, from the Education University of Hong Kong, has conducted many surveys on plastic pollution around Hong Kong. Huahong Shi, from East China Normal University, has an interest in surveying plastic pollution and ingestion in wild marine organisms.

### 11.4 Summary of understanding

China leads the region in terms of number of research papers on marine plastics, focused on a few key topics of interest. There is a particular emphasis on monitoring surveys, spanning all marine environs and a variety of different habitat types, from sandy beaches to mangroves, from estuarine waters to coral reefs, including less frequently studied habitats such as the deep ocean floor. However, there is still a lack of standardised protocols for detection, sampling and extraction of plastics. The plastic classification system proposed by Wang et al. (2019) may be useful on this path of harmonisation and consistency in preferred sampling protocols for different environs, polymers and/or their associated contaminants.

There is also a strong interest in understanding ecological and environmental impacts, partly on human health, including through the monitoring of absorption of plastics by selected species used as indicators or proxies, as well as the interactions of microplastics with other pollutants through understanding the sorption dynamics of a wide variety of chemicals on microplastics.

All these studies are overwhelmingly focused on microplastics, with extremely little discussion of macroplastics (from which microplastics may originate) and sources. In particular, despite the importance of the mariculture industry highlighted in the human health/food safety papers, there is little focus on ALDFG and its impacts on the environment, or entanglement of fishing gear in marine biota. Understanding the presence and effect of macroplastics, in conjunction with the advanced technological expertise present in many papers, would lend well to more in-depth analyses on fragmentation and weathering processes from macro- to micro- or even nano-plastics.

There is little research outside of a few focal topics, though there is likely an existing interest in advancement into other topics. While many studies are clustered around major rivers (e.g. Pearl River, Yellow River), riverine contributions are not often quantified beyond a general influence. Given the large volume of data on the pollution status of marine debris in China, it would be highly advantageous to employ modelling of plastic transport and more in-depth investigation into accumulation areas and hotspots in the region, as well as source differentiation.

The status of marine plastic pollution research conducted in China is voluminous, with involvement from a large number of institutions and diverse research groups. Much of the research is conducted at relatively high levels of technology, particularly evident in the frequent use of spectroscopy in pollution surveys and in understanding sorption dynamics of specific chemicals. This high level of interest and technological ability place research in this region in an advantageous position to broaden the scope of study and deepen the understanding of the effects of plastic pollution on the marine environment, wildlife, and human society in a global context.

# 12. JAPAN

***Summary of research topics:*** *Japan's research effort on marine plastics is notable for its early start in 2001 and its breadth across research topics covering most aspects of pollution by plastics. Some of the research requires a more technical understanding and advanced research material (i.e. plastic as a transport vector, and plastic adsorption/desorption experiments). All environs are also being investigated, including a few studies on the deep seafloor and deep-sea organisms. More than half of the articles published seek to quantify the presence and abundance of marine plastic debris. The second most common research focus is ecological and environmental impacts, with a primary interest in ingestion of macro- and microplastics by various marine life, including seabirds, fish, and shellfish.*

***Summary of understanding at national level:*** *For most of the microplastics studies published, the studies distinguish the types of plastic polymers and the shapes of plastics (i.e. fragments, microbeads, pellets, etc.), as well as specific ecological and environmental impacts. However, there is limited polymer-specific research investigating the extent of polymer-types fragmentation and degradation in the marine environment. Nearly one-third of the papers focus on marine plastics as a pathway for pollution by other organic substances or by inorganic contaminants (e.g. POPs and heavy metals). Dominant sources of marine plastics appear to be ALDFGs, rivers, land runoffs and untreated sewers. Other sources mentioned are the unintentional release to the environment of resin pellets during manufacturing and transport, as well as plastic fragments from nearby large ocean basins. No investigation on plastic transfer through the food chain has been found, nor article on the physical impacts of macroplastics on marine life such as endangered migratory species (e.g. whales, sea turtles and seabirds).*

***Keywords/research fields:*** *National approach; solid waste; trade of plastic waste; research foci; marine environs; laws and administrative measures; public outreach; beach clean-up; waste management; surveys and monitoring; methodology for the monitoring and assessment of marine litter; source differentiation; contribution from fisheries; ALDFG; contribution from rivers; accumulation zones; hotspots; fragmentation and degradation; ecological and environmental impact; movement of plastics; adsorption-desorption of contaminants; organic contaminants; inorganic contaminants; plastics as transport vector; plastic additives; main players*

## 12.1 Context

### 12.1.1 National approach to plastic waste and its management

Japan has adopted a Packaging Waste Recycling Act (covering PET since 1997, and others since 2000), and promotes domestic packaging waste recycling to reduce the burden of waste disposal of municipalities (Terazono, 2019).

In addition, there are strict plastic separation regulations for households, as well as a good plastic collection system in place at the national level. The Plastic Waste Management Institute (PWMI), originally founded in 1971, now has the objective of surveying and researching the recycling of plastic waste and helping plastic-related industries expand their business soundly in Japan (PWMI, 2019: available https://www.pwmi.or.jp/ei/about.pdf).

Based on studies from PWMI Japan, the country has good recycling capabilities, with a high 86% plastic 'recycling' rate in 2017 (PWMI Japan, 2019; Figure 1.2.13.1). Approximately 58% would be credited to incinerated plastic through 'thermal recycling' to recover energy, while the remaining 28% is equally split between actual plastic recycling within the country, and exported plastic waste to other countries, respectively.

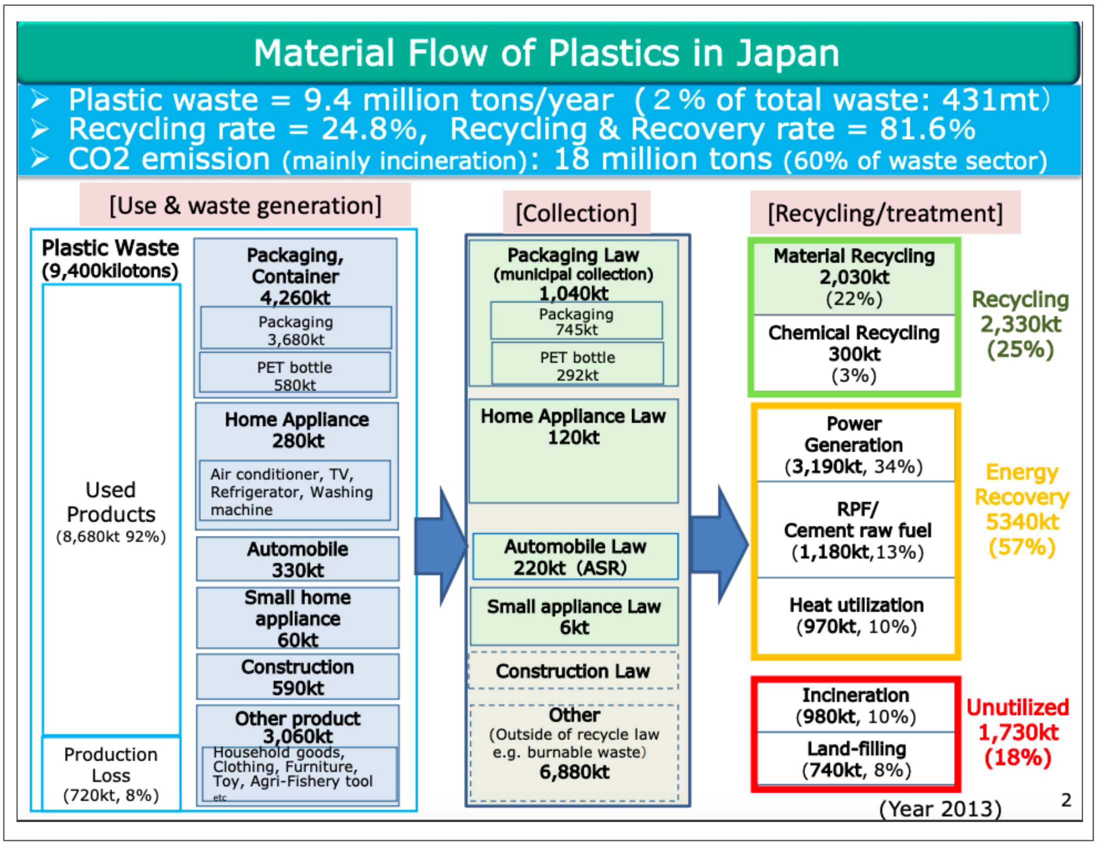



Figure 1.2.13.1. Plastic resource flow in Japan (source: Ministry of the Environment, Japan).

In June 2018, the Ministry of the Environment considered a plastic resource recycling strategy due to interest in marine plastics (Terazono, 2019). The 'Plastic Resources Circular Strategy (Draft)' was adapted in March 2019 and submitted to the Minister of the Environment. The current strategy proposes '3R + Renewable' as a basic principle. Specifically, restrictions on use (Reduce), thorough separation and recycling (Recycle), bioplastics introduction, marine plastic countermeasures, etc. are included. Japan also has various regulations in place, such as the Containers and Packaging Recycling Law which adopts concepts of EPR to hold businesses responsible for their plastic usage. However, a challenge for Japan appears to be the existing long-term emphasis on waste incineration and energy recovery, with limited demand for recycled plastics.

On reducing plastic waste, Japan targets to reduce single-use plastic by 25% by 2030. At the recent G20 Osaka Summit meeting, Japan launched the 'Osaka Blue Ocean Vision' (available: https://www.mofa.go.jp/files/000493728.pdf), which aims to reduce additional pollution by marine plastic litter to zero by 2050.

In November 2019, a joint-panel of Japan's industry and environment ministries agreed to require all retailers nation-wide to place charges on plastic bags, regardless of sizes, in effect from July 2020 (Channels News Asia, 2019: available https://www.channelnewsasia.com/news/asia/japan-retailers-charge-plastic-bags-2020-12055412) . This move was said to be a leading step to the then-upcoming 2020 Tokyo Olympics and Paralympics (before the onset of the COVID-19 pandemic), which had undertaken the UN Sports for Climate Action framework pledge (https://www.olympic.org/news/tokyo-2020-sustainable-games-for-a-sustainable-society).

### 12.1.2 Plastics as a proportion of solid waste

In 2016, the MSW (excluding disaster waste such as debris from the tsunami) was estimated at 44.6 million tonnes, and with a projection of reaching 45 million tonnes in 2030, but with a decline to 43.3 million tonnes in 2050 as population declines (Kaza et al., 2018).

Reports emphasise an obsession of Japanese people with hygiene and their pride in 'omotenashi' or customer service, which would dictate that everything should be wrapped with multiple layers of plastic packaging. It was estimated that every person in Japan uses around 300 or 400 plastic bags annually, which is equivalent to more than 40 billion for the entire nation. (Washington Post, 2019, available: https://www.washingtonpost.com/world/asia_pacific/japan-wraps-everything-in-plastic-now-it-wants-to-fight-against-plastic-pollution/2019/06/18/463fa73c-7298-11e9-9331-30bc5836f48e_story.html).

By contrast, the government reports very high recycling rates. Estimates from 1986 indicate that plastics accounted for 7% to 20% of total solid waste across the various major cities in Japan (Sakai, 1996). A more recent estimate by Jambeck et al. (2015) suggests that the national average for Japan would be 10%, and interestingly, 0% of mismanaged waste.

However, Harada (2015) surmised that several major rivers in Japan are sinks of marine litter. For instance, the Kansai Wide Area Union estimated about 3 million plastic bags and 6.1 million plastic pieces on the seafloor of Osaka Bay, suggesting possible leakages into river systems (The Sankei News, 2019: available https://www.sankei.com/west/news/190612/wst1906120024-n1.html).

### 12.1.3 Illegal trade of plastic waste

Prior to the 2018 China ban on imported plastic waste, Japan was exporting up to 1.5 million tonnes of plastic waste into China annually. Following the ban, Japan redirected its plastic waste to alternative countries in the Southeast Asia region (Greenpeace, 2019). Specifically, Japan redirected its plastic waste primarily to Malaysia, Thailand and Vietnam, and sent much smaller shipments to Myanmar, the Philippines, Singapore, Lao PDR, and Cambodia (Trademap, 2019 from Greenpeace, 2019). In 2018 alone, Japan exported 430,064 tonnes to ASEAN, making it one of the top exporters of plastic waste in this region.

## 12.2 Research review of pollution from marine plastic

### 12.2.1 Research overview

Research on marine plastics in Japan is in progress, with a moderate number of published peer-reviewed articles (n=30). Although the number of publications may not be comparable to that of some countries reviewed here (e.g. China, Indonesia, the RO KOREA and Malaysia), there is a high level of awareness of marine plastics among the scientific community, with notable researchers leading scientific research.

A non-academic association, the Plastic Waste Management Institute (PWMI) Japan was founded in December 1971 to oversee research and develop technology for the optimal processing and effective use of plastic waste, as well as to publicise their findings. More recently, PWMI's objectives were newly re-established in April 2013 as "surveying and researching the recycling of plastic waste and contributing to a reduction in environmental load by the total recycling of plastic, and helping plastic-related industries to expand their business soundly and contributing to the creation of a society capable of sustainable growth." Two publications are available in English: An Introduction to Plastic Recycling 2016 (https://www.pwmi.or.jp/ei/plastic_recycling_2016.pdf) and Plastic Products, Plastic Waste and Resource Recovery 2017 (https://www.pwmi.or.jp/ei/siryo/ei/ei_pdf/ei48.pdf).

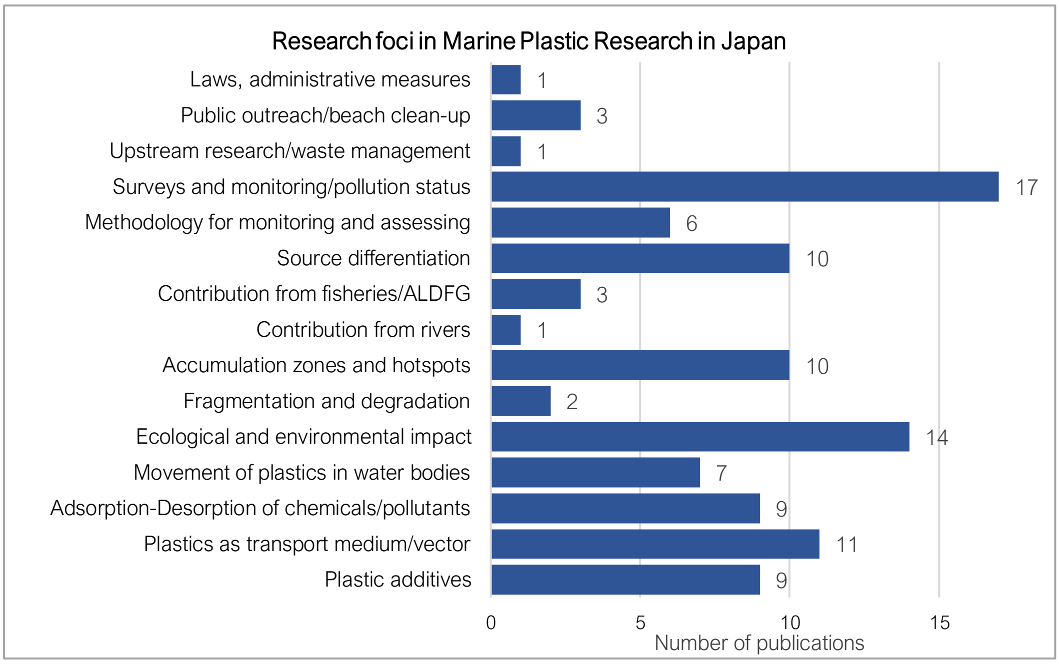



Figure 1.2.12.2. Research foci of marine plastic research conducted in Japan.

The 30 studies reviewed were conducted in different decades; three studies in 2001, 2003, and 2005 respectively, and 27 studies between 2011 and 2019, which geographically cover the entire shoreline of island Japan. No studies have been found for the Ryukyu Archipelago (Okinawa), south of the main island.

In 2019 alone, seven studies were published, the highest yearly count. This suggests an increased interest in the field of marine plastics. In general, these studies cover a wide range of research topics and provide useful insights to various issues surrounding marine plastics in Japan.

Looking at the research foci in more detail (Figure 1.2.12.2), Japan research efforts show a balanced interest in nine research foci. The majority of studies focus on survey and monitoring to understand pollution status (n=17), followed by ecological and environmental impact (n=14), plastics as transport vector (n=11), source differentiation (n=10) and accumulation zones and hotspots (n=10). Other major interests include the adsorption-desorption of chemicals and pollutants by plastic debris, and the impacts and interactions of plastic additives with plastic debris.

### 12.2.2 Types of research conducted

*Types of plastics research foci*

Studies examining microplastics focus either on their presence/absence in marine biota (Tanaka and Takada, 2016; Jamieson et al., 2019) or in coastal environs such as sediments (Matsuguma et al., 2017) or coastal waters (Hirai et al., 2011; Isobe et al., 2014, 2015; Isobe, 2016; Sagawa et al., 2018); on hydrodynamic modelling of how microplastics move with ocean currents (Iwasaki et al., 2017; Isobe et al., 2019; Amamiya et al., 2019); or on contamination of microplastics with other pollutants (Mato et al., 2011; Hirai et al., 2011), typically associated with marine biota such as seabirds (Yamashita et al., 2011; Tanaka et al., 2013, 2015, 2019) and mussels (Endo et al., 2005). There was also an experimental study that looked at the ingestion and egestion of size-dependent microplastics by mussels (Kinjo et al., 2019).

Macroplastics studies also focus on different research areas, which include abundance surveys (Kusui and Noda, 2003; Goto and Shibata, 2015; Chiba et al., 2018); heavy metal contamination of macro-debris (Yamashita et al., 2011; Nakashima et al., 2012; Tanaka et al., 2013, 2015; Nakashima et al., 2016); methods to detect and quantify macroplastic debris (Kako et al., 2011; Kataoka et al., 2012, 2013); hydrodynamic modelling of how macroplastics move with ocean currents (Isobe et al., 2014; Kataoka et al., 2015; Kataoka and Hinata, 2015; Maximenko et al., 2018); and policy regarding plastic waste management (Terazono, 2019). Apart from PVC (Nakashima et al., 2012, 2016), no other polymer type was identified for the macroplastic studies.

Studies that look at both micro- and macro-plastics can be divided into two groups: one that looks at impacts of contaminated (PCB and PBDE) plastics on seabirds (Yamashita et al., 2011; Tanaka et al., 2013, 2015), and the other that looks at survey and transport of plastics in coastal waters (Isobe et al., 2014, 2015; Iwasaki et al., 2017).

*Coverage of marine environs*

Of the 30 studies examined (Figure 1.2.13.4), the shoreline environment appears to have benefited from the most attention (Mato et al., 2001; Kusui and Noda, 2003; Endo et al., 2005; Hirai et al., 2011; Kako et al., 2011; Nakashima et al., 2012; Kataoka et al., 2012, 2013, 2015; Kataoka and Hinata, 2015; Sagawa et al., 2018; Amamiya et al., 2019). This is followed by coastal waters (Hirai et al., 2011; Isobe et al., 2014, 2015, 2016; Nakashima et al., 2016; Iwasaki et al., 2017; Sagawa et al., 2018; Maximenko et al., 2018; Isobe et al., 2019; Amamiya et al., 2019).

The other studies examined impacts of marine plastics on marine organisms, such as Japanese anchovy (*Engraulis japonicus*) (Tanaka and Takada, 2016), Mediterranean mussel (*Mytilus* *galloprovincialis*) (Endo et al., 2005; Kinjo et al., 2019), few species of seabirds (Yamashita et al., 2011; Tanaka et al., 2013, 2015, 2019), and deep sea Lysianassoidea amphipods (Jamieson et al., 2019). Few studies have examined the occurrence of macroplastics in sediment cores (Matsuguma et al., 2017) and on or in the deep seabed (Goto and Shibata, 2015; Chiba et al., 2018).

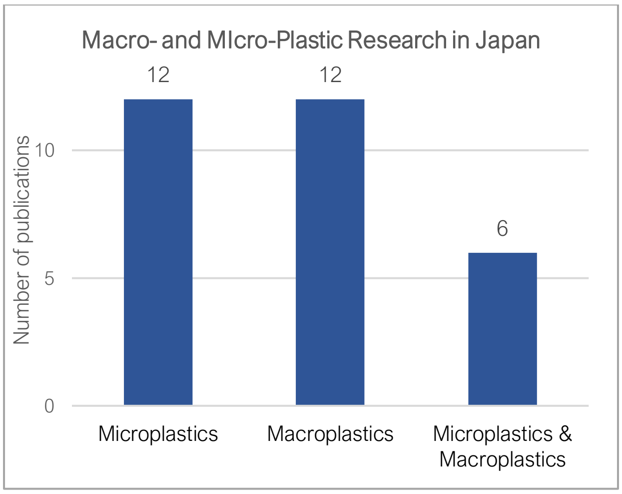



Figure 1.2.12.3. Marine micro-/macro-plastics researched in marine plastic research in Japan.

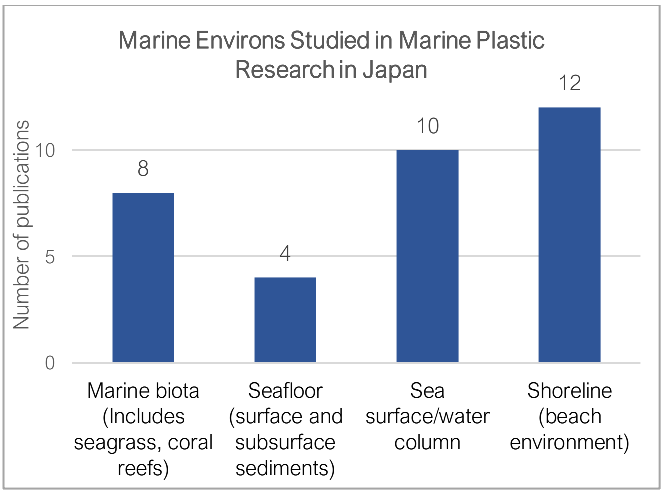



Figure 1.2.12.4. Distribution of marine environs researched in Japan.

## 12.2.3 Survey and monitoring

More than half of the published articles conducted surveys and monitoring in various marine environs, but the methods used to study distribution and abundance are varied. Some studies attempted to quantify marine plastics in beaches (Kusui and Noda, 2003; Isobe et al., 2015), the deep-sea (Goto and Shibata, 2015; Chiba et al., 2018), sediment cores (Matsuguma et al., 2017), and coastal waters (Isobe, 2016). A paper by Sagawa et al. (2018) also examined microplastics in three areas: bottom sediments, beach sediments, surface waters.

With respect to marine biota, one paper focused on the presence/absence of plastics in seabirds (Yamashita et al., 2011; Tanaka et al., 2013, 2015, 2019) and another on Japanese anchovy (Tanaka and Takada, 2016). These studies typically quantified the abundance of plastics relative to an individual, for instance, the number of plastic fragments ingested per individual or total number of plastic fragments found in sampled individuals. Most of these studies identified the types of plastic polymers, such as PE, PP, PS. Generally, these studies sought to quantify abundance of plastics based on counts (e.g. number of litter items, concentration of litter in items per $100m_2$, weight of debris, number of plastic pieces per kg).

Most of the studies also examined the types of microplastic polymers, and the types of macroplastics (e.g. fishing gear, household items, metals, glass, wood). Studies of microplastics mostly adhered to the definition of size <5 mm, and they also reported the shapes of microplastics (such as fibre, fragment, granule, film, foam, pellet). Among the microplastic studies conducted, the following plastic polymer types were identified: FPS, EVA, PE, PA, PP, PS, PEP, PET, PAK, PVA, PVC, PCL, PMMA, PEPD (Tanaka and Takada, 2016; Matsuguma et al., 2017; Sagawa et al., 2018; Tanaka et al., 2019; Amamiya et al., 2019; Jamieson et al., 2019).

New techniques were also being developed to assess distribution and quantity of marine plastic debris on beaches (Kataoka et al., 2012) and in the ocean (Isobe et al., 2014) on a large scale and with less human resources. Kataoka et al. (2012) also developed a technique to detect pixels of plastic debris monitored through time-series images, thus allowing users to compute the amount of beached plastic debris, and to remotely monitor the amount of plastic debris. Isobe et al. (2014) assessed the occurrence of small plastic fragments using field surveys and numerical particle-tracking model (i.e. hydrodynamic modelling) to understand plastics accumulation.

Other authors have surveyed the presence of toxic chemicals (Mato et al., 2001; Hirai et al., 2011; Yamashita et al., 2011; Tanaka et al., 2013, 2015, 2019) or heavy metals (Nakashima et al., 2012) on plastic debris, either on micro- or macroplastics.

### 12.2.4 Source differentiation and pathways

A substantial number of papers (n=10) examine or mention potential sources of plastics to the oceans. A dominant source of marine plastics in Japan's coastal waters appears to be derived from offshore fisheries and (derelict) fishing gear (Isobe et al., 2014; Goto and Shibata, 2015; Nakashima et al., 2016; Sagawa et al., 2018). The next common source would be derived from rivers (Isobe et al., 2014), land runoffs (Amamiya et al., 2019), and untreated sewers (Isobe, 2016; Tanaka and Takada, 2016).

Several papers also referred to the March 2011 Tohoku Earthquake and the large quantity of anthropogenic debris that seemed to have been transported by the tsunami into the ocean (Goto and Shibata, 2015; Maximenko et al., 2018). Other sources mentioned are the unintentional release to the environment of resin pellets during manufacturing and transport (Mato et al., 2001) as well as plastic fragments from nearby large ocean basins (i.e. Yellow Sea and East China Sea) that would contribute to marine plastics found in coastal waters of Japan (Isobe et al., 2015).

Notably, some papers were concerned with the adsorption-desorption of organic and inorganic contaminants associated with marine plastic debris whether as plastic additives or otherwise. For example, PP resin pellets were found to contain significant concentrations of PCBs and DDE (Mato et al., 2001; Endo et al., 2005), while plastic fragments may have had PCBs, PAHs, DDTs, PBDEs, NP, and BPA (Hirai et al., 2011). As demonstrated further in studies, these contaminated particles became potential vectors of chemicals and pollutants when consumed by marine life such as seabirds (Yamashita et al., 2011; Tanaka et al., 2013, 2015, 2019).

### 12.2.5 Movement of plastics, accumulation and hotspots

Studies examining the movement of plastics, accumulation and hotspots can broadly be categorised into two groups. The first category focuses on the seaward transport of plastic debris from the shoreline (beach) and via different circulation models (Kako et al., 2011; Kataoka et al., 2013, 2015; Kataoka and Hinata, 2015). The second category focuses on transport of plastic debris within coastal waters via numerical and particle-tracking modelling that also use currents and wind data (Isobe et al., 2014, 2019; Iwasaki et al., 2017). In particular, Maximenko et al. (2018) used numerical simulations to investigate the movement of macro-debris derived from the Great Japan Tsunami 2011.

### 12.2.6 Ecological and environmental impacts

Studies that focused on ecological impacts include impacts on marine life via ingestion of plastic debris, with an apparent interest in seabirds (Endo et al., 2005; Yamashita et al., 2011; Tanaka et al., 2013, 2015, 2019). These studies on seabirds also discussed the uptake and possible transfer of contaminants (i.e. toxic chemicals and heavy metals) to the tissues of these seabirds. More recently, studies have examined the impacts of microplastics on fish (Tanaka and Takada, 2016) and invertebrates (Jamieson et al., 2019; Kinjo et al., 2019). Notably, the study by Jamieson et al (2029) was conducted in various marine environs, including the deep-sea.

With respect to environmental impacts, some studies briefly mentioned direct impacts on the environment, such as the way plastic debris affected the marine environment, but none in detail. Similarly, these studies were conducted in various marine environs, from the beach (Kako et al., 2011), sediment cores (Matsuguma et al., 2017), to deep-sea areas (Chiba et al., 2018).

Papers that looked at both ecological and environmental impacts only implyied potential risks to shorelines exposed to contaminated plastic debris (Mato et al., 2001; Hirai et al., 2011; Nakashima et al., 2012). They suggested that further studies are needed to characterise impacts.

Of note, no studies were found on the physical impacts of plastic debris on marine wildlife such as endangered migratory species known to come through Japan's EEZ, except for one study on the ingestion of PCB-contaminated plastic debris by seabirds (e.g. Tanaka et al., 2013, 2015, 2019).

### 12.2.7 ALDFG

Few papers (three out of 30) specifically mention impacts of ALDFG in Japan, despite being highlighted as a potential dominant marine plastic source in oceans (see Part 1, Section 13.2.4).

In particular, two papers noted the presence of derelict fishing gear in deep-sea areas (Goto and Shibata, 2015; Chiba et al., 2018). Goto and Shibata (2015) noted that a major source of sea-based debris found post-tsunami 2011 was fishing gear and related items from adjacent fishing grounds.

Chiba et al. (2018) also found that ALDFGs cause entanglement with several deep-sea organisms.

Another paper by Sagawa et al. (2018) documented an indirect impact of ALDFG, whereby the foamed polystyrene (FPS) derived from oyster culture had been found to break down into small FPS microplastics (i.e. using digital microscopy, field emission scanning electron microscopy (FE-SEM) and X-ray computed tomography (X-ray CT) to deduce sinking and fragmentation process). As a result, these FPS microplastics could be found in both beach and bottom sediments off Hiroshima Bay.

### 12.2.8 Social perceptions and socio-economic impacts

There is no published peer-reviewed study on social perceptions, but possibly these data and information may exist in the form of unpublished reports, or were published in Japanese.

A single study strongly implied the socio-economic impacts of marine plastic pollution on a commercially-valuable fish, the Japanese anchovy (*Engraulis* sp.). The species is widely distributed around Japan and is a common food in the country. The study finds that >70% of sampled fish contain microplastics. Typically eaten without removal of their digestive tracts, the presence of microplastics in the guts of this fish means that human consumers and predators of this fish (such as other fish, birds and marine mammals) are directly exposed to ingestion of marine plastics. This study also pointed out that consuming fish that ingested contaminated plastics from the marine environment may pose health risks.

## 12.3 Main players in marine plastic research

More than 90% of marine plastic research conducted in Japan is carried out by locally-based researchers (n=28), with one study led by an international institution from RO KOREA and another one from the UK (Figure 1.2.13.5). Several Japanese researchers appear to have taken the lead of marine plastics research over different research foci.

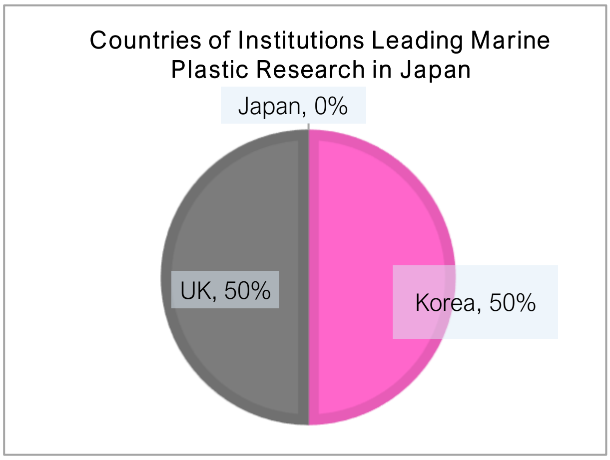



Figure 1.2.13.5. Composition of research efforts in Japan.

Takada, H. of Tokyo University of Agriculture and Technology has been conducting research since 2001 (Mato et al., 2001), with a specific focus on contaminants associated with marine plastic debris, particularly their impact on marine seabirds and other biota. Isobe, A. of Kyushu University also stands out as another lead researcher whose focus is on forecasting the quantity and movement of plastic debris around Japan waters. Other researchers, Hinata, A. of Ehime University and Kataoka, T. of the National Institute for Land and Infrastructure Management have worked closely together to examine accumulation zones and hotspots, and movement of plastics in water bodies.

## 12.4 Summary of understanding

Japan is an early pioneer in the publication of studies on the country's status of marine plastic pollution; the earliest article found was published in 2001. The interest of the scientific community has steadily increased since, with the highest number of articles found in 2019 alone. The research effort is also notable for its breadth across research topics covering most aspects of pollution by plastics. Some of this research requires a more technical understanding and advanced research material (i.e. plastic as a transport vector, and plastic adsorption/desorption experiments). All environs are also being investigated, including a few studies on the deep seafloor and deep-sea organisms – an environment not as well-studied in most other countries.

More than half of the articles published seek to quantify the presence and abundance of marine plastic debris. Across the studies, varied methodologies have been used in monitoring marine litter in marine biota and environments across Japan. This makes it difficult to do cross-comparisons. On closer examination, comparisons may be possible between studies conducted by the same researchers, as they attempt to streamline their protocols for their work (e.g. studies published by the team at Tokyo University of Agriculture and Technology).

For most of the microplastics studies published, papers distinguish the types of plastic polymers and the shapes of plastics (i.e. fragments, microbeads, pellets, etc.), as well as specific ecological and environmental impacts. However, there is limited polymer-specific research investigating the extent of polymer-types fragmentation and degradation in the marine environment. Of the studies examined for Japan, nearly one-third of them investigated how marine plastics can act as a pathway for pollution by other organic substances or by inorganic contaminants (e.g. POPs and heavy metals).

The second most common research focus is ecological and environmental impacts, with a primary interest in ingestion of macro- and microplastics by various marine life, including seabirds, fish, and shellfish. No investigation on plastic transfer through the food chain has been found so far. Interestingly, there is no peer-reviewed article on the physical impacts of macroplastics on marine life such as endangered migratory species (e.g. whales, sea turtles and seabirds).

Marine plastic research in Japan appears to be in at an advanced stage regionally, as studies are beginning to present evidence of a direct link between plastic pollution and marine wildlife health. The current research landscape also appears to be uniquely heterogenous, as overlaps in research interests seem to be minimal among lead researchers. As one of the leading countries in this research area in the region, it would be beneficial for Japanese researchers to engage the wider scientific community and conduct knowledge exchanges of their current techniques. In particular, some research groups have developed novel methodologies for monitoring and assessing marine litter more efficiently; these methodologies could be shared with the wider scientific community within the ASEAN+3 region.

Japan appears to have an elaborated regulation system in place for the management of public waste, including plastics. However, it seems that half of the reported (high) recycling rates goes to waste-to-energy incineration, and that plastic use remains very high within the country. Notably, there are articles suggesting pathways for the discharge of land-based plastic debris into the oceans via river systems. These pathways might be more numerous than what has been believed before.

There has been a conscious effort from the research community in Japan to investigate and differentiate sources and pathways of marine plastic debris, including offshore fisheries and derelict fishing gear, land-based sources (i.e. rivers, land runoffs, untreated sewers), and how marine plastics are transport vectors of chemicals and pollutants across the oceans. However, only a handful of articles have identified abandoned fishing gears and rivers as an important source of discharge of plastic waste at sea. More research in these two areas would therefore be useful.

## 13. RO KOREA

***Summary of research topics:*** *RO Korea has acknowledged issues linked to pollution from marine plastic and surveyed marine debris since the 1990s. However, scientific research papers on the topic were only published after 2000 and mostly since 2014. Early publications focused specifically on pollution from EPS (styrofoam) buoys used in mariculture. Studies from RO Korea covered the most number of research foci among the ASEAN+3 countries, and had the most balanced representation of different research foci. A majority of the papers examined (n=67) focused on surveys and monitoring to understand pollution status, followed by plastics as a transport vector, and other contaminants associated with marine plastics (especially HBCD and PCB). However, there is a lack of research and consistent methodology to survey macroplastics found in the water column, on or in the seabed and coastal environments other than sandy beaches (e.g. mudflats).*

***Summary of understanding at national level:*** *Plastic pollution research is concentrated mostly on sandy beaches and near-coastal sea surface, with a particular focus on the region of Geoje Island and the Nakdong River. Several surveys advance beyond inventorying and compare plastic abundances and composition within their environ, leading to a more specific understanding of the distribution and accumulation of plastic debris. ALDFGs are the subject of a number of papers which suggest that they represent a very substantial contribution of marine plastic debris. Another finding is that concentration in HBCD would be greater in sediments close to industrialised areas and EPS buoys (such as those used in aquaculture farms). Several articles highlighted a strong interest to and proposal for improving methodologies for sampling and research on marine plastics. Several papers stand out as they focused on marine plastic clean-up operations on the seabed and in the water column. However, they focus primarily on the cost-effectiveness of existing methods without an analysis of net ecological benefit or relative benefits of different removal methods.*

***Keywords/research fields:*** *National approach; solid waste; trade of plastic waste; research foci; marine environs; public outreach; beach clean-up; waste management; surveys and monitoring; methodology for the monitoring and assessment of marine litter; source differentiation; fibreglass-reinforced plastic vessels; contribution from fisheries; ALDFG; contribution from rivers; accumulation zones; hotspots; fragmentation and degradation; ecological and environmental impact; socio-economic impact; methodology for marine plastic clean-up; movement of plastics; social perceptions; adsorption-desorption of contaminants; organic contaminants; inorganic contaminants; plastics as transport vector; plastic additives; heavy metals; main players*

## 13.1 Context

### 13.1.1 National approach to plastic waste and its management

RO Korea has acknowledged issues linked to pollution from marine plastic for a number of years. The government has been surveying marine debris and developing strategies to combat them since the late 1990s, first under the Ministry of Maritime Affairs and Fisheries (MOMF), and now under the Ministry of Oceans and Fisheries (MOF). Multiple nationwide surveys to determine the extent of marine debris pollution have been conducted in 2002 (Cho, 2005), 2008-2009 (Hong et al., 2014), and 2015 (findings not found). Subsequent monitoring appears to have also been carried out, though the details were not found (MOF, 2018: available https://wedocs.unep.org/bitstream/handle/20.500.11822/26499/ML_Korea.pdf?sequence=1&isAllowed=y).

The Ministry of Environment has established a long-term master plan called the National Waste Comprehensive Management Plan (First: 1993–2001, Second: 2002–2011, Third: 2012–2021) (Cho, 2005), which requires land-based waste management systems. To tackle marine-based issues, MOF adopted the National Marine Litter Management Plan (First: 2009–2013, Second: 2014–2018, Third: 2019–2023). As part of the 2nd National Marine Litter Management Plan, KRW 331.9 billion (USD 280.2 million) have been spent on marine debris collection projects, the management of marine litter sources, and public awareness programmes. EPS buoy debris was among the key issues tackled in this programme (Lee et al., 2015). RO Korea is currently engaged in its 3rd National Marine Litter Management Plan (2019–2023) (MOF, 2019: available in Korean http://www.mof.go.kr/synap/view.do?fn=MOF_ARTICLE_26953_2019080516c607d33cb790&fd=202002). The aims of the Plan include: to analyse and forecast global and domestic trends in marine litter policies, to estimate the volume of domestic marine litter, to establish directions for mid- to long-term management policies under the review of expert advisory groups, and to improve the implementation of legislation and management actions (MOF, 2018: available https://wedocs.unep.org/bitstream/handle/20.500.11822/26499/ML_Korea.pdf?sequence=1&isAllowed=y).

Several schemes have been employed to collect marine debris, such as a buyback programme for fishermen to bring marine debris caught in their nets back to port for processing (in operation since 2003), clean-up of port regions using ships (since 1995), beach clean-up programmes (both municipal and community-based), and floating reception barges for trapping riverine waste (since 2009) (Morishige, 2010; Hong et al., 2015). Through these various programmes, about 42,917 tonnes of marine debris was collected from the environment in 2018, or 52.3% of the total estimated annual national output of marine litter (Marine Environment Information System, 2019: available in Korean https://www.meis.go.kr/portal/main.do).

As with other countries in the region, China's 2018 ban of plastic imports was a catalyst for the Korean government to pursue stronger measures. Following the 2018 China ban, the Ministry of Environment indicated that it would halve plastic waste generation and raise the domestic recycling rate from 34% to 70% by 2030. The aim of plastic use reduction is handled through a series of measures and regulations. These include bans and levies to manage excessive and/or harmful packaging and change consumer behaviour with respect to single-use plastic items. Disposable plastic bags were banned in supermarkets from 1 April 2019, followed by paper boxes and packaging tapes in November 2019

(Yonhap News Agency, 2019: available https://en.yna.co.kr/view/AEN20190902003600315?section=search).

Under a revised Extended Producer Responsibility (EPR) legislation put in place on 25 December 2019, importers and producers of various packaging materials are required to pay higher financial contributions, depending on the recycling rate of the product. This resulted in manufacturers designing more recyclable packaging, e.g. by changing from coloured to clear plastics (Yonhap News Agency, 2019: available https://en.yna.co.kr/view/AEN20191227004000320?section=search).

### 13.1.2 Plastics as a proportion of solid waste

In 2016, the MSW for the RO Korea was estimated at 18.6 million tonnes, and with a projection of reaching 22.4 million tonnes in 2030 and 24.6 million tonnes in 2050 (Kaza et al., 2018). Government statistics for 2017 estimated daily household and industrial waste production at about 53,490 tonnes (i.e. 19.5 million tonnes for the year), including 5,850 tonnes of plastic, 2,168 tonnes of recycled synthetic resins, and 143 tonnes of recycled foamed plastics. Of the total daily MSW, 61.5% are recycled, 13.5% are put into landfills, and 25% are incinerated. Overall plastic waste (categorised in the study as general plastic waste, foamed plastics and resins) are 15.3% of solid waste, with 57.5% of this being recycled. Of the category of general plastics, 2,382 tonnes (40%) are recycled daily, not including the synthetic resins and foamed plastics collected through specialised recycling channels; for these, 100% of segregated waste is recycled.

In the 2016 National Waste Statistics Survey, about 21.6% of household waste (total: 306.5 g/day/capita) consists of plastics (PET: 21.7 g/day/capita, HDPE, LDPE, PP, PS, PVC, EPS: 29.9 g/day/capita, film packaging: 6.63 g/day/capita, disposable plastic products: 1.14 g/day/capita, other plastic: 6.93 g/day/capita) (Statistics Korea, 2020: available http://kosis.kr/index/index.do). The RO Korea is estimated to generate approximately 25.7 billion plastic cups and 21.1 billion plastic bags as waste each year (Yonhap News Agency, 2019: available https://en.yna.co.kr/view/AEN20190902003600315?section=search).

In 2018, an estimated 117,000 tonnes of marine debris were generated in the RO Korea, with 67% from land-based sources and 33% from sea-based sources (Marine Environment Information System, 2019: available in Korean https://www.meis.go.kr/mli/intro/learn.do).

### 13.1.3 Illegal trade of plastic waste

The RO Korea is both an importer and exporter of illegal plastic waste. In 2018, 170,000 tonnes of waste plastics were reported to have been imported into the RO Korea (Yonhap News Agency, 2019: available https://en.yna.co.kr/view/AEN20190816004000315?section=search).

Following the 2018 Chinese ban on illegal plastic waste imports, the RO KOREA's plastic waste exports were diverted to Southeast Asian countries (Greenpeace, 2019). However, a number of these shipments have since been returned by importing countries, such as in a prominent dispute with the Philippines over 6,300 tonnes of plastic waste which included hazardous materials (Yonhap News Agency, 2019: available https://en.yna.co.kr/view/AEN20190104004200315?section=search).

Difficulties encountered in the export of plastic waste resulted in waste piles being more visible in Korean cities such as Uiseong (CNN, 2019: available https://edition.cnn.com/2019/03/02/asia/south-korea-trash-ships-intl/index.html). According to the Ministry of Environment, there were 1.2 million tonnes of illegal trash in South Korea in 2019, which is planned to be removed by 2022 (Yonhap News Agency, 2019: available https://en.yna.co.kr/view/AEN20190221006400315).

## 13.2 Research review of pollution from marine plastic

### 13.2.1 Research overview

There is a significant body of research on marine plastics in the RO Korea, which spans across a large breadth of topic and shows a strong government interest in this body of research. Much of the work on marine plastic litter has been conducted by the Korea Institute of Ocean Science and Technology (KIOST - formerly known as the Korean Ocean Research and Development Institute, KORDI), the Korea University of Science and Technology, as well as Our Sea of East Asia Network (OSEAN), which is a non-profit research organisation dedicated to studying marine debris.

The research inventory built for this study includes 67 studies for assessing the current state of knowledge of pollution from marine plastics in the RO Korea. Most of these studies were conducted after 2012 and published after 2014, though there are some studies from as early as 2005. Early studies had been interested in general marine debris and pointed to ALDFG, especially EPS buoys, as major contributors to the marine debris issue. The increase in marine litter research coincided with more interest in plastic-specific studies. Studies from the RO Korea covered the greatest number of research foci among the countries analysed in this report, and had the most balanced representation of different research foci. A majority of the papers examined focused on surveys and monitoring to understand pollution status, followed by plastics as a transport vector, and other contaminants associated with marine plastics.

Six out of 23 of the papers that involved monitoring the status of marine plastic debris covered sites that are distributed around the entire coast of South Korea. Most of the rest of the papers focused on areas near the Nakdong River mouth and around Geoje Island, along the south coast of the RO Korea. KIOST is located on Geoje Island, and the area is known for oyster mariculture, which has been identified as a major source of EPS debris in the area.

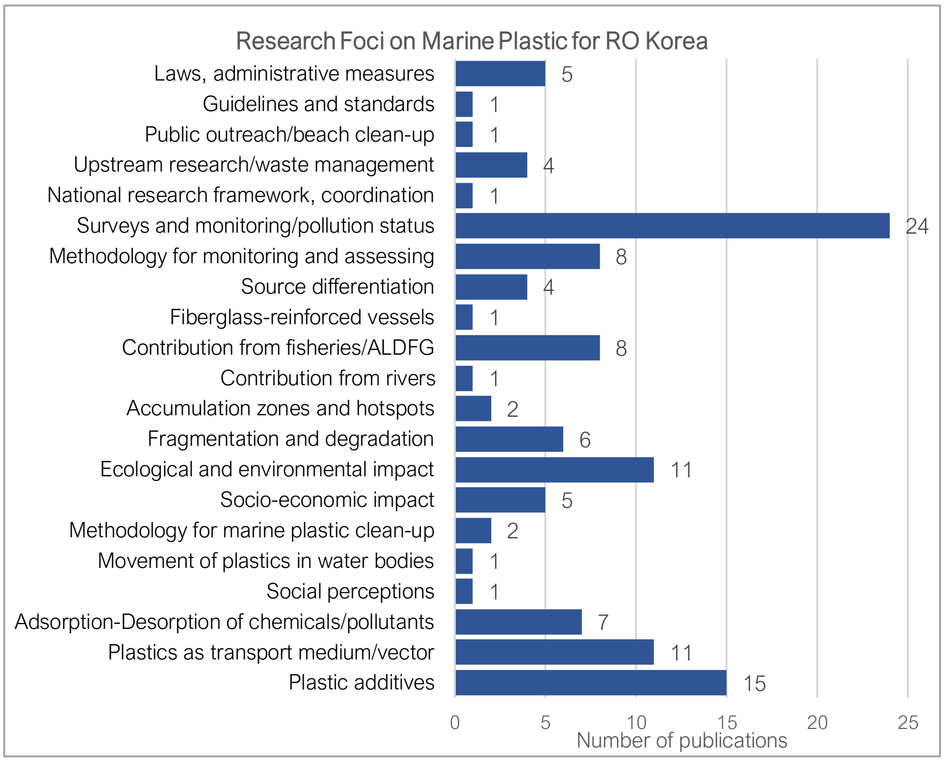



Figure 1.2.13.1. Research foci of marine plastic research conducted in RO Korea.

## 13.2.2 Types of research conducted

*Types of plastics research foci*

Microplastics and macroplastics appear to be of equal concern, with a comparable number of studies focusing on only microplastics (n=29) or only macroplastics (n=27), and nearly a fifth (n=18) examining both. Papers examining microplastics are predominantly about surveying quantities and distributions in the marine environment (e.g. Song et al., 2018; Eo et al., 2018), and laboratory studies regarding the physio-chemical impacts of ingested microplastics (e.g. Jeong et al., 2016; Chae et al., 2020). Papers examining macroplastics are largely also about surveying their quantities in the environment (e.g. Hong et al., 2014a), as well as their role as vector of additives and persistent organic pollutants (e.g. Rani et al., 2014). Studies regarding laws, policies and other domestic measures on pollution from marine plastic debris are focused on macroplastics.

A majority of the plastics research singled out styrofoam as a major component of plastic debris found in their areas of study. The nine papers which surveyed microplastics in Korean environments identified PS, PP, PE, and alkyd paint particles as major polymers. Papers which surveyed macroplastic tended to mention EPS as a major component of marine debris, likely originating from buoys used in mariculture, though vinyl was also mentioned in some papers. When it is not the primary focus of papers, EPS is frequently included in the research scope of many papers which examine plastics as vectors of harmful chemicals or investigate impacts of plastic consumption on marine organisms in laboratory settings.

Six papers investigated plastic fragmentation, through surveying styrene oligomers which are the molecules comprising EPS (Hong et al., 2016; Kwon et al., 2015; Saido et al., 2014) and its fragmentation process, through field observations (Rani et al., 2017) and laboratory experiments using abiotic simulations (Song et al., 2017) and ingestion by polychaetes (Jang et al., 2018).

15 of the studies examined contaminants associated with marine plastics, primarily HBCDs, PCBs, and other organic chlorinated compounds. Six of them measured levels of these associated plastic contaminants in the marine environment, either directly on debris or in mussels, while five of them measured desorption rates into either seawater or simulated fish intestinal fluid. Chae et al. (2020) examined the effect of polystyrene leachate on photosynthetic activity of marine algae, and measured levels of common plastic associated contaminants in the leachate.

Notably, in three papers examined for this study, the Korean authors attempted to estimate country-wide output of plastics into the marine environment, one of which was published prior to the seminal work of Jambeck et al. (2015). Jang et al. (2014a) attempted to estimate macroplastic debris output, extrapolating from both local surveys and data from other regions; they included estimates of land-based and sea-based plastic debris as well as river outputs. However, this study was not considered by Jambeck et al. which only focused on land-based sources. Interestingly, Jang et al.'s assessment is consistent with recent estimates published by the government. Kim et al. (2015a) estimated the output of HDPE and LDPE using economic and waste data from 1995–2012. Lee and Kim (2017) estimated the output of microplastics into the marine environment.

*Coverage of marine environs*

Most of the studies have been conducted either on the shoreline or on the water surface/water column. 23 papers include the water column in their research environments. Nearly all of the studies have been conducted on surface waters. A notable exception is the paper by Song et al. (2018), which focused on samplings in the water column at multiple depths. 22 papers included shorelines in their research scope; those indicated that their study had been conducted on sandy beaches, or did not specify the type of coastal environment being studied.

Eleven papers examined plastic debris in marine biota. Hong et al. (2013) described a participatory survey of volunteers and experts in recording entanglement and ingestion in wild organisms, which included 18 species of birds, two species of mammals, and one species of crab. Cho et al. (2019) measured microplastics found in bivalves obtained from seafood markets, namely oyster (*Crassostrea gigas*), blue mussel (*Mytilus edulis*), Manila clam (*Tapes philippinarum*), and scallop (*Patinopecten yessoensis*). Other papers examined plastic ingestion in wild mussels (Jang et al., 2016), marine polychaetes (Jang et al., 2018), and zooplankton (Kang et al., 2015a). Laboratory-based studies tended to use plankton as model organisms, such as marine algae (Chae et al., 2019, 2020), rotifers (Jeong et al., 2016, 2018), and copepods (Lee et al, 2013a; Jeong et al., 2017).

Comparatively few papers considered plastic debris on and in the seabed. Two papers provided measures of plastic in seafloor sediments, namely styrene oligomers in a lagoon (Hong et al., 2016) and macroplastics in the deep sea (Lee et al., 2006). Other papers reviewed methods and policies regarding plastic debris clean-up operations from the seafloor (Cho et al., 2009; Jung et al., 2010; Hong et al., 2015), or were more general literature reviews.

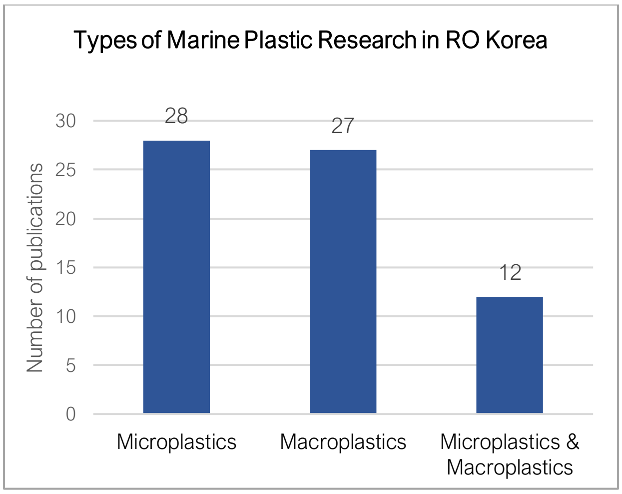



Figure 1.2.13.2. Micro- and macro-plastic research in RO Korea.

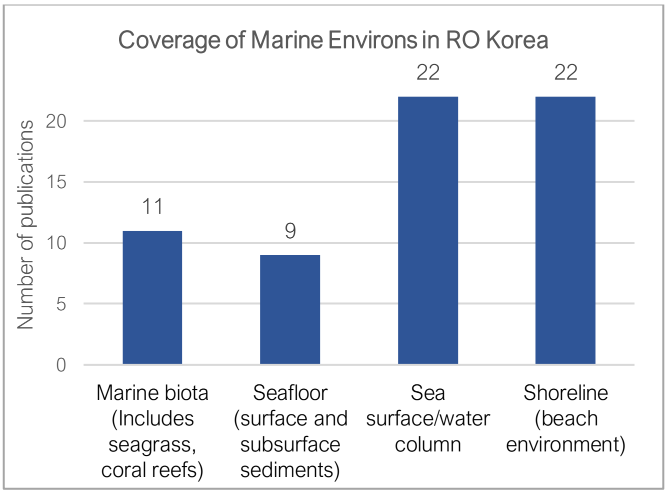



Figure 1.2.13.3. Marine environs studied in marine plastic research in RO Korea.

## 12.2.3 Survey and monitoring

There is substantial interest in monitoring marine plastic pollution in the marine environment, with 24 relevant papers from Korean authors. 21 of these papers refer to studies that conducted original field research on marine debris pollution in various environs within the RO KOREA, with a slightly greater interest in microplastics compared to macroplastics. Notably, several of these papers reported data dating back to the early 2000s or even the 1990s (Lee et al., 2006). Kwon et al. (2015) reported results from a long-term survey of styrene oligomers, with a dataset spanning 2003–2013.

Some papers discussed research scoping and aims which went beyond inventorying, such as predicting factors to determine the abundance or distributions of plastics (Song et al., 2018; Eo et al., 2018; Kim et al., 2015b), correlating abundances across size classes (Eo et al., 2018; Lee et al., 2015; Lee et al., 2013b), or highlighting potential ingestion risks to zooplankton (Kang et al., 2015a).

*Microplastics*

Most of the 15 surveys that included microplastics were conducted on either near-coastal surface waters or on sandy beaches, with one in marine biota (Cho et al., 2019) and one including deeper parts of the water column (Song et al., 2018).

The size definition used is these papers is considerably varied, especially before 2016. The three papers published after 2016, however, all used the more typical definition of less than 5 mm. Among the studies published prior to 2016, two studies used definitions smaller than the 5 mm threshold. Two papers only surveyed ‘large microplastics’ (1-5 mm).

All the papers identified at least a selection of the polymers found in their sample, whether through purely visual means, using FTIR spectroscopy to identify more specific polymer compositions, or by focusing on one specific polymer (styrene oligomers in Kwon et al., 2015 and Saido et al., 2014). Authors who used visual means primarily singled styrofoam out of other types of plastic debris. Authors who investigated specific polymers found mostly similar types across different environs, though their relative proportions differed. Cho et al. (2019) found the most common polymers in market-bought bivalves to be PE, PP, PS, and PET. Kim et al. (2015b) found predominantly EPS, PP, PE, and PU foam on sandy beaches. Three papers surveying sea surface environments all found EPS, alkyd paint particles, PP, PE, and polyacrylate/styrene to be among the most common polymers. Song et al. (2018) surveyed deeper parts of the water column in addition to the surface, and listed PP, PE, and PEVA as the predominant polymers.

Most papers further described the shapes of microplastics found, primarily as pellets/spherules, hard plastic fragments, fibres, film/sheets and foam. One paper (Kang et al., 2019) additionally visually distinguished paint resin particles. Whether or not papers include a description of morphologies did not depend on the level of technology used, however – two of the papers which did not include a description of shapes reported on results from spectroscopy. Some of the earliest papers (Lee et al., 2013b; Heo et al., 2013; Hong et al., 2014b) mentioned the status of degradation on the samples by distinguishing between fragmented pieces and intact items, but later papers did not make this distinction.

Units used to report results are fairly consistent. Due to their focus on the molecular scale, Kwon et al. (2015) and Saido et al. (2014) reported their results on styrene oligomers in terms of μg/kg wet weight of sand and μg/L seawater. All other papers included units in terms of item counts:

- In the marine biota study (Cho et al., 2019), the units used were item/g of tissue (wet weight) and item/individual for bivalves.
- On the sea surface (n=6), all papers used items per volume of seawater, though some additionally reported items per area of sea surface. None reported the weight of the plastics surveyed.
- On the shoreline (n=6), papers primarily reported in terms of item count per area. Three papers additionally included weight per area (Heo et al., 2013; Hong et al., 2014b; Lee et al., 2015).

The methodologies employed by the authors depended on the environs studied. Sea surface surveys consistently referred to Song et al. (2014). Shoreline surveys were more varied, using sampling methods that referred to or modified Hidalgo-Ruz et al. (2012) or Browne et al. (2010), or made no reference. Processing methods were generally not referenced, and differed in whether FTIR spectroscopy and density separation methods were used. In the marine biota study, Cho et al. (2019) referred to Karami et al. (2017).

*Macroplastics*

The 11 studies which investigated macroplastics mostly surveyed sandy beaches, with a minority investigating sea surface waters (Kim et al., 2005, Jo et al., 2005) and the seabed (Lee et al., 2006).

There were no harmonized detailed categories used to describe macroplastic items found. The main mode of description was done by visually distinguishing between EPS and other plastic polymers. Early papers used the additional categories of nylon rope (Kim et al., 2005) and vinyl (Kim et al., 2005, Jo et al., 2005, Lee et al., 2006). Five papers described the types of macroplastic items found: Hong et al. (2014b) focused on EPS buoys, others anecdotally described fishing gear including EPS buoys, nets, fishing lines, ropes, and octopus pots (Jang et al., 2014b; Heo et al., 2013; Lee et al., 2006), and Hong et al. (2014a) are the only authors who provided systematic sorting of macroplastics based on ICC categories.

The units used to report results of the surveys were very consistent across the seven papers focused on sandy beaches, but inconsistent across the three surveys carried out in sea surface waters, as follows:

- On sandy beaches, most papers reported findings in terms of both items/$m^2$ and g/$m^2$, with only one paper omitting weight (Lee et al., 2013b) and one paper using weight and volume per 100m of transect (Hong et al., 2014a);
- On the sea surface, Kim et al. (2005) used items/$km^2$, Jo et al. (2005) used items/site, and Kang et al. (2015b) used items/$m^3$. The relative earliness of the two first papers in marine plastic research may explain this choice of unit;
- On the seabed, Lee et al. (2006) used kg/$km^2$.

*Meta-analysis and methodology for the monitoring and assessment of marine litter*

In a meta-analysis paper, Khim et al. (2018) conducted a literature review of papers regarding various measures of ecosystem health of the Yellow Sea, including surveys of marine plastic pollution from both the RO KOREA and China. These authors concluded that the region generally has a higher density of plastic debris as compared to other Regional Seas.

Eight papers on different aspects of monitoring methodologies pointed to a strong interest in improving methodologies used in this field. These articles focused in particular on improving areas of sampling in beach surveys (Heo et al., 2013), use of remote surveillance and citizen science for rapid surveys of macrodebris (Jang et al., 2015; Lee et al., 2019), and methods to quantify styrene oligomers in beach sediments and sea surface waters (Saido et al., 2014), separate low-density PE films by size (Kim and An., 2019), and identify microplastics (Song et al., 2015; Shim et al., 2016) and associated contaminants (Hong et al., 2017a).

### 13.2.4 Source differentiation and pathways

Many of the papers point to fisheries as a likely source of plastic debris, particularly EPS buoys. Four papers attempted to explicitly identify sources. Authors of two of these papers, Hong et al. (2014a) and Jang et al. (2014b), used similar probabilistic scoring methods to suggest possible sources for plastic debris on beaches and estimate proportionate contributions of land- and sea-based sources to marine plastic pollution. They also suggested that sea-based activities, particularly commercial fisheries and aquaculture, would be the main source of macroplastic debris. However, proximity to a river mouth has also been found to be a significant factor in abundance of microplastics in a study of 20 sites throughout coasts in South Korea (Eo et al., 2018).

With respect to other associated contaminants, Al-Odaini et al. (2015) measured HBCDs in Jinhae Bay and Masan Bay and found three main areas with HBCDs in high concentrations – the outfall of a WWTP, in sediments close to industrialised areas, and in waters and EPS (styrofoam) buoys near aquaculture farms.

### 13.2.5 Movement of plastics, accumulation and hotspots

Jang et al. (2014c) modelled the behaviour of floating debris within the Nakdong River basin through tracking buoys. Through this method, they were able to identify hotspots of debris accumulation within the downstream portions of the river, as well as estimate flow rates of debris being discharged into the ocean, which were estimated as >4500 $m^3$/s.

As mentioned previously, Al-Odaini et al. (2015) identified hotspots of HBCD concentrations within Jinhae bay and Masan bay in the outfall of a WWTP and of aquaculture farms.

### 13.2.6 Ecological and environmental impacts

There are comparatively few field studies on plastic ingestion in marine organisms in the RO KOREA relative to its total body of work (n=5). Only one of these involved macroplastics (Hong et al., 2013), where 45 records of entanglement and ingestion of marine debris in wild organisms were collected through a participatory survey of volunteers and experts who recalled incidents spanning between 2003–2012. Of the 21 species recorded to have been impacted by marine debris, five were threatened, and fishing gear was recorded as the most frequent debris type.

Two papers were specifically focused on marine organisms found living on EPS buoys: polychaetes buried in buoys (Jang et al., 2018), mussels adhered to buoys (Jang et al., 2016), ratio of microplastic to zooplankton (Kang et al., 2015a), and bivalves from seafood markets (Cho et al., 2019).

There is relatively high interest in laboratory-based studies compared to field studies, to understand specific physio-chemical impacts of plastic exposure to marine organisms. The RO KOREA is one of only two countries in the region to have more than one such published paper on this. Again, there is a strong interest in the effect of polystyrene (as PS beads and EPS leachates).

Chae et al. (2019, 2020) found that the photosynthetic activity of marine algae was increased upon exposure to EPS leachates and PE beads. Three papers examined the effect of PS microbead ingestion on the survival, development, and fecundity of zooplankton such as rotifers (Jeong et al., 2016), and copepods (Lee et al., 2013a; Jeong et al., 2017). Jeong et al. (2018) specifically investigated the impact of PS bead exposure to the activity of molecules associated with multi-xenobiotic resistance in rotifers. In all four papers, the toxic effects of PS microbead ingestion increased as the size of the microbeads decreased.

### 13.2.7 ALDFG

Eight papers focused on plastic pollution from ALDFG and aquaculture equipment, especially EPS (styrofoam) buoys, including pollution surveys (Hong et al., 2014b; Al-Odaini et al., 2015), and ingestion in marine organisms (Jang et al., 2016, 2018), and marine debris management (Cho, 2005; Hong et al., 2015). All the experimental fieldwork was conducted on or near Geoje Island. Hong et al. (2017b) examined navy records of ship propeller entanglement in derelict fishing gear, and found an average of 397.7 cases of propeller entanglement every year over a period of six years.

13.2.8 Social perceptions and socio-economic impacts

Three of the five papers published on economic impacts of marine plastic pollution sought to measure economic costs: loss in beach tourism (Jang et al., 2014d), cost of naval ship propeller entanglement (Hong et al., 2017b), and the cost of potential programmes for derelict fishing gear removal (Hong et al., 2015). Choi & Lee (2018) also estimated the value of social willingness-to-pay for removing microplastics from the ocean, implying that the social perception of risks from microplastics are high. One study (Choi et al., 2019) can be considered to also provide information on the potential economic impact of marine plastic pollution through the presence of microplastics in seafood.

## 13.3 Main players in marine plastic research

All of the research reviewed for the RO KOREA have been led by local researchers, with one paper with a second corresponding author from a Japanese institution, and much of it conducted by the Korea Institute of Ocean Science and Technology (KIOST), particularly the Oil and POPs Research Group, as well as the Korea University of Science and Technology and Our Sea of East Asia Network (OSEAN).

Won Joon Shim and Sang Hee Hong of KIOST and of the Korea University of Science and Technology, as well as Jongmyong Lee and Sunwook Hong from OSEAN, stand out as lead researchers who frequently collaborate to survey plastic pollution and other associated contaminants, particularly HBCDs. Jung Hwan Kwon from Korea University focuses on desorption modelling of chemicals from plastic materials. Other institutions with researchers working on marine plastic debris include Pukyong University, Korea Maritime Institute, Konkuk University, Incheon University as well as the Korea Marine Environment Management Corporation (KOEM).

## 13.4 Summary of understanding

Research on marine plastic pollution in the RO KOREA is at an advanced stage, with a strong interest on the impact of marine debris since the early 2000s. There is a diverse spread of research topics presenting evidence of impacts of marine plastic debris on the marine environment, marine organisms, and human society. This body of research also demonstrates particular interest in understanding less commonly studied topics, such as the distribution of plastic additives and other plastic-associated contaminants; fragmentation of plastic in the marine environment; economic and monetary impacts of plastic pollution; and laws and policies on marine debris. Some papers also use comparatively long-term datasets to study plastic abundances, calculate outputs of marine debris, and estimate economic impacts.

Understanding of the status of marine plastic pollution in the RO KOREA includes multiple nation-wide surveys of pollution status. Environs and regions where plastic pollution research is conducted are concentrated mostly on sandy beaches and near-coastal sea surface, with a particular focus on the region of Geoje Island and the Nakdong River. There is a need for a greater understanding of marine plastic pollution on and in the seabed, in the water column, and coastal environments other than sandy beaches (e.g. mudflats). Several surveys advance beyond inventorying and compare plastic abundances and composition within their environ, leading to a more specific understanding of the distribution and accumulation of plastic debris. This could be used for further studies using hydrological modelling to predict the movements of plastic debris on a larger scale coupled with a risk assessment approach to aid more targeted intervention strategies.

Uniquely, research in the RO KOREA initially focused on a single polymer and industry, namely expanded polystyrene (EPS and often known as styrofoam) used in mariculture. This has allowed in-depth research into the potential ecological and environmental impacts of this material, and its role as a vector of hazardous chemicals. While EPS understandably is of particular interest due to its prevalence, other polymers such as alkyd paints, PP, and PE are also abundant in the environment, and there is comparatively less research on them. It may be beneficial for researchers to extend their expertise to other commonly found polymers.

## 14. REGIONAL SUMMARY

### 14.1 Scientific publications across ASEAN+3

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

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

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

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

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

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

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

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

## 14.2 Comparison of research focus

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

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

23. Language and cultural barriers/data accessibility

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

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

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

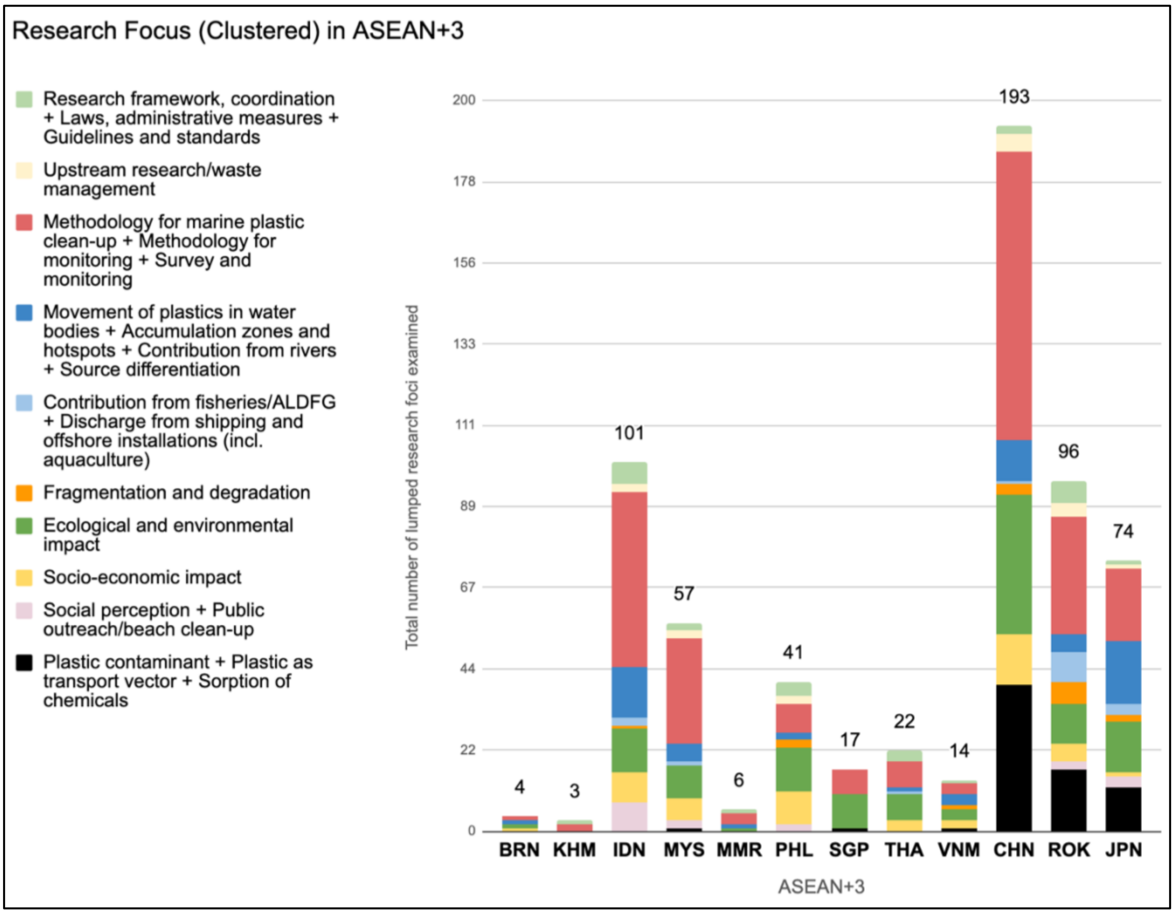



Figure 1.2.14.2. Top 10 clustered research foci in the marine plastics research across ASEAN+3.

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

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

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

+

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

-

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

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

## 14.3 Comparison of methodologies used

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

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

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

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

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

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

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

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

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

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

## 14.4 Comparison of types of plastics research

*Macroplastics and microplastics*

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

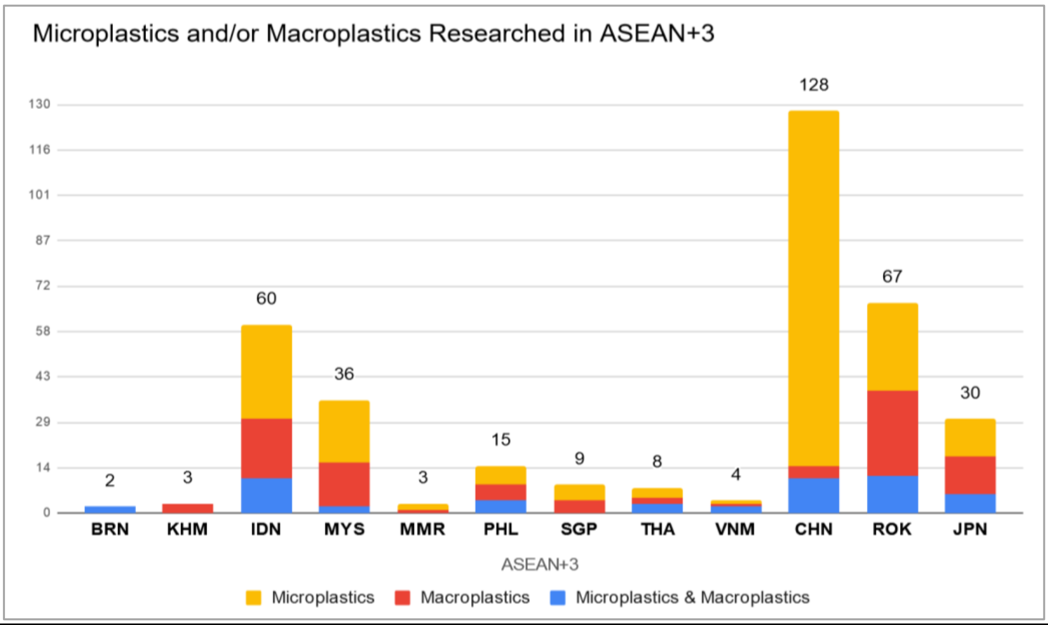



Figure 1.2.14.5. Research efforts on micro-/macro- plastics in the ASEAN+3.

*Polymer types*

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

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

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

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

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

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

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

*Regulations on plastic polymers under examination*

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

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

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

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

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

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

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

### 14.5 Comparison of organic and inorganic contaminants

*Organic contaminants (associated additives or sorbed chemicals)*

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

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

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

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

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

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

*Inorganic contaminants*

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

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

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

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

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

### 14.6 Comparison of sampling efforts across marine environs

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

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

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

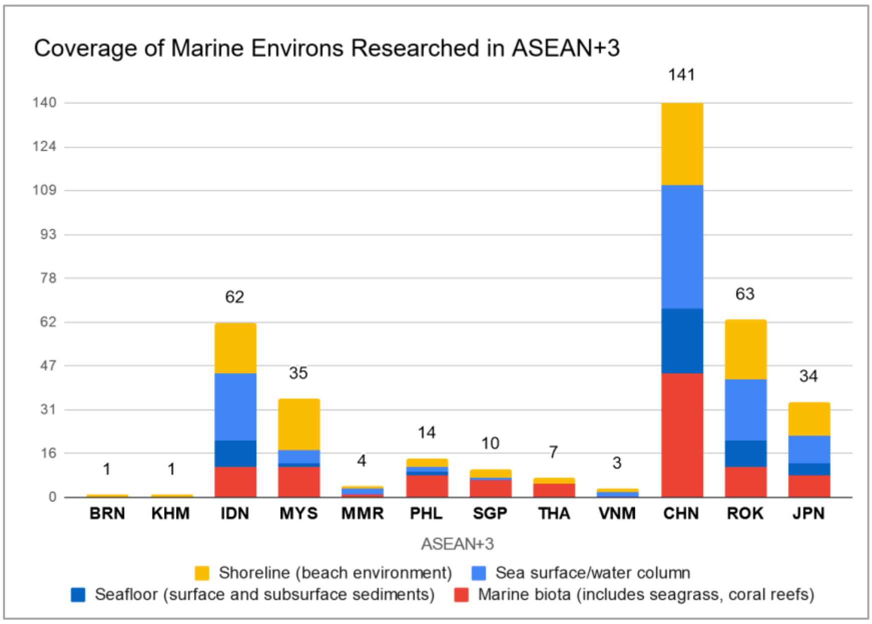



Figure 1.2.14.11. Sampling efforts in four major marine environs in ASEAN+3.

## 14.7 Comparison of ecological and environmental impacts

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

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

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

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

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

Two other areas are the subject of very few studies:

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

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

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

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

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

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

## 14.8 Comparison of ALDFG

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

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

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

## 14.9 Comparison of social perception

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

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

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

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

## 14.10 Main players

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

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

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

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

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

# SECTION 3 – 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 and East Asia.

# 1. THE UNITED NATIONS CONVENTION ON THE LAW OF THE SEA (UNCLOS)

***Summary of role:*** *Often referred to as the constitution for the oceans, UNCLOS is a comprehensive and near universal treaty. It is not the only treaty that applies to pollution of the sea and the protection of the marine environment, but it is the only one which is intended to regulate all activities at sea. UNCLOS includes both provisions that are directly implementable by states and framework provisions that require agreement and formulation of further regulations, measures, standards and procedures at international, regional and/or national levels. With 168 state parties, UNCLOS is near universal.*

***Scope and work:*** *UNCLOS covers land-based pollution as well as all activities at sea. In the absence of a COP for UNCLOS, implementation work on pollution from plastic is handled by relevant competent organisations such as UNEA, IMO, FAO, COP to the London Convention and Protocol, etc.*

***Keywords/research field:*** *UNCLOS; land-based pollution; sea-based pollution; pollution from shipping; pollution from dumping; pollution from mining; general provisions; obligation of cooperation*

## 1.1 Overview and state parties

UNCLOS was signed on 10 December 1982 in Montego Bay, Jamaica and entered into force in 1994. Considered the “constitution for the oceans”, the Convention aims to provide the legal framework for all human activities in the sea. From a marine environmental perspective, UNCLOS is also the most comprehensive international legal framework for the protection of the marine environment thus far. As of 31 January 2020, UNCLOS has 168 state parties including all ASEAN member states, China, Japan and Korea.

The status of UNCLOS is available online: https://www.un.org/depts/los/convention_agreements/convention_overview_convention.htm.

## 1.2 Relevant provisions

### 1.2.1 General obligations

UNCLOS has a number of general provisions that apply to pollution from marine plastics. Some apply to all activities at sea and in all maritime zones, while others apply to specific sources of pollution and to cooperation in controlling pollution of the marine environment.

First, the definition of ‘pollution’ in Article 1(4) of UNCLOS includes pollution from plastic debris provided that marine plastic debris have an adverse impact on the marine environment, human health and other uses of the sea, which plastic debris do.

Article 1(4) of UNCLOS defines 'pollution' as:

> *The introduction by man, directly or indirectly, of* **substances** *or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities* [emphasis added]

Second, the general obligation in Article 192 of UNCLOS provides that states have an obligation to protect and preserve the marine environment.

Furthermore, according to Article 194 of UNCLOS:

> *States shall take, individually or jointly as appropriate, all measures consistent with this Convention that are necessary to* ***prevent, reduce and control pollution of the marine environment from any source****, using for this purpose the best practicable means at their disposal and in accordance with their capabilities, and they shall endeavour to harmonize their policies in this connection*
>
> *(…)*
>
> *These measures shall include, inter alia, those designed to minimize to the fullest possible extent:*
>
> *(a)* ***the release of toxic, harmful or noxious substances****, especially those which are* ***persistent****, from land-based sources, from or through the atmosphere or by dumping;*
>
> *(b)* ***pollution from vessels****, in particular measures for preventing accidents and dealing with emergencies, ensuring the safety of operations at sea,* ***preventing intentional and unintentional discharges*** *(…)*
>
> [Emphasis added]

In the context of marine plastic debris, the regulation of pollution generally distinguishes pollution from plastic debris that are generated from land-based activities (e.g. rivers, run-offs, etc) and end up in the marine environment (referred to as land-based sources of pollution), as opposed to plastic debris that are generated from sea-based activities and therefore are directly released in the marine environment (referred to as sea-based activities).

### 1.2.2 Specific provisions on pollution from land-based sources

The following provisions of UNCLOS are particularly relevant:

> *Article 207 Pollution from land-based sources*
>
> *1- States shall adopt laws and regulations to* ***prevent, reduce and control pollution of the marine environment from land-based sources****, including* ***rivers, estuaries, pipelines and outfall***

***structures**, taking into account internationally agreed rules, standards and recommended practices and procedures.*

*5-* [These] *laws, regulations and measures rules, standards and recommended practices and procedures (…) shall include those designed to **minimize**, to the fullest extent possible, the release of **toxic, harmful or noxious substances**, especially those which are **persistent**, into the marine environment.*

[Emphasis added]

There is therefore no doubt that the release of polymers and plastic-associated contaminants which are toxic, harmful or noxious and/or persistent must be regulated. States failing to do so would be in breach of their obligations under UNCLOS. Arguably they would also be in breach of general international law as these provisions are now generally considered as obligations under customary international law. They therefore apply also to non-signatories.

### 1.2.3 Specific provisions on pollution from sea-based sources: dumping, mining and shipping

UNCLOS requires states to adopt regulations and measures against pollution from specific activities that include the discharge of macro- and microplastic debris. States must also ensure compliance with the domestic measures that they have adopted accordingly.

These specific provisions cover pollution from:

- Mining with respect to the discharge of polymer drilling mud used in mining activities (Articles 208 and 214);
- The discharge of plastic waste at sea under the provisions on pollution from dumping (Articles 210 and 216); and
- Vessels, including the release of plastic garbage regulated under MARPOL and the purview of the IMO (Articles 211, 217, 218 and 220). Further details of the work of the IMO are provided in Part 1, Section 3.5 below.

These specific provisions require measures adopted y states to be as effective as the applicable international rules, standards and procedures adopted by competent international and regional organisations or diplomatic conferences. This highlights the critical importance of the work done by such bodies and of states' engagement with them. It also puts in a different light the obligation to cooperate.

### 1.2.4 Regional approach and obligation of cooperation at regional level

The obligation to cooperate for the protection and preservation of the marine environment is provided in a number of articles in UNCLOS, including the general provisions on the protection of the marine environment, and the specific provisions on particular sources of pollution.

The general provisions include in particular Articles 197 and 123.

Article 197 provides that:

> *States shall cooperate on a global basis and, as appropriate, on a regional basis, directly or through competent international organisations, in formulating and elaborating international rules, standards and recommended practices and procedures consistent with this Convention, for the protection and preservation of the marine environment, taking into account characteristic regional features.*

Article 123 provides that:

> *States bordering an enclosed or semi-enclosed sea should cooperate with each other in the exercise of their rights and in the performance of their duties under this Convention. To this end they shall endeavour, directly or through an appropriate regional organisation*
>
> *(…)*
>
> *(b) to coordinate the implementation of their rights and duties with respect to the protection and preservation of the marine environment;*

The specific provisions on land-based sources of pollution (Article 207), pollution from seabed activities (Article 208), pollution by dumping (Article 210), and pollution from vessels also include an obligation for international and regional cooperation.

### 1.3 Implementation of UNCLOS' provisions

With its provisions on states' obligations to prevent and control pollution of the marine environment from plastic debris, UNCLOS provides high-level guidance to the way in which these obligations should be implemented and fulfilled, particularly through cooperation with other states and with competent international and regional organisations.

As UNCLOS does not have a Conference of Parties (COP), the implementation of its provisions appears to be more robust and effective for activities that fall within the scope of an international or regional organisation with a suitable mandate. Such organisations include the IMO with regards shipping or the Barcelona Convention and regional institutions for the Mediterranean Sea, one of a number of Regional Seas programmes. The work of regional institutions in Southeast and East Asia to combat pollution from marine plastic is examined and discussed in the next section of this report. The Global Programme of Action for the Protection of the Marine Environment from Land-based Activity (GPA), which was intended as a platform for the implementation of Article 207, is effectively under review through a holistic assessment undertaken under the auspices of UNEA and UNEP. These numerous institutional mechanisms are discussed below.

Of note, the Meeting of State Parties to the 1982 United Nations Convention on the Law of the Sea (SPLOS) is not a COP as it is convened by the Secretary-General of the United Nations once or twice a year in accordance with Article 319(2)(e) to elect the Members of the International Tribunal for the Law of the Sea (ITLOS) and to discuss budgetary and administrative issues related to UNCLOS. It is however a meeting where state parties can agree to discuss current issues (e.g. SPLOS/29/9, 8 July 2019, https://undocs.org/en/splos/29/9).

## 2. THE UNITED NATIONS ENVIRONMENT ASSEMBLY (UNEA)

*Summary of role:* *UNEA is the world's highest-level decision-making body on the environment. It is also the highest decision-making body with the most general and applied mandate to combat pollution from marine plastic litter and microplastics. Decisions (resolutions, declarations, recommendations and other formal decisions) are made by consensus.*

*Summary of recommendations and work status:* *UNEA is driving to strengthen coordination and research capacity for better understanding of sources, pathways and hazards as well as barriers and challenges to actions to combat pollution from marine plastic litter and microplastics. A review is scheduled at UNEA-5 in 2021 of commissioned studies and reports from other bodies.*

*Keywords/research fields:* *United Nations Environment Assembly (UNEA); The Future We Want; United Nations General Assembly (UNGA); Creation of UNEA; function and mandate; SGD 14; UNEA Resolutions on marine plastic litters and microplastics; UNEA-1, UNEA-2, UNEA-3, UNEA-4*

### 2.1 Creation of UNEA and development of work of UN Bodies on marine plastics

#### 2.1.1 The Future We Want

The pressing emphasis on plastic as a critical source of marine environmental pollution at the international policy level has been enabled by the United Nations General Assembly (UNGA)'s careful attention 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 and was adopted on 27 July 2012, endorsed 'The Future We Want'. The UNGA is the highest deliberative, law and policymaking and representative organ of the UN. It has universal representation (i.e. 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 2006, in a UNGA Resolution which highlighted the lack of information and data, encouraged further studies and the raising of awareness of the impact of marine debris on health and productivity of the marine environment and consequent economic loss (UNGA, Oceans and the Law of the Sea, A/RES/60/30 (8 March 2006)).

#### 2.1.2 Creation of the UNEA: Its Function and Mandate

Another outcome of Rio+20 was the establishment of the UNEA, the world's highest-level decision-making body on the environment. The UNEA reports to the UNGA. The work of UNEA contributed to the adoption by the UNGA of the 2030 Agenda for Sustainable Development and its 17 Sustainable

Development Goals (SDGs) in 2015. 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 fosters cooperation between the relevant UN bodies (see below). Update on the 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.

## 2.2 Status of work

This report focuses on specific provisions on marine plastic debris (or litter) and microplastic. However, it is important to note that the outlook of UNEA and its framing of the issue of pollution from marine plastic is wider than these provisions. It also involves other more general environmental considerations and SDGs than those included in SDG 14 on life underwater. These include overall sustainability including sustainable product design and services and sustainable food production system, single use plastic, resource efficiency, life-cycle assessment, environmental governance, etc. Many of these themes have aspects that are relevant to combating pollution from marine plastics.

### 2.2.1 UNEA-1, Resolution 1/6 on marine plastic debris and microplastic

The first UNEA (June 2014) adopted Resolution 1/6 on marine plastic debris and microplastic. This two-page resolution describes issues raised by pollution from marine plastic debris and microplastics. It highlights the complexity of the issue and the need for more knowledge and research, emphasises the need for urgent action, and requests:

> “the Executive Director, in consultation with other relevant institutions and stakeholders, to **undertake a** study on marine plastic debris and marine microplastics, building on existing work and taking into account the most up-to-date studies and data, focusing on: (a) **Identification of the key sources** of marine plastic debris and microplastics; (b) Identification of possible measures and **best available techniques and environmental practices** to prevent the accumulation and minimize the level of microplastics in the marine environment; (c) Recommendations for the **most urgent actions**; (d) Specification of **areas especially in need of more research**, including key impacts on the environment and on human health; (e) Any other **relevant priority areas** identified in the assessment of the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection [GESAMP]”
>
> [Emphasis added]
>
> (UNEA-1, Resolution 1/6: https://papersmart.unon.org/resolution/uploads/unep.aheg_.2019.3.inf_.2_compilation_of_resolutions.pdf)

### 2.2.2 UNEA-2, Resolution 2/11 on marine plastic litter and microplastic

Following the adoption of the SDGs in 2015, UNEA-2 adopted a new and more comprehensive resolution, Resolution 2/11, on marine plastic litter and microplastics on 27 May 2016. It describes issues raised by pollution from marine plastic debris and microplastics, reiterates past UN resolutions, and welcomes the activities of relevant UN bodies and organisations on this topic, including the IMO:

> [Para 16] "Recognizes the role of the [IMO] in mitigating marine litter; recalls annex V of [MARPOL]; and agrees on the need to reduce illegal dumping of litter in the sea, including through the establishment and use of effective port reception facilities, the identification and, as appropriate, recovery of costs related to the disposal of garbage and waste, including through harbour fees, and consideration of other incentives and innovative approaches"
>
> (…)
>
> [Para 21] "**Requests** the Executive Director, in close cooperation with other relevant bodies and organisations, to **undertake** an assessment **of the effectiveness of relevant international, regional and subregional governance strategies and approaches to combat marine plastic litter and microplastics, taking into consideration the relevant international, regional and subregional regulatory frameworks and identifying possible gaps and options for addressing them, including through regional cooperation and coordination**, and to present the assessment to the Environment Assembly at its next session, within available resources for this purpose"
>
> [Emphasis added]
>
> (UNEA-2, Resolution 2/11: https://papersmart.unon.org/resolution/uploads/unep.aheg_.2019.3.inf_.2_compilation_of_resolutions.pdf)

### 2.2.3 UNEA-3, Resolution 3/7 on marine plastic litter and microplastic

In January 2018, UNEA-3 adopted Resolution 3/7 on marine plastic litter and microplastics. This four-page resolution further elaborates on issues raised by pollution from marine plastic debris and microplastics and reiterates past UN resolutions. Other points include the establishment of an Ad Hoc Open-Ended Expert Group on Marine Litter and Microplastics. See extracts below:

> [Para 7] "Requests the Executive Director, subject to the availability of resources, to **strengthen the capacity and activity of [UNEP] on marine litter and microplastics,** including by: (a) Strengthening the contribution of [UNEP] to the Global Partnership on Marine Litter; (b) Providing advice on the prioritizing of activities upon request based on best available scientific knowledge, and the most environmentally sound and cost-effective measures to prevent and reduce marine litter and microplastics, according to resolutions 1/6 and 2/11 and the present resolution; (c) Facilitating the establishment and implementation of regional and national action plans to prevent and reduce litter and microplastics in the marine environment, as requested by member states; (d) Supporting countries, upon request and in collaboration with other international organisations and relevant stakeholders, in closing data gaps and improving the availability of accessible data on the sources and extent of marine litter and microplastics in the environment; (e) Closely

liaising with other United Nations agencies to encourage them to support programmes to reduce marine litter and microplastics"

[Para 10] "**Decides to convene, subject to the availability of resources, meetings of an open-ended ad hoc expert group** to further examine the barriers to and options for combating marine plastic litter and microplastics from all sources, especially land-based sources, and: (a) Requests the Executive Director to provide the secretariat for that work; (b) Decides that the open-ended ad hoc expert group will be informed by and build on, among others, relevant resolutions, decisions and reports by the United Nations Environment Programme, other organisations, member states and stakeholders as appropriate; (c) Decides that the open-ended ad hoc expert group will include experts with the relevant technical expertise from all member states, representation from international and regional conventions and organisations and relevant stakeholders; (d) Decides that the open-ended ad hoc expert group will have the following initial programme of work: (i) **To explore all barriers to combating marine litter and microplastics, including challenges related to resources in developing countries; UNEP/EA.3/Res.7 4 (ii) To identify the range of national, regional and international response options, including actions and innovative approaches, and voluntary and legally binding governance strategies and approaches; (iii) To identify environmental, social and economic costs and benefits of different response options; (iv) To examine the feasibility and effectiveness of different response options; (v) To identify potential options for continued work for consideration by [UNEA]**"

[Emphasis added]

(UNEA-3, Resolution 3/7: https://papersmart.unon.org/resolution/uploads/unep.aheg_.2019.3.inf_.2_compilation_of_resolutions.pdf)

### 2.2.4 UNEA-4, Resolution 4/6 on marine plastic litter and microplastic

In March 2019, UNEA-4 adopted Resolution 4/6 on marine plastic litter and microplastic. This four-page resolution reiterates prior concerns and resolutions. It also highlights relevant legal and policy work done in other UN bodies:

[Preambular] "Taking note of important developments with regard to exploring options within the mandates of relevant existing international agreements and organisations for addressing marine litter, in particular:

(…)

(b) The adoption of an action plan by the [IMO MEPC], supported by the [LC/LP], to reduce marine plastic litter from ships;"

[Para 2] "Requests the Executive Director of the United Nations Environment Programme, subject to the availability of resources and benefiting from the work of existing mechanisms, to **immediately strengthen scientific and technological knowledge with regard to marine litter, including marine plastic litter and microplastics**, through the following activities: (a) **Convening** existing relevant science advisory initiatives with input from Member states, as appropriate, to provide input into the activities outlined in paragraphs 3 and 7 of the present resolution; (b) **Compiling available scientific and other relevant data and information to prepare an assessment on sources, pathways and hazards of litter, including plastic litter and microplastics pollution, and its presence in rivers and oceans**; scientific knowledge about adverse effects on ecosystems and potential adverse effects on human health; and environmentally sound technological innovations; (c) **Recommending indicators to harmonize monitoring, reporting and assessment methodologies**, taking into account key sources of marine litter, including plastic litter and microplastics, in cooperation with relevant international organisations; (d) Gathering information with a view to informing policies and action regarding environmentally sound technological innovations, options and measures for reducing the risk of discharges of litter, including plastic litter and microplastics, into the marine environment, taking into account the whole life cycle of plastics, in support of local, national, regional and global action"

[Para 3] "**Decides to strengthen coordination and cooperation by establishing**, subject to the availability of resources and building on existing initiatives, a **multi-stakeholder platform within [UNEP]** to take immediate action towards the long-term elimination, through a life-cycle approach, of discharges of litter and microplastics into the ocean"

[Para 7] "Decides to **extend until its fifth session the mandate of the ad hoc open-ended expert group on marine litter and microplastics** established by its resolution 3/7, and requests the expert group, building on its previous work, to: (a) Take stock of existing activities and action by governments, regional and global instruments, international organisations, the private sector, non-governmental organisations and other relevant contributors to reduce marine plastic litter and microplastics with the aim of the long-term elimination of discharge into the oceans; (…) (d) Analyse the effectiveness of existing and potential response options and activities with regard to marine litter and microplastics at all levels to determine the contribution that they make to solving the global problem (...)."

[Emphasis added]

(UNEA 4, Resolution 4/6: https://papersmart.unon.org/resolution/uploads/unep.aheg_.2019.3.inf_.2_compilation_of_resolutions.pdf)

UNEA-5 is planned to take place on 22-26 February 2021 in Nairobi, Kenya. Available https://environmentassembly.unenvironment.org/unea5.

### 2.3 Regional approach in UNEA resolutions on marine plastic debris and microplastics

All UNEA resolutions highlight the critical importance of regional cooperation, implementation through regional institutional mechanisms, regional instruments, regional response options and/or regional action plans for the prevention of pollution from marine plastic debris and microplastics.

Examples include:

- Encouraging states to cooperate through relevant Regional Seas conventions with a view to adopting actions plans to combat marine litter and to implement regional action plans to reduce marine litter [UNEP/EA.1/Res.6, paras 10 and 11];

- Acknowledging that sources of marine plastic litter and microplastics and resources available can vary between regions so that measures need to be taken and adapted as appropriate to local, national and regional situations [UNEP/EA.2/Res.11, para 1];

- Urging states to collaborate to establish regional action plans to combat marine litters if they have not done so yet [UNEP/EA.2/Res.11, para 4]

- Recognising the need to identify transport and distribution pathways and hotspots of marine litter, and to cooperate regionally and internationally to clean up such hotspots [UNEP/EA.2/Res.11, para 12]

- Recognising that governments need to further identify the most significant sources, as well as important and cost-effective preventive measures at regional level [UNEP/EA.2/Res.11, para 17]

- Inviting regional organisations and conventions including Regional Seas conventions and programmes to increase their action, within their mandate, to prevent and reduce marine litter and microplastics and their harmful effects and to coordinate where appropriate to achieve that end [UNEP/EA.3/Res.7, para 8]

- Calling states and other actors, including at the regional level to address the problem of marine litter and microplastics [UNEP/EA.4/Res.6 para 1]

- Establishing a multi-stakeholder platform within the [UNEP] to take immediate action towards the long-term elimination, through a life-cycle approach, of discharges of litter and microplastics into the oceans; this may include promoting action in the framework of Regional Seas conventions and programmes to address marine litter through action plans, protocols, partnerships and other activities [UNEP/EA.4/Res.6, para. 3(f)]

## 3. UNITED NATIONS ENVIRONMENT PROGRAMME (UNEP)

*Summary of role:* *UN Environment Programme (UNEP) coordinates the United Nations' environmental activities and assists developing countries in implementing environmentally sound policies and practices. UNEP supports global actions on marine plastics litter and microplastics according to the mandate given at UNEA meetings.*

*Summary of recommendations and work status:* *UNEP has undertaken various actions to support global actions on marine plastic litter:*

(i) *Hosting the global programme of action for the protection of the marine environment from land-based activities*
(ii) *Developing the Global Partnership on Marine Litter initiative (GPML) with other UN Bodies*
(iii) *Launching the Clean Seas campaign*
(iv) *Publishing technical guidelines, toolkits and reports on marine litter and microplastics including single-use plastics*

*Keywords/research fields:* *UN Environment Programme; UNEP; function and mandate; technical guides; toolkits and reports; Legal Limits on Single-Use Plastics and Microplastics: A Global Review of National Laws and Regulations; Combatting marine plastic litter and microplastics: An assessment of the effectiveness of relevant international; regional and subregional governance strategies and approaches; Marine Plastic debris and microplastics - Global lessons and research to inspire action and guide policy change; Guidelines on Survey and Monitoring of Marine Litter; Clean Seas; single-use plastics; Global Partnership on Marine Litter; GPML*

### 3.1 Function and mandate

UN Environment Programme (UNEP) is the leading global environmental agency within the UN system. It seeks to support implementation of the global environmental agenda adopted by UNEA and promote the coherent implementation of the environmental dimension of sustainable development. It is the UN coordinator for this portfolio.

Global action on marine litter was initiated within UNEP and in the context of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA), established in 1995. (For more details on the GPA refer to Part 1, Section 3.4.1 below.) Under the GPA, UNEP established the Global Partnership on Marine Litter initiative described in Part 1, Section 3.3.3 below, which is now a vehicle of implementation of decisions from UNEA.

UNEP also supports the cooperation for the protection of the marine environment at the regional level through its Regional Seas Programme, initiated in 1974. Currently, seven of these cooperation mechanisms in marine environmental protection are administered by UNEP including the East Asian

Seas. Available: https://www.unenvironment.org/explore-topics/oceans-seas/what-we-do/working-regional-seas.

UNEA also mandated the Executive Director of UNEP to assist states in the development and implementation of regional measures and action plans, in particular in regions that are the largest sources of marine litter and with the greatest potential to contribute to the global reduction of marine plastic pollution [UNEP/UNEA.2/Res.11, para 11].

### 3.2 Technical guides, toolkits and reports

The work of UNEP 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.

- UNEP (2018) Compilation of the UN Environment Assembly resolutions on marine litter and microplastics, UNEP/AHEG/2018/1/INF/2. Available: https://papersmart.unon.org/resolution/adhoc-oeeg-information-documents.

- UNEP (2018) Legal Limits on Single-Use Plastics and Microplastics: A Global Review of National Laws and Regulations. Available: https://www.unenvironment.org/resources/publication/legal-limits-single-use-plastics-and-microplastics-global-review-national.

- 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. Available: https://papersmart.unon.org/resolution/uploads/unep_aheg_2018_inf3_full_assessment_en.pdf.

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

- Marine Litter: A Global Challenge, 2009 (By UNEP, GPA and Ocean Conservancy). Available: http://wedocs.unep.org/handle/20.500.11822/7787.

- UNEP/IOC (2009) Guidelines on Survey and Monitoring of Marine Litter, Regional Seas Reports and Studies No.186, IOC Technical Series No.83. Available http://wedocs.unep.org/xmlui/handle/20.500.11822/13604.

### 3.3 Global Partnership on Marine Litter (GPML)

***Summary of role:*** *The Global Partnership on Marine Litter (GPML) is a multi-stakeholder partnership of state and non-state actors working to prevent marine litter with the aim of sharing knowledge and experience and advancing solutions to this pressing global issue. Its mission is to protect the global marine environment, human well-being and animal welfare by primarily enhancing international coordination and cooperation to combat the global problem of marine litter.*

***Summary of work status:*** *A GPML Platform was created to serve as a database on all measures such as treaties, decisions, action plans and projects relating to marine litter worldwide*

***Keywords/research fields:*** *Global Partnership on Marine Litter; GPML; establishment; Manila Declaration; Honolulu Strategy; objectives; GPML platform; regional node; webinars; online course; training of trainers workshop;*

#### 3.3.1 Establishment: Manila Declaration and Honolulu Strategy

The GPML was established by UNEP in 2012 and announced at Rio+20 prior to the establishment of UNEA. In 2012, member states of the GPA adopted the Manila Declaration on Furthering the Implementation of the GPA. This Declaration identified marine litter as a priority source category for action for 2012–2016 and triggered the development of the GPML. For more details on the GPA and Manila Declaration, refer to Part 1, Section 3.4.1 below.

The GPML aims to further the implementation of the 2011 Honolulu Strategy, which is a global framework for prevention and management of marine debris developed in collaboration with the National Oceanic and Atmospheric Administration (NOAA) of the United States of America.

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

#### 3.3.2 Objectives

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.

### 3.3.3 The GPML platform and regional node

The GPML functions as a network with regional nodes and includes a web-based platform designated to facilitate collaboration among supporting partners. Further information is available at http://marinelitternetwork.com/global-membership/. See also the 2018 GPML Framework Document, UNEP/GPA/IGR.4/INF/25. Available: http://marinelitternetwork.com/wp-content/uploads/2018/03/gpml_framework_document.pdf).

The GPML platform uses Ecolex as source-database of relevant legal instruments, policies, global and regional action plans, regulations, court decisions and other relevant material on the topic of marine debris (available: http://marinelitternetwork.com/global-projects/legal/). The platform also has a listing of global projects on marine litter divided into different categories such as action plans, awareness, clean-up, coordination, education, emergency response, facilitation, monitoring, prevention, removal, report and research (available http://marinelitternetwork.com/all-projects/).

There is currently no regional node for Southeast Asia. However, efforts are being undertaken within the Coordinating Body on the Seas of East Asia (COBSEA) to develop a regional node for Southeast Asia that would be as inclusive as possible. At the COBSEA Intergovernmental Meeting 24 (IM24) in June 2019, the Secretariat was requested to develop an East Asian Seas Regional Node of the GPML for consideration by COBSEA IM25. This decision is available in Annex III to the IM24 report: https://www.sea-circular.org/wp-content/uploads/2019/10/COBSEA-IGM-24-Report-adopted.pdf.

The GPML also organises online courses and webinars relating to marine plastics such as the GPML Webinar on Innovation and Technology Solution for Marine Litter Prevention in March 2019 (available: https://vimeo.com/328741879) and the Massive Open Online Course on Marine Litter (available: https://www.ou.nl/-/unenvironment-mooc-marine-litter).

From 9–13 October 2019, the GPML and COBSEA organised the workshop ‘Training of Trainers on Monitoring and Assessment of Marine Plastic Litter and Microplastics’ in Bali, Indonesia. A ‘Manual-Training the Trainers on Monitoring and Assessment of Marine Plastic Litter and Microplastics’ was published in September 2019. In October 2019, the report of the workshop was also published. Both are available online: https://www.unenvironment.org/cobsea/resources.

### 3.4 UNEP: Clean Seas

| |
|---|
| ***Summary of role:*** *Clean Seas is a campaign launched by UNEP with the aim of engaging governments, the general public and the private sector on pollution from marine plastic and develop education and provide outreach on this topic.* <br><br> ***Summary of work satus:*** *A number of online and in-person training courses* <br><br> ***Keywords/research fields:*** *UN Environment Programme; UNEP; Clean Seas; marine litter; establishment; objectives; work in the region; online course* |

#### 3.4.1 Establishment

Clean Seas is a campaign launched by UNEP in February 2017 with the aim of engaging governments, the general public and the private sector in the fight against marine plastic pollution. Further information is available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/25398/Clean%20Seas%20Campaign%20on%20marine%20litter.pdf?sequence=2&isAllowed=y.

#### 3.4.2 Objectives

This campaign focuses on:

- Establishing national and regional marine litter action plans;
- Educating and engaging citizens – resources are available on the Clean Seas website: https://www.Clean Seas.org/resources;
- Collaborating with governments and the private sector; and
- Replicating and scaling up efforts around the world.

#### 3.4.3 Work in the region

Indonesia, Philippines and Thailand take part in this campaign, with 57 countries currently participating globally.

One of the recent outcomes of this initiative is the 'Massive Open Online Course on Marine Litter' created by UNEP and the Open Universiteit of the Netherlands, available at: https://www.ou.nl/-/unenvironment-mooc-marine-litter. This was organised with support from the GPA, Clean Seas and GPML. Two online courses have been coordinated to date, in 2015 and 2019 respectively.

In addition, Japan and UNEP also announced in March 2019 that they will join in efforts to boost information and know-how to develop countermeasures against marine plastic litter in Southeast Asia. The project will develop a simulation model for the movement of plastic leakage into and within the oceans and establish monitoring programmes to determine leakage hotspots along the Mekong River (as well as the Ganges River in India). See: https://www.cleanseas.org/impact/japan-and-un-environment-announce-new-cooperation-boost-knowledge-marine-litter-southeast.

# 4. INTERGOVERNMENTAL PROCESSES THAT DIRECTLY SUPPORT THE WORK OF UNEA AND UNEP ON MARINE PLASTICS

## 4.1 Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA)

***Summary of role:*** *The Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities (GPA) is an intergovernmental mechanism established in 1995 to respond to land-based sources of pollution of the marine environment and includes plastics waste in its scope. It is a voluntary and non-binding programme. An Intergovernmental Review Meeting (IGR) had been organized every 5 years since 2001to review implementation of the GPA*

***Summary work status:*** *The last IGR, in 2018, resulted in a general agreement on continuing work on enhancing the mainstreaming of the protection of coastal and marine ecosystems, especially from the environmental threats caused by increased nutrients, wastewater, and marine litter and microplastics. The future of the GPA was also discussed and referred to UNEA-4. However, the latter did not make a decision on this. The future of the work of this GPA is therefore unclear.*

***Keywords/research fields:*** *Function and Mandate; Status of work; 2012 Manila Declaration on Furthering Implementation of the GPA*

### 4.1.1 Function and mandate

The GPA was created as an intergovernmental mechanism to respond to land-based sources of marine pollution. It aims at preventing the degradation of the marine environment from land-based activities by facilitating the realization of the duty of states to preserve and protect the marine environment. It was adopted by 108 governments, and the European Commission at an intergovernmental conference convened in Washington D.C. in 1995. It is designed to assist states in taking actions individually or jointly within their respective policies, priorities and resources, that will lead to the prevention, reduction, control and/or elimination of the degradation of the marine environment, as well as to its recovery from the impacts of land-based activities. (GPA, I.B.3) Available: https://papersmart.unon.org/resolution/uploads/1995-gpa.pdf.

From an international law perspective, the GPA is a mechanism developed to implement UNCLOS (in particular Articles 207 and 213 on pollution from land-based sources) as well as other relevant treaties. In addition to UNCLOS, it specifically refers to the London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention and its Protocol), the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal (Basel Convention), the Convention on Biological Diversity (CBD), the United Nations Framework Convention on Climate Change (UNFCCC), the Regional Seas conventions and the International Convention for the Prevention of Pollution from Ships (MARPOL). (GPA, I.C.4-7)

With respect to contaminants, the GPA specifically identifies litter (including plastic litter) as one of eight contaminants that characterise a problem and need management measures. The other seven are: sewage, POPs, radioactive substances, heavy metals, oils (hydrocarbons), nutrients and sediment mobilization. Plastic is also mentioned in the context of sewage. In the specific context of litter, sources of marine litter are identified as including land-based and sea-based sources. Importantly, the GPA already refers to floatable litter which is known to travel considerable distances with regional and sometimes broader implications, as well as resin pellets used as industrial feedstock which circulate and deposit on oceanic scales. Finally, it also highlights that the burning of litter containing plastics may generate significant quantities of POPs, metals and hydrocarbons which can reach the marine and coastal environment. (GPA, H.142-143)

#### 4.1.2 Method and status of work

The GPA emphasises the critical role of regional and sub-regional conventions, programmes, arrangements and their institutional mechanisms for successful actions to protect the marine environment from land-based activities. (GPA, III.21-35)

An Intergovernmental Review Meeting (IGR) has been organized every 5 years since 2001 and it also involves IGOs and non-state stakeholders such as NGOs. The 2012 Manila Declaration on Furthering Implementation of the GPA was adopted ahead of the 3rd IGR (IGR 3) and is included in the meeting report where work on plastic litter is a particular area of concern and focus. Reports of the meetings are available online at: https://www.unenvironment.org/explore-topics/oceans-seas/what-we-do/addressing-land-based-pollution/governing-global-programme.

The last IGR (IGR 4) was held in Bali in November 2018. The report is short as is the Bali Declaration adopted at the end of the meeting. This Declaration indicates a general agreement on continuing work on enhancing the mainstreaming of the protection of coastal and marine ecosystems, especially from the environmental threats caused by increased nutrients, wastewater, and marine litter and microplastics. It does not include other detail and refers to UNEA-4. For further details on the outcome of UNEA-4, refer to Part 1, Section 3.2.2.4 above. IGR 4 and the Bali Declaration are available online at: https://papersmart.unon.org/igr-meeting/sites/default/files/english.pdf.

#### 4.1.3 2012 Manila Declaration on Furthering Implementation of the GPA

The Manila Declaration on Furthering Implementation of the GPA (2012 Manila Declaration) was adopted by 65 governments and the European Commission ahead of IGR 3. It identifies marine litter as a priority source category for action for 2012–2016 and triggered the development of the GPML. The Declaration also recognises the important role of regional cooperation, in particular the Regional Seas Conventions and Action Plans, to implement the GPA and calls for strengthening and promoting the existing Regional Seas Conventions and Action Plans to further implement the GPA [Manila Declaration, p2]. For further details on the GPML, refer to Part 1, Section 3.3.3 above. The 2012 Manila Declaration is available online at: http://wedocs.unep.org/bitstream/handle/20.500.11822/12347/ManillaDeclarationREV.pdf?sequence=1&isAllowed=y.

### 4.2 Ad Hoc Open-Ended Expert Group (AHEG) on Marine Litter and Microplastics

*Summary of role:* *The AHEG was established by the 3rd UNEA (UNEA-3) in 2017 to further examine and report on the barriers to and options for combating marine plastic litter and microplastics from all sources. It is not a decision-making body. Two meetings of the AHEG were held prior to UNEA-4 and a further three meetings before UNEA-5.*

*Summary of recommendations and work status:* *The current programme of work of the AHEG, decided by UNEA-4, includes : (i) To take stock of existing activities and action by governments, regional and global instruments, international organisations, the private sector, non-governmental organisations and other relevant contributors to reduce marine plastic litter and microplastics; (ii) To identify technical and financial resources or mechanisms for supporting countries in addressing marine plastic litter and microplastics; (iii) To encourage partnerships that undertake activities such as the development of source inventories, the improvement of waste management, awareness-raising and the promotion of innovation in relation to the prevention of marine litter, including plastic litter and microplastics; and (iv) To analyse the effectiveness of existing and potential response options and activities with regard to marine litter and microplastics at all levels to determine the contribution that they make to solving the global problem.*

*Keywords/research fields:* *Ad Hoc Open-Ended Expert Group (AHEG) on Marine Litter and Microplastics; Function and mandate; UNEA 3/7; UNEA 4/6; Status of work; Scientific Advisory Committee; barriers to combating marine litter and microplastics; national; regional and international response options; Marine litter; microplastics; stocktaking of existing activities; plastic; effectiveness; response options; partnerships; technical; financial; resources; private sector*

#### 4.2.1 Function and mandate

The AHEG was established by Resolution UNEA 3/7 (UNEP/EA.3/Res.7) to further examine the barriers to and options for combating marine plastic litter and microplastics from all sources, especially land-based sources. This resolution stresses the importance of long-term elimination of discharge of litter and microplastics to the oceans and of avoiding detriment to marine ecosystems and the human activities dependent on them from marine litter and microplastics.

The AHEG comprises experts with relevant technical expertise from member states, representation from international and regional conventions and organisations and relevant stakeholders. UNEP provides the secretariat.

The AHEG is not a decision-making body and therefore does not require consensus, providing only summary documents that reflect discussions. These discussions have tended to be open in nature, with breakout groups focusing on specific topics and providing input to the plenary sessions. Country position statements are not generally requested but are accepted. Countries may be asked to make submissions on particular topics prior to meetings and to submit contributions post meetings to support discussions.

Resolution UNEA 3/7 assigned the AHEG with the following initial programme of work:

(i) To explore all barriers to combating marine litter and microplastics, including challenges related to resources in developing countries;
(ii) To identify the range of national, regional and international response options, including actions and innovative approaches, and voluntary and legally binding governance strategies and approaches;
(iii) To identify environmental, social and economic costs and benefits of different response options;
(iv) To examine the feasibility and effectiveness of different response options; and
(v) To identify potential options for continued work for consideration by UNEA.

Resolution UNEA 4/6 (UNEP/EA.4/Res.6) provided the AHEG with additional work:

(i) To take stock of existing activities and action by governments, regional and global instruments, international organisations, the private sector, non-governmental organisations and other relevant contributors to reduce marine plastic litter and microplastics with the aim of the long-term elimination of discharge into the oceans;
(ii) To identify technical and financial resources or mechanisms for supporting countries in addressing marine plastic litter and microplastics;
(iii) To encourage partnerships that undertake activities such as the development of source inventories, the improvement of waste management, awareness-raising and the promotion of innovation in relation to the prevention of marine litter, including plastic litter and microplastics; and
(iv) To analyse the effectiveness of existing and potential response options and activities with regard to marine litter and microplastics at all levels to determine the contributions that they make to solving the global problem.

#### 4.2.2 Status of work

The first meeting of the AHEG (AHEG-1) took place on 29 –31 May 2018 in Nairobi. The meeting highlighted the importance of dialoguing with international and regional organisations, and multilateral environmental agreements and of learning more about the challenges in addressing marine litter under their respective instruments and activities. Available: https://papersmart.unon.org/resolution/adhoc-oeeg-working-documents.

AHEG-2 was held in December 2018 in Geneva. The meeting proposed options for the Group's continued work to be considered at UNEA-4, such as to consider modalities for the establishment of a global knowledge hub, to consider the establishment of a scientific and technical advisory group on marine litter and microplastics, and to consider the establishment of a forum for governments, industry, academia, civil society, and other stakeholders to share experiences and coordinate. Available: https://papersmart.unon.org/resolution/second-adhoc-oeeg.

AHEG-3 was held in Bangkok in November 2019. The meeting provided guidance to UNEP (as the Secretariat) for the preparations of the work mandated by UNEA-4 to be considered at AHEG-4. AHEG-4 and AHEG-5 were planned respectively for May 2020 and November 2020 prior to Covid-19 Crisis. AHEG-4 has now been postponed until further notice. Available: https://papersmart.unon.org/resolution/third-adhoc-oeeg and https://environmentassembly.unenvironment.org/expert-group-on-marine-litter.

The members of the AHEG include representatives from regional conventions and organisations (UNEP/UNEA.3/Res.7, para 10(c)). Within the framework of the implementation of its programme of work, AHEG would have to review measures undertaken at the regional level, namely regional response options, activities and actions taken by regional instruments (UNEP/UNEA.3/Res.7, para 10(d)).

### 4.2.3 Scientific Advisory Committee to AHEG

The Scientific Advisory Committee on Marine Plastic Litter and Microplastic was established on the basis of Resolution 4/6, paragraph 2 of UNEA-4 to prepare an assessment on sources, pathways and hazards of litter including plastic litter and microplastic pollution. This Scientific Advisory Committee convened four times through online meetings and one in-person meeting in February 2020. Its work is to be reported to UNEA-5.

## 5. PLASTIC POLLUTION FROM SHIPPING ACTIVITIES AT THE IMO

*Summary of role:* *IMO is the global regulator of international shipping including disposal of waste from vessels at sea and in port reception facilities as well as other potential disposal of matter or substances from vessels that may contain plastic or other noxious contaminants such as possible additives to plastic. Marine environmental issues, including marine plastic pollution, are dealt with primarily by the IMO's Marine Environmental Protection Committee (MEPC). Since 2018, marine plastics have become an item under the Agenda of MEPC.*

*Summary of recommendations and work status:* *An Action Plan to Address Marine Litter from Ships and a Working Group was established under the MEPC, with measures to be completed by 2025. These include the reduction of marine plastic litter generated by shipping in general, as well as in particular from and retrieved by fishing vessels, effectiveness of port reception facilities and new regulatory measures. The MEPC also agreed on terms of reference of a study group on marine litter from ships, a regulatory framework matrix to identify all international regulatory instruments and best practices associated with the issue of marine plastic litter from ships. The last MEPC meeting mandated a Correspondence Group to develop a strategy to address marine litter from ships for discussion at MEPC75 in March 2020.*

*Keywords/research fields:* *International Maritime Organisation (IMO); function and mandate; international shipping; regulatory framework; Marine Environmental Protection Committee (MEPC); MARPOL; work on marine plastic pollution at the MEPC; marine litter from ships; garbage from ships; ALDFG; Action plan to address marine litter from ships; IMO Study on marine plastic litter from ships; correspondence group*

### 5.1 Function and mandate

The International Maritime Organisation (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. 16 international treaties have been negotiated and adopted by states at the IMO for this purpose. The body of the IMO that deals 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.

Disposal of plastic from vessels as garbage has been addressed 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 deals explicitly with garbage generated during the normal operations of a ship and offshore platforms and, where this garbage includes plastic, bans its disposal in all maritime zones. However, other vessel sources of plastic litter and microplastics do not as easily fall within the scope of MARPOL annexes as currently drafted. These include plastic fibres and other microplastic in sewage and greywater as well as plastic in lost containers at sea. Greywater is not included in the regulations on discharge of sewage from ships (MARPOL Annex IV). There is also no mandatory requirement for the loss of containers at sea and/or their tracking in a way that would help combatting of unintended release of plastic materials at sea.

Another area under consideration at the IMO in the context of plastic pollution from shipping is the contribution of abandoned fishing gear to marine plastics as several publications highlight that in a number of marine areas they compose a substantial contribution to marine plastic particles that were sampled. Practices involved in this pollution appear to be the initial placement of fishing gear at sea and subsequent non-retrieval or abandonment which may be motivated by a variety of circumstances, including the legitimate loss or impossibility of retrieval of the gear. Whereas the discharge of plastic at sea is prohibited under MARPOL Annex V and its implementation guidelines, the current language of the provisions do not clearly envisage this situation of initial legitimate placement for fishing purposes and subsequent non-retrieval, except in the case of loss, leaving this situation open to opposite interpretations. One of the difficulties in regulating effectively this situation arises from the fact that it is at the interface of the mandate of the IMO and the FAO and that, unlike MARPOL Annex V, the relevant FAO instruments are non-mandatory.

The mandate of the MEPC includes all environmental impacts from shipping activities that are conducted under IMO regulations, and shipping activities that should be regulated. The MEPC holds three sessions over a two-year cycle. The last session, MEPC 74, and was held in May 2019. The MEPC 75 which planned for March 2020 has been postponed until further notice due to the Covid-10 crisis.

## 5.2 Adoption of MARPOL by ASEAN+3

Table 1.3.5.1. Status of adoption of the MARPOL Convention and its Annexes in ASEAN+3.
Legend: Red: no adoption; Green: adoption.

| MARPOL | Status of Adoption | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BRN | KHM | CHN | IND | JAP | KOR | LAO | MYS | MYN | PHL | SGP | THA | VNM |
| Annexes I and II: Oil and noxious liquid substances respectively | | | | | | | | | | | | | |
| Annex III: Harmful substances carried by sea in packaged form | | | | | | | | | | | | | |
| Annex IV: Sewage from ships | | | | | | | | | | | | | |
| Annex V: Garbage from ships | | | | | | | | | | | | | |

MARPOL is widely adopted by ASEAN+3 countries, including Annex V. Of note, Adoption of Annexes III to VI require separate adoption process for each and are therefore independent from prior adoption MARPOL and its Annexes I and II. Governments of ASEAN+3 countries are also represented and active in working and correspondence groups of the MEPC.

## 5.3 Work on marine plastic pollution from shipping at the IMO

### 5.3.1 MEPC

Following UNGA's adoption of the SDGs, the SDGs were introduced into the strategic planning of a number of relevant international bodies. The IMO is one of 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 supporting 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 Part 1, Section 3.6.1) for detailed consideration and action as deemed necessary. The issue was widely supported as one that concerns plastic pollution from vessels and offshore structures.

Marine plastic litter was subsequently added as an agenda item of the MEPC in June 2018 (MEPC 72) with an output of 'development of an action plan to address marine plastic litter from ships'. The Working Group on Marine Plastic Litter was established at MEPC 73 (October 2018) and the Action Plan to Address Marine Plastic Litter from Ships was adopted, 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 is still to be followed-up on once the work of the Working Group reaches this new workstream proposed by Indonesia.

Items of the Action Plan to Address Marine Plastic Litter from Ships 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.

(Available: http://www.imo.org/en/MediaCentre/HotTopics/marinelitter/Documents/IMO%20marine%20litter%20action%20plan%20MEPC%2073-19-Add-1.pdf)

Under the Action Plan, the Regional Sea Conventions are associated partners to conduct a study on marine plastic litter, including macro- and microplastics, from all ships (see page 9 of IMO/MEPC/Reso.310(73), adopted on 26 October 2018).

At MEPC 74 on 13–17 May 2019, the MEPC approved the report of the Working Group on Marine Plastic Litter, including the terms of reference of an IMO study on marine plastic litter from ships, and a regulatory framework matrix that identified all international regulatory instruments and best practices associated with the issue of marine plastic litter from ships. This regulatory framework matrix is to be updated by the Secretariat and posted on IMO website.

A Correspondence Group was established to finalize a draft strategy to address marine plastic litter from ships, based on discussions during MEPC 74, and to report to MEPC 75. This strategy will include a table showing actions of the Action Plan in short-term, mid-term, long-term and continuous categories, as well as a timeline of follow-up actions. Available: http://www.imo.org/en/MediaCentre/MeetingSummaries/MEPC/Pages/MEPC-74th-session.aspx.

MEPC 74 also raised the question of determination of the most appropriate instrument to address the responsibility and liability for plastic consumer goods in containers lost at sea from ships and invited states and international organisations to submit proposals to the IMO Legal Committee (LEG 107), in March 2020. However, this meeting has been postponed.

### 5.3.2 At PPR

At the meeting of the Sub-Committee on Pollution Prevention and Response (PPR-7) in February 2020, PPR-7 established a Correspondence Group on Marine Plastic Litter from Ships, with a view to progressing work in relation to marine plastic litter. This includes:

- Several potential amendments to MARPOL Annex V to extend its scope and clarify it;
- New potential requirements in Annex V on the mandatory reporting of the loss or discharge of fishing gear to the coastal state or the administration of the flag of the vessel to the IMO; this could include the removal of a condition to the obligation of reporting linked to the fact that the discharged fishing gear 'poses a significant threat to the marine environment or navigation' (Annex V - Regulation 10.6) as it leaves the requirement open to interpretation; and
- Potential amendments to the 2017 Guidelines for the Implementation of MARPOL Annex V in accordance with the new provisions, to provide more detailed information on the implementation of the new provisions and to ensure compliance.

PPR-8 is scheduled for January 2021.

These ongoing issues are of great relevance to Southeast Asia where shipping density is particularly high and reception facilities for different waste streams from vessels are known to be commonly unavailable and generally inadequate. ALDFGs are also a growing issue in the region with a fishing fleet that is much larger than that of other regions and ghost nets being frequently found.

## 6. DUMPING OF WASTE AT SEA (LC/LP)

*Summary of role:* *The 1972 London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its 1996 Protocol (LC/LP) promote effective control and prevention of pollution of the sea by dumping of waste and other matter. Given this mandate, LC/LP also addresses the dumping of plastic waste generated on land or offsfore into the ocean.*

*Summary of recommendations and work status:* *Dumping of plastic waste at sea is prohibited under the LC/LP. Additionally, the governing bodies of LC/LP adopted a statement encouraging action to combat marine litter including through the identification and control of marine litter at source and to encourage monitoring, additional study and knowledge-sharing. An inventory on the workstreams carried out under the bodies of LC/LP on the issue of marine litter and microplastics is being developed.*

*Keywords/research fields:* *London Convention/Protocol (LC/LP); function and mandate; provisions on plastics and ongoing work on marine plastic; persistent plastics and other persistent synthetic materials; dumping at sea; assessment of wastes proposed for disposal at sea; ongoing work; presence of plastics in the waste streams; recommendation to encourage action to combat marine litter; marine litter; microplastics*

### 6.1 Function and 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. The LC follows a 'black list/grey list' approach: Annex 1 (black list) contains materials which are prohibited from dumping at sea, while Annex 2 (grey list) contains those that require special permits to be dumped at sea. The LP follows a 'reverse list' approach in that it prohibits the dumping of all materials unless they are explicitly permitted. The LC/LP does not apply to land-based pollution, except if it is loaded onto a vessel for the purpose of disposal at sea. The IMO provides the secretariat of the LC/LP but the meetings of the governing bodies are separate from the meetings of the MEPC. The LC/LP is administered separately from other IMO treaties (which are focused on 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 the United Nations Convention on the Law of the Sea (UNCLOS) and all states in ASEAN+3 (except Cambodia) are a party to UNCLOS. As the only international body competent to establish global standards on dumping is the LC/LP, the work of the LC/LP is relevant to all states in ASEAN+3, whether or not they are a party to the LC/LP.

## 6.2 Work on marine plastics

### 6.2.1 Mechanism under the Convention and the Protocol

Disposal of 'persistent plastics and other persistent synthetic materials' is prohibited under both the London Convention and its Protocol. However, there has been no further definition of substances that would qualify as 'persistent plastics and other persistent synthetic materials' under the Convention and its Protocol.

In the situation where 'persistent plastics and other persistent synthetic materials' is not the waste stream being envisaged, but where another waste stream (such as dredge sludge, or seaweed) is considered for sea disposal which contains 'persistent plastics and other persistent synthetic materials', the question can be seen differently. In this case, the disposal of plastic at sea is incidental to the main disposal of another waste, and the point at which it would be considered as contaminated is a question that arises.

While dredge sludge and organic matter can be considered for disposal, they require a prior general permit to be granted after an assessment of the waste proposed for disposal. The Guidelines adopted by the governing bodies of the LC/LP for the Assessment of Wastes Proposed for Disposal at Sea includes an eight-step procedure: (i) waste characterization; (ii) waste prevention audit and waste management options; (iii) action list; (iv) selection of dump-site; (v) impact hypothesis; (vi) permit decision; (vii) permitting system; and (viii) monitoring of compliance and impact.

It is in particular in step 3 that the presence of plastic in the waste stream can be addressed. The 'action list' (step 3) is a mechanism for screening candidate wastes and their constituents on the basis of their potential effects on human health and the marine environment. Substances selected for consideration in an action list are expected to be those that are toxic, persistent and bio-accumulative such as plastics and associated contaminants. In the context of disposal of dredged material, this step typically involves action levels to be established as decision rules that identify dredged material that may be disposed with minimum adverse risk. While such action levels have been adopted in national laws and policies, there is no adopted standard under the LC/LP. There is therefore no clear guidance on the point at which the presence of plastic material in a waste stream would prevent its disposal at sea under the LC/LP.

### 6.2.2 Ongoing work

In 2014, the Scientific Groups 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 with regards 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. Available: http://www.imo.org/en/OurWork/Environment/LCLP/newandemergingissues/Documents/Marine litter review for publication April 2016_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; encourages member states to make every effort to combat marine litter, including through the identification and control of marine litter at source; and encourages monitoring, additional study and knowledge-sharing on this issue.

The Scientific Group and Conference of Parties (COP) 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 ongoing interest for these bodies include:

- Developing methods to enable routine, reliable monitoring, assessment and reporting of plastics and microplastic contaminant levels in waste streams disposed at sea as soon as possible;

- Plastics and microplastics in sewage sludge and dredged materials, sampling and analytical protocols and relationship between concentrations and effects;

- 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)

The Scientific Group of the LC/LP met in March 2019 and the next meeting, which was initially scheduled for March 2020 could not be held due to the Covid-19 crisis. The Governing bodies are scheduled to meet on 28 September 2020.

## 6.3 Status of adoption

Table 1.3.6.1. Status of adoption of the London Convention and its Protocol in ASEAN+3.
Legend: Red: no adoption; Green: adoption.

| Instruments | Status of Adoption | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BRN | KHM | CHN | IND | JAP | KOR | LAO | MYS | MYN | PHL | SGP | THA | VNM |
| London Convention | | | | | | | | | | | | | |
| London Protocol | | | | | | | | | | | | | |

Whilst the status of adoption of these instruments is low in ASEAN+3, the LC/LP COP is the competent organisation under UNCLOS for the adoption of global rules, standards and recommended practices and procedure on pollution by dumping. Furthermore, under UNCLOS, states shall adopt laws and regulations that are no less effective in preventing, reducing and controlling pollution then the global rules and standards. All ASEAN+3 states are therefore expected to take into account the work of the LC/LP, including on pollution from marine plastics when developing their own domestic measures.

# 7. HAZARDOUS AND TOXIC CONTAMINANTS: BASEL, STOCKHOLM AND ROTTERDAM CONVENTIONS

## 7.1 The Basel Convention

***Summary of role:*** *The Basel Convention regulates the transboundary movement of hazardous waste and other wastes to make such trade operate in accordance with environmentally sound management principles. Until May 2019, as most plastic material was not considered to be hazardous, most trade of plastic scrap and waste could be considered to fall outside the scope of measures. However, the 2019 amendments clarify the scope of plastic wastes presumed to be hazardous and therefore subject to the PIC procedure.*
*The Basel Convention plays a complementary role with that of the Stockholm and Rotterdam Conventions (see details on these conventions below). Together they provide for regulations on different aspects of the management of environmentally hazardous materials and aim to restrict and control the production, use and trade of hazardous chemicals for production or as waste.*

***Summary of recommendations and work status:*** *The 2019 amendment come in the context of the strengthening of the joint work programme of the Basel, Stockholm and Rotterdam Conventions which started in 2017 which includes joint effort on hazardous substances from plastic products. This also includes the establishment of a 'triple COP,' meaning that meetings of their respective COPs occur concomitantly or jointly for subjects that fall within the scope of each three such as the regulation of hazardous substances associated with plastic products. The Working Group of the Basel Convention Partnership on Plastic Waste was also established in 2019 and its work is ongoing.*

***Keywords/research fields:*** *Basel Convention; Stockholm Convention; Rotterdam Convention; triple COP; function and mandate; transboundary movements of hazardous wastes and their Disposal; persistent organic pollutants; POPs; prior informed consent; PIC; hazardous chemicals; technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal; plastic waste partnership; adoption of Conventions in ASEAN+3*

### 7.1.1 Function and 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 and other wastes. It establishes a strict consent mechanism for the export of hazardous waste.

It was adopted in reaction to the expansion in the export trade of hazardous waste. The export of hazardous waste for the purpose of disposal from developed to developing countries is generally prohibited. In 1995, the Basel Ban further prohibited transfers of hazardous waste for recycling or recovery operations from developed to developing countries. Waste is hazardous under the Convention if it meets the conditions set out in Annex I and/or II, or under the legislation of the importing state. Hazardous waste addressed by this Convention includes both organic and inorganic contaminants.

First, the Basel Convention seeks to control the transboundary movements of hazardous waste and other wastes. Second, it includes the reduction in generation of hazardous wastes and the promotion of environmentally sound management of hazardous wastes and other wastes. It embraces a waste management approach known as the proximity principle, according to which waste should, as far as possible, be disposed of in the state where it is generated.

Until May 2019, as most plastic material was not considered to be hazardous, most trade of plastic scrap and waste could be considered to fall outside the scope of measures. In particular, Annex IX included a list of solid plastic waste products (fully polymerised scrap plastic materials made) that could be traded, even if they were mixed, provided that they were not mixed with other wastes or contaminated by hazardous wastes.

These included in particular the following list (now replaced by the 2019 amendments):

(i) *Scrap plastic of non-halogenated polymers*: ethylene, styrene, polypropylene, polyethylene terephthalate, acrylonitrile, butadiene, polyacetals, polyamides, polybutylene terephthalate, polycarbonates, polyethers, polyphenylene sulphides, acrylic polymers, alkanes C10-C13 (plasticiser), polyurethane (not containing CFCs), polysiloxanes, polymethyl methacrylate, polyvinyl alcohol, polyvinyl butyral, polyvinyl acetate

(ii) *Waste resins*: urea formaldehyde resins, phenol formaldehyde resins, melamine formaldehyde resins, epoxy resins, alkyd resins, polyamides

Fluorinated polymer wastes were also included in this list of 'clean' plastic waste even if mixed together, provided that they were not post-consumer waste.

The Technical Guidelines for the Identification and Environmentally Sound Management of Plastic Wastes and for their Disposal were adopted in 2002 to support waste prevention and reduction, including hazardous constituents (UNEP/CHW.6/21). The guidelines are available at: http://www.basel.int/Implementation/TechnicalMatters/DevelopmentofTechnicalGuidelines/TechnicalGuidelines. These guidelines are currently being revised (see ongoing work below). A number of other guidelines developed under the Basel Convention apply to plastic waste and reducing the generation thereof.

The 2019 amendments are detailed below.

### 7.1.2 Adoption in ASEAN+3

Table 1.3.7.1. Status of adoption of the Basel, Stockholm and Rotterdam Conventions in ASEAN+3.
Legend: N: not a party; N.na: No notification of non-acceptance as of 20 February 2020; S: signed only.

| Instruments | Status of Adoption | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | BRN | KHM | CHN | IND | JAP | KOR | LAO | MYS | MYN | PHL | SGP | THA | VNM |
| Basel Convention | 2002 | 2001 | 1991 | 1993 | 1993 | 2010 | 2010 | 2015 | 2015 | 1993 | 1996 | 1997 | 1995 |
| *1995 Ban Amendment* | 2002 | N | 2001 | 2005 | N | N | N | N | N | N | N | N | N |
| *2019 amendments on plastic* | N.na | N.na | N.na | N.na | N.na | N.na | N.na | N.na | N.na | N.na | N.na | N.na | N.na |
| Rotterdam Convention | N | 2013 | 2005 | 2019 | 2004 | 2004 | 2010 | 2004 | N | 2005 | 2005 | 2004 | 2007 |
| Stockholm Convention | N | 2006 | 2004 | 2009 | 2004 | 2007 | 2016 | 2002 (s) | 2004 | 2005 | 2005 | 2005 | 2002 |

All states in ASEAN+3 are a party to the Basel Convention although few have accepted the 1995 Ban Amendment.

However, they have accepted the 2019 amendments relating to the trade of plastic waste. These 2019 amendments are of different nature as the 1995 Amendment because they affect only Annexes II, VIII and IX and were made by decision 14/12 of the Basel Convention COP in 2019. Amendments to annexes are the subject of a different amendment procedure than amendments to the text of the Convention. No formal acceptance is necessary. Member states are bound at the expiry of a 6-month period that starts from the communication of the adoption of the amendments by the depository, unless they notify their non-acceptance. This 6-month period expired on 23 March 2020 and no state in ASEAN+3 has notified its non-acceptance.

### 7.1.3 2019 amendments to the Basel Convention (BC COP14, decision 12) and guidelines revision

*The 2019 Amendments*

The 2019 amendments are particular to plastics and consist of amendments to its three annexes which define hazardous plastic wastes, as well as the conditions for potentially-hazardous plastic waste to be the subject to regulation of the transboundary trade under the Basel Convention. Entry into force of these amendments is set for 1 January 2021, which means that the superseded provisions will apply until 31 December 2020.

In a nutshell, these amendments clarify the existing categorisation of plastics presumed to be hazardous and therefore subject to the Prior Informed Consent (PIC) procedure, as previously provided for. They also add a new classification of mixed plastics, also requiring PIC, and a new categorisation of ‘clean’ uncontaminated plastics that do not require PIC.

In more specific details, these amendments can be summarised as follows:

- The amendment to Annex VIII (with the insertion of a new entry A3210) clarifies the scope of plastic wastes presumed to be hazardous and therefore subject to the PIC procedure. To do so the entry A3210 creates a new general category of plastic waste which is considered as *a priori* hazardous: ‘plastic waste, including mixtures of such waste, containing or contaminated with Annex I constituents, and it exhibits annex III characteristic', meaning that it is 'toxic' or 'ecotoxic', or can be responsible for 'toxic' or 'ecotoxic' leachates.

Consistently, a new entry Y48 in Annex II lists 'plastic waste, including mixture of such waste' as a new category of 'other waste' that requires a PIC procedure. Of note, Annex II items follow a similar treatment to that of 'hazardous wastes' under Annex I of the Convention. Annex I does not list any plastic polymer but it lists wastes from the production or formulation and use of resins, plasticizers and glues/adhesives are, as well as from surface treatment of plastics.

- The amendment to Annex IX (with the insertion of a new entry B3011 which replaces existing B3010) clarifies the scope of plastic wastes presumed to not be hazardous, and, therefore, not subject to the PIC procedure. Annex IX lists wastes that are presumed to not qualify as 'waste' regulated under the Convention unless they contain hazardous materials listed in Annex I and exhibit hazardous characteristics listed in Annex III. The new entry B3011lists the following types of plastic waste that may be exported for recycling in an environmentally-sound manner under the condition that it is free from contamination and other types of wastes:

  (i) Non-halogenated polymers (with the condition that the plastic waste considered is composed of only one of these polymers): polyethylene (PE), polypropylene (PP), polystyrene (PS), acrylonitrile butadiene styrene (ABS), polyethylene terephthalate (PET), polycarbonates (PC) and polyethers.
  (ii) Waste composed of one cured resin or condensation product including urea formaldehyde resins, phenol formaldehyde resins, melamine formaldehyde resins, epoxy resins, alkyd resins;
  (iii) Plastic waste made of fluorinated polymers

  Entry B3011 also lists mixtures of plastic waste consisting of PE, PP and/or PET provided that they are destined for separate recycling of each material and in an environmentally sound manner and are uncontaminated from other wastes.

  Consistently, the entry Y48 in Annex II also creates a corresponding new category of tradable 'clean' plastic waste or plastic waste presumed to not require a PIC provided that it is destined for recycling in an environmentally sound manner.

- The following plastic wastes are therefore now under tighter control: ethylene (other than PE and PP) styrene (except PS), acrylonitrile, butadiene, polyacetals, polyamides, polyphenylene sulphides, acrylic polymers, alkanes C10-C13 (plasticiser), polyurethane, polysiloxanes, polymethyl methacrylate, polyvinyl alcohol, polyvinyl butyral, polyvinyl acetate.

- The waste plastic composed of mixed polymers with the most permissive trade regime is a mixture of PE, PP and PET.

These new restrictions over categories of plastic waste will come into effect on 1 January 2021 and are expected to affect a number of products including electrical wirings, cable insulations and pipe linings used in all kinds of electrical devices (restrictions on fluorinated polymers).

*Revision of guidelines (BC COP14, decision 13)*

At BC COP14, the state parties decided to establish a small intersessional working group (SMWG) operating by electronic means to assist in the updating of the technical guidelines on plastic waste.

## 7.2 The Stockholm and Rotterdam Conventions

***Summary of role:*** *The Stockholm and Rotterdam Conventions provide for regulations to restrict and control the production, use and trade of toxic and hazardous chemicals for production or as waste. The chemicals covered include some of those associated with plastic production, its use and disposal which can be found with marine plastic litter. The Stockholm Convention prohibits, restricts and sometimes aims to eliminate the production, use and import-export of persistent organic pollutants (POPs). Annexes A and B list POPs that must be eliminated or restricted. Annex C focuses on the minimisation of releases from unintentional production of chemicals it lists. A number of POPs under the control of the Stockholm Convention are used as additives, flame retardants or plasticizers in plastics, such as BDEs, HCHs, PFOSA, its salts and perfluorooctane sulfonyl fluoride. The Rotterdam Convention stipulates a prior informed consent (PIC) mechanism for the international trade of hazardous chemicals. Chemicals that are subject to this procedure are listed in Annex III of the Convention and include some of the chemicals also regulated by the Basel and Stockholm Conventions and associated with the production of plastic products or marine plastic litter (i.e. PCB and DDT).*

***Summary of recommendations and work status:*** *Since 2017, the COPs of the Stockholm, Rotterdam and Basel Conventions have strengthened their joint work programme including joint effort on hazardous substances from plastic products. They also set up a 'triple COP' meaning that meetings of their respective COPs occur concomitantly or jointly for subjects that fall within the scope of each three such as the regulation of hazardous substances associated with plastic products. Led to successive amendments to the Conventions resulting in the strengthening of scrutiny and control over plastic wastes, hazardous plastic or plastic-associated substances and their associated chemicals (especially additives and plasticizers). New plastic-related POPs were listed for control in 2018.*

***Keywords/research fields:*** *Stockholm Convention; Rotterdam Convention; Basel Convention; triple COP; function and mandate; persistent organic pollutants; POPs; prior informed consent; PIC; hazardous chemicals; technical guidelines for the identification and environmentally sound management of plastic wastes and for their disposal; plastic waste partnership; adoption of Conventions in ASEAN+3*

### 7.2.1 Function and mandate: The Stockholm Convention

The 2001 Stockholm Convention on Persistent Organic Pollutants (POPs) (Stockholm Convention) is a global treaty to protect human health and the environment from organic pollutants that remain intact in the environment, bioaccumulate in humans and wildlife and have the potential for long-range environmental transport.

POPs are listed under the Convention and potential new POPs are reviewed for listing by a POP Review Committee. Some additives used in plastic or found in recycled plastics (such as plasticizers and flame retardants) may be slowly released into the sea from marine plastic litter. Plastics can also adsorb POPs such as PCB, DDT and dioxins which are frequently detected in marine plastic litter, rendering these chemicals more bioavailable to marine animals.

As of 2019, the Convention controls more than 28 POPs, including those which have been used as additives, flame retardants or plasticizers in plastics such as: brominated diphenyl ethers (BDE); hexabromocyclododecane (HBCDD); perfluorooctane sulfonic acid (PFOS), its salts and perfluorooctane sulfonyl fluoride (PFOSF); and short-chain chlorinated paraffins (SCCP).

This Convention is widely adopted in ASEAN+3. Details of its status are included in Table 1.3.7.1 above.

#### 7.2.2 Function and mandate: The Rotterdam Convention

The 2008 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade (Rotterdam Convention) aims to promote shared responsibility and cooperative efforts among state parties in the international trade of certain hazardous chemicals in order to protect human health and the environment from potential harm. It also facilitates information exchange about the characteristics of hazardous chemicals. Annex III of the Convention lists chemicals that are submitted to the prior informed consent procedure (PIC procedure) to ensure that recipients are fully informed of hazardous characteristics and support their environmentally sound use. It includes 52 chemicals. This formal PIC procedure applies to all substances listed in the Basel and Stockholm Conventions that may still be traded but under a number of conditions (e.g. DDT and PCB). Some chemicals, of which the disposal at sea is prohibited under the LC/LP, are also listed in this Annex III (e.g. mercury).

This Convention is widely adopted in ASEAN+3. Details of its status are included in Table 1.3.7.1 above.

### 7.3. The Triple COP, The Plastic Waste Partnership and Regional Centres

#### 7.3.1 The Triple COP

In 2011, the COPs of these conventions agreed to develop processes to improve coordination and cooperation between them. Since 2013, meetings 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 three conventions and between issues such as plastic pollution and marine litter. They focus on the toxicity of plastics and additives.

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 latest Triple COP (BC COP 14, RC COP 9 and SC COP 9) meetings took place in Geneva in 29 April–10 May 2019. Marine plastic litter and microplastics were discussed in all three meetings and jointly. The possibility of negotiating a new international binding instrument to control pollution from plastic waste and associated hazardous substances was also raised.

### 7.3.2 The Plastic Waste Partnership and tightening of international cooperation

One of the outcomes of the Triple COP was the establishment of a Plastic Waste Partnership under the Basel Convention to improve and promote the environmentally-sound management of plastic waste, and in the long-term, eliminate the discharge of plastic waste and microplastics in the marine environment. The Terms of Reference of the Plastic Waste Partnership is set out in UNEP/CHW.14/INF/16/Rev.1. See also: http://www.basel.int/Implementation/Plasticwastes/PlasticWastePartnership/tabid/8096/Default.aspx.

The COPs of the Rotterdam Convention and the Stockholm Convention also requested their respective Secretariats to work closely with other international organisations, within the scope of their mandates, on activities relating to marine plastic litter and microplastics (Decisions RC 9/9 and SC 9/19).

### 7.3.3 Regional Centres

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 that are involved in issues related to marine plastic waste, mercury and new POPs in Southeast Asian countries include the GEF, USAID and KemI (Swedish Chemicals Agency). The main activity of the Regional Centre thus far has been the organisation of workshops, i.e. the Asian Network for Prevention of Illegal Transboundary Movement of Hazardous Wastes (the most recent meeting was in November 2019), and the Asia Pacific Regional Consultations for the meeting of the Conference of the Parties to the Minamata Convention on Mercury (the most recent meeting was in October 2019).

## 8. FAO COMMITTEE ON FISHERIES (COFI)

***Summary of role:*** *COFI is the subsidiary body of the FAO Council, established at its 13th Meeting in 1965 to the only global intergovernmental forum where major international fisheries and aquaculture problems and issues are examined. Plastics are relevant in the work of COFI in dealing with abandoned, lost or otherwise discarded fishing gears (ALDFG).*

***Summary of recommendations and work status:*** *FAO has undertaken projects and studies on reducing ALDFG and the effects of microplastics in fisheries and aquaculture:*

- *(i) FAO voluntary guidelines on the marking of fishing gear*
- *(ii) A global feasibility project on the marking of fishing aggregating devices (completed)*
- *(iii) A field project in Indonesia focused on the practical application of gear marking and lost gear retrieval in small-scale coastal fisheries (completed)*
- *(iv) Study on microplastics in fisheries and aquaculture*

***Keywords/research fields:*** *FAO Committee on Fisheries (COFI); function and mandate; work on marine plastics: Abandoned; Lost or Otherwise Discarded Fishing Gears; ALDFG; gear marking; lost gear retrieval; voluntary guidelines; work on marine plastics: microplastics; plastic and microplastics in fisheries and aquaculture; FAO Fisheries Circular 1163; Symposium on Responsible Fishing Technology for Healthy Ecosystems and Clean Environment; FAO study on Microplastics in Fisheries and Aquaculture*

### 8.1 Function and mandate

The Committee on Fisheries (COFI), which was established in 1965, is a subsidiary body of the Council of the Food and Agriculture Organisation (FAO), a specialized agency of the UN. It is an intergovernmental 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 and East Asia that are not a member of COFI.

### 8.2 Work on marine plastics: combating ALDFG

A main topic of focus of the FAO is on combatting ALDFG. It aims to reduce ALDFG by 2025 by combatting, minimising and eliminating ALDFG and facilitating the identification and recovery of such gear.

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

A field project was deployed in Indonesia in 2017–2018 on the practical application of gear marking and lost gear retrieval in small-scale coastal fisheries. Under this project, a workshop on gillnet marking and retrieval in Indonesian small-scale fisheries was organised in Bogor in January 2018. Participants to the workshop highlighted that gear marking is viewed as an effective tool in achieving better management tool fishing gear, but needs to be incorporated into a wider holistic framework of best practice measures to achieve maximum effectiveness (available: http://www.fao.org/blogs/blue-growth-blog/towards-voluntary-guidelines-on-marking-fishing-gear/en/).

At its 33rd session in July 2018, FAO-COFI adopted a set of Voluntary Guidelines on the Marking of Fishing Gears to assist states and regional fisheries bodies (RFBs), including regional fisheries management organisations and arrangements (RFMO/As), in developing and applying a system for the marking of fishing gear and related measures to address ALDFG (available: http://www.fao.org/3/ca3546t/ca3546t.pdf).

The Voluntary Guidelines provide:

- Practical means of locating and identifying the ownership of fishing gear;
- Guiding text on the development of appropriate marking systems;
- A framework for undertaking risk assessment to identify the appropriateness or otherwise of implementing a system for marking fishing gear; and
- A basis for the preparation of recommendations and regulations designed to minimise the abandonment loss and discarding of fishing gears and encourage recovery of ALDFG.

Additionally, in 2018, the FAO published the Fisheries Circular 1163 on "[s]takeholders' views on methods to identify the ownership and track the position of drifting fish aggregating devices used by tuna purse seine fisheries". This Circular was the result of an FAO global survey on the marking of fish aggregating devices (FADs) that was initiated in 2017. (See: https://www.wcpfc.int/node/30924.)

On 8–12 April 2019, the ICES-FAO Working Group on Fishing Technology and Fish Behaviour held a Symposium on Responsible Fishing Technology for Healthy Ecosystems and Clean Environment in Shanghai, China. One session of the Symposium was on 'ALDFG: Assessment of quantity and measures to prevent ALDFG and its impact'. (See: http://wgftfb2019.org/web/assets/Uploads/FTFB-2019-ABSTRACT-20190404-update.pdf.)

COFI also collaborates with other organisations on ALDFG and marine litter. In addition to the GPML, COFI is involved in the Global Ghost Gear Initiative (GGGI), and engages, advises and holds workshops with the fishing industry.

Of note, despite the recognition of the problem of ghost nets in the region, the Asia Pacific Fisheries Commission (APFIC) website does not mention ALDFG. The last reports published by the APFIC in 2016 and 2017 do not mention ALDFG either. The APFIC was established as the Indo-Pacific Fisheries Council under the APFIC Agreement in 1948 by the FAO. It is a FAO Regional Fishery Body. (See FAO (2017) Asia-Pacific Fishery Commission, "Report of the Seventy-sixth Session of the Executive Committee of the Asia-Pacific Fishery Commission, Manila, the Philippines, 21–23 February 2017, Bangkok". Available: http://www.fao.org/3/a-i7600e.pdf.)

### 8.3 Work on marine plastics: Microplastics

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

The decision was based on an FAO Study on Microplastics in Fisheries and Aquaculture dated June 2018. The study found that there was a growing amount of micro- and nanoplastics in aquatic environments but a general lack of understanding on this issue (e.g. occurrence of microplastics, sources and flow). However, the study also found that current knowledge suggested that trophic transfer of microplastics would not lead to accumulation in seafood, and that associated PBTs and additives would have a negligible effect on the total human dietary intake of these compounds. These findings are nevertheless still under scientific investigation. The study is available at: http://www.fao.org/3/MX201EN/mx201en.pdf.

The study recommended:

- Application of a risk assessment approach to both environmental risk and potential human health risk through targeted monitoring of microplastic in the environment, biota and seafood product and hotspots identification for prioritization;

- Quantification of relative contributions from land-based and sea-based sources and investigation of pathways; and

- More collaboration between International organisations and regional organisations (such as regional fisheries organisations and Regional Seas programmes) on microplastic and nanoplastic contamination of aquatic environments and potential impacts on food safety and fishery and aquaculture resources.

The next meeting of COFI is scheduled for 13-17 July 2020 in Rome.

## 9. GESAMP

*Summary of role:* *The Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP) is an advisory body of experts tasked to provide status of science on specific topics on marine environmental protection through a mandate granted by UN bodies. GESAMP publishes its finding in public reports. Plastics and microplastics in the marine environment have been a topic of study under GESAMP since 2012.*

*Summary of recommendations and work status:* *GESAMP has established the Working Group 'Sources, Fate and Effects of Plastics and Microplastics in the Marine Environment' in 2012 and produced several reports on pollution from marine debris and microplastic, in particular 'Sources, Fate and Effects of Microplastics in the Marine Environment' Part 1 (2015) and Part 2 (2016); and 'Guidelines For the Monitoring and Assessment of Plastic Litter in the Ocean' (2019).*

*Keywords/research fields:* *Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection; GESAMP; function and mandate; environmental assessments; publications; reports; studies; guidelines and workshops; working group (WG 43); GESAMP reports on plastic pollution in the marine environment; working group (WG 40): Sources, Fate and Effects of Microplastics in the Marine Environment; Guidelines For the Monitoring and Assessment of Plastic Litter in the Ocean; report: A Global Assessment*

### 9.1 Function and 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 organisations 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.

The GESAMP's 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. See GESAMP publications: http://www.gesamp.org/publications/the-new-gesamp-science-for-sustainable-oceans.

This institutional research mechanism is not intergovernmental in that it is not limited to experts nominated by states. Furthermore, none of the current members are from Southeast Asia. However, GESAMP working groups call on experts around the world and each report is submitted to a peer-review process through this network. Their reports have an important credibility and legitimacy in the context of a number of intergovernmental organisations that set international law and policies that are applicable to Southeast and East Asia.

### 9.2 Reports, studies, guidelines and workshops

In 2018, the 45th session of GESAMP established a new working group (WG 43) to build a broader understanding of sea-based sources of marine litter, in particular from the shipping and fishing sectors, including the relative contribution of different sources, analysis of plastic use and management within both industries and the range and extent of impacts from sea-based sources of marine litter. The Terms of Reference of the WG was adopted in April 2019. The first meeting of WG 43 was held by teleconference on 19 June 2019 and the first workshop was held on 28–30 October 2019 in Rome, Italy. The second workshop is scheduled for mid-year 2020. See the update provided at the GESAMP 46th session in September 2019: http://www.gesamp.org/site/assets/files/2040/46_4_6.pdf.

The two concurrent workstreams of the WG 43 are:

(i) An overarching scoping study designed to provide initial information required for IMO's Action Plan to Address Marine Litter from Ships, and help identify priorities within this overarching scope; and

(ii) Scientific research focused on ALDFG. A first report is expected by early 2020 (http://www.gesamp.org/work/groups/wg-43-on-sea-based-sources-of-marine-litter).

The next annual session of GESAMP is scheduled for 7–11 September 2020 in Monaco.

Of note, GESAMP became involved in pollution from marine plastics and microplastics in the early days, when the strong wind of research first begun and worries of this 'new' pollution stream gained steam. In 2012, a Working Group named "Sources, Fate and Effects of Plastics and Microplastics in the Marine Environment" was established to deal with plastic and micro-plastic in the ocean (WG 40) with the Intergovernmental Oceanographic Commission (IOC) as the lead agency, and with additional in-kind or financial support from the IMO, UNEP, the NOAA, Plastics Europe and the American Chemistry Council.

Notable works and events undertaken by GESAMP on pollution from marine plastics include:

- An international workshop on 'Assessing the risks associated with plastics and microplastics in the marine environment', which was held on 21–23 May 2019 and hosted by the secretariat of the Basel Convention in Geneva, Switzerland.

  The Workshop recommended that a global assessment of microplastics in the context of the marine litter problem as a whole be initiated under the leadership of GESAMP, and with the cooperation of UN agencies, regional and national administrations, IGOs and NGOs, in order to further advise policy-makers on many aspects of the marine plastic debris problem which are currently poorly-known and understood. The proceedings of the Workshop are available at: https://www.marinelittersolutions.com/wp-content/uploads/2016/03/GESAMP_Workshop_on_Microplastics.pdf.

- Guidelines for the Monitoring and Assessment of Plastic Litter in the Ocean, 2019.

  This authoritative report has already become a key reference for intergovernmental organisations as well as research projects and papers. The report provides a step-by-step approach in designing and implementing a programme of monitoring of marine plastic litter. Its recommendations are directed at assisting national authorities and regional bodies in setting programmes to establish the current status and trends of contamination of marine litter in the waters under their jurisdiction. (Available: 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.

  This report updates and further assesses the source, fate and effects of microplastics in the marine environment identified in the previous report (see below) carried out by WG 40 of GESAMP. (Available: 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.

  This report provides an improved evidence base to support policy and management decisions on measures that might be adopted to reduce the input of microplastics to the oceans. (Available: http://www.gesamp.org/publications/reports-and-studies-no-90.) It also makes three action-oriented recommendations:
    - To identify the main sources and categories of plastics and microplastics entering the ocean;
    - To utilise end-of-plastic as a valuable resource rather than a waste product; and
    - To promote greater awareness of the impact of plastics and microplastics in the marine environment.

## 10. INTERPOL: ILLEGAL TRADE OF PLASTIC

*Summary of role:* *International Criminal Police Organisation (INTERPOL) facilitates worldwide police cooperation and crime control. INTERPOL provides investigative support, expertise, and training to law enforcement worldwide in battling three major areas of transnational crime: terrorism, cybercrime, and organized crime.*

*Summary of recommendations and work status:* *INTERPOL Environmental Security Programme and its Pollution Crime Working Group participate in coordinated global effort in tackling the illegal trade of plastic worldwide through global law enforcement.*

*Keywords/research fields:* *International Criminal Police Organisation; INTERPOL; function and mandate; INTERPOL Environmental Security Programme; Pollution Crime Working Group (PCWG); illegal trade of plastic work; work; illegal waste crime, capacity building; Operation 30 days of Action, Operation 30 days at sea*

### 10.1 Function and mandate

The INTERPOL Environmental Security Programme (ENS) and its Pollution Crime Working Group (PCWG), in cooperation with several other key stakeholders, has shown coordinated global effort in tackling the illegal trade of plastic worldwide through global law enforcement. PCWG focuses on offshore pollution, land-based and river pollution and waste trafficking through ports.

### 10.2 Ongoing work

INTERPOL recognises the need to tackle illegal plastic waste trade as there has been a clear trend of this illegal trade, with 80% of the illegal goods making their way to the region of the seas of East Asia.

INTERPOL also helps train customs officers on how to recognise illegal shipments according to international and domestic law (e.g. by distinguishing scrap and waste). See: https://www.interpol.int/en/How-we-work/Capacity-building/NCB-and-police-training.

Relevant examples of INTERPOL's activities and operations include '30 Days of Action' and '30 Days at Sea':

- Operation 30 Days of Action was conducted in June 2017, in close cooperation with the European Union Network for the Implementation and Enforcement of Environmental Law (IMPEL) in Europe, and with the UNEP project, Regional Enforcement Network for Chemicals and Waste (UN-REN) in Asia. It was the largest law enforcement operation against illegal waste crime activities, including those that involved plastic waste. These crime activities focused on the illegal shipments of hazardous waste, illegal disposal of hazardous waste and other wastes (including chemicals), illegal landfill activities and dumping sites, and unlawful recycling operations. INTERPOL reported that 43 countries came together in tackling over 650 cases of criminal and administrative waste violations and detecting over 1.5 million tonnes of illicit waste. Three of these countries were in the ASEAN+3: China, the Philippines and Thailand. Available: https://www.interpol.int/en/content/download/5165/file/Operation%2030%20Days%20of%20Action%20Key%20Findings.pdf.

- Operation 30 Days at Sea was conducted in October 2018, in close cooperation with EUROPOL in the European region. It was the first law enforcement operation ever led globally that dealt specifically with marine pollution 'crimes'. In this concept, INTERPOL uses the term 'crime' to designate activities that may not qualify as crimes under international law or national laws, such as illegal discharges from vessels and offshore platforms, ocean dumping, ship breaking, violations of ship emissions regulations, land-based and river-effluent pollution impacting the marine environment. INTERPOL reported that 58 countries came together in tackling close to 100 cases involving businesses relating to illegal plastic bags, which were detected only in Europe. According to INTERPOL, Regional communication and coordination mechanisms greatly facilitated joint operations and sped up information exchanges. Available: https://www.interpol.int/en/content/download/14329/file/Final%20Operational%20Report_Operation%2030%20Days%20at%20Sea_Oct%202018.pdf.

## 11. OTHER UN ORGANISATIONS AND GLOBAL INTERGOVERNMENTAL BODIES INVOLVED IN COMBATTING POLLUTION FROM MARINE PLASTICS

### 11.1 Global Environment Facility (GEF)

*Summary of role:* *GEF provides funding for developing countries and countries with economies in transition to meet the objectives of the international environmental conventions and agreements. GEF support is provided to government agencies, civil society organisations, private sector companies and research institutions, to implement projects and programmes in recipient countries.*

*Summary of recommendations and work status:* *Under the 7th replenishment of the GEF fund, marine litter and microplastics is now a GEF's focal area.*

*Keywords/research fields:* *Global Environment Facility; GEF; funding marine litter and microplastics projects and programmes; GEF Trust Fund; GEF assembly*

#### 11.1.1 Background and aim

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 organisations 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. GEF provided funding to many projects implemented by Regional Seas programmes worldwide such as the GEF/UNEP project 'Reversing Environmental Degradation Trends in the South China Sea and Gulf of Thailand' under COBSEA. Available: http://www.unepscs.org/.

#### 11.1.2 Ongoing work

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

Marine plastics was a key topic of the 2018 GEF Assembly held in Vietnam. 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). According to the GEF, because of the transboundary nature of pollution from marine plastics, global and regional alliances building on public-private partnership are critical to effectively combat this source of pollution. Available: https://www.thegef.org/sites/default/files/publications/GEF%20Assembly_MarinePlastics%20Factsheet_9.4.18.pdf.

At the 56th GEF Council Meeting on 11–13 June 2019 in Washington D.C., the issue of pollution from marine plastic was discussed. Some Council Members encouraged GEF to work further on the issue.

See: https://www.thegef.org/council-meetings/gef-56th-council-meeting. The 57th GEF Council Meeting took place on 16–19 December 2019 and plastic was one of the numerous issues considered. However, agreed initiatives did not focus on this in the context of Southeast and East Asia. GEF 58 and GEF 59 were scheduled for June and December 2020 respectively.

## 11.2 G7 and G20 Action Plans to Combat Marine Litter

*Summary of role:* *Group of Seven (G7) is an intergovernmental economic organisation consisting of seven of the largest advanced economies of the world. The organisation regards itself as a "community of values". An annual Summit is attended by its Members' Leaders while its Members' Ministers and civil servants meet throughout the year to discuss issues such as energy policy, climate change, HIV/Aids and global security. Group of Twenty (G20) was founded at the G7 Finance Ministers' Meeting on 26 September 1999. Its Members are the G7 plus 12 major advanced and emerging economies and the EU. Issues discussed at the G20 focus on shared economic, political and health challenges.*

*Summary of recommendations and work status:* *In 2015, the G7 adopted an Action Plan to Combat Marine Litter. In 2017, the G20 also adopted an Action Plan on Marine Litter which is very aligned with the G7 Action Plan. However, the G20 is more active. In 2019, the G20 adopted the G20 Implementation Framework for Actions on Marine Plastic Litter. It provides G20 Members' commitments for facilitation and collaborative actions to implement the Action Plan whilst emphasising the importance of UN and other relevant intergovernmental bodies.*

*Keywords/research fields:* *Group of Seven; G7; Group of Twenty; G20; Action Plan to Combat Marine Litter; Action Plan on Marine Litter; G20 Implementation Framework for Actions on Marine Plastic Litter*

### 11.2.1 Background and aim

The Group of Seven (G7) consists of Canada, France, Germany, Italy, Japan, the United Kingdom and the United States and has been meeting annually since 1975. In 2015, the G7 highlighted marine litter (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. See: https://www.env.go.jp/water/marine_litter/07_mat13_2_%EF%BC%93-2ALD.pdf.

### 11.2.2 Work and Action Plan

The G7 Action Plan to Combat Marine Litter 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.

The Action Plan also states that G7 countries support the development and implementation of regional action plans to reduce waste entering inland and coastal waters and ultimately becoming marine litter, as well as to remove existing waste. It also states that they recognise the value of existing platforms and tools for cooperation, such as Regional Seas conventions and action plans and therefore support their use. (G7 Action Plan to Combat Marine Litter, page 8)

In 2017, the Group of 20 (G20) also adopted an Action Plan on Marine Litter (available: https://www.mofa.go.jp/mofaj/files/000272290.pdf). The G20 is composed of the G7 countries plus Argentina, Australia, Brazil, China, European Union (EU), India, Indonesia, Mexico, Russia, Saudi Arabia, South Africa, Republic of Korea and Turkey.

The G20's 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. It also includes the launch of a Global Network of the Committed (GNC), a platform linked to UNEP GPML. In their Action Plan, the G20 affirmed that it will work to promote and initiate measures and actions at regional levels to prevent and reduce marine litter. Many concrete actions are also to be implemented at the regional level, such as communication and cooperation between different regions, as well as research and coordination to identify and remediate, through environmentally sound methods, sources of marine waste and concentrated areas of marine litter. The G20 also committed to contributing to the implementation of existing regional plans tackling marine litter and the development of new such plans.

In June 2019, the G20 adopted the G20 Implementation Framework for Actions on Marine Plastic Litter (available: https://www.env.go.jp/press/files/jp/111826.pdf). This Implementation Framework commits G20 members to the facilitation of and collaborative actions for the effective implementation of the Action Plan. Notably, collaborative actions include the establishment by G20 presidencies of a G20 Resource Efficiency Dialogue and a multi-stakeholder platform, as well as the development of a portal website by IGES with the support of the Japan government to share actions and progress on marine plastic litter by G20 members. The site was launched on 23 November 2019 and is available at https://g20mpl.org/. For each member, this site aims to provide a summary of the policy framework, measures, achievements and best practices with respect to marine plastic litter. The countries from Southeast and East Asia that are included on this site are China, Indonesia, Japan, RO KOREA and Singapore. The 'G20 Report on Actions Against Marine Plastic Litter - First information sharing based on the G20 Implementation Framework' is available at https://www.env.go.jp/press/files/jp/112576.pdf.

The G20 Implementation Framework for Actions on Marine Plastic Litter also highlights regional cooperation. It states that the G20 will promote international and regional cooperation, with an emphasis on regional cooperation in collaboration with relevant Regional Seas programmes, Regional Fisheries Management Organisations and other regional initiatives. (G20 Implementation Framework for Actions on Marine Plastic Litter, page 3)

Of note is the proactive role played by Japan in these fora, as well as the ASEAN as a dialogue partner. The next G20 Summit is scheduled for November 2020.

Finally, both G7 and G20 Action Plans also highlight the central role played by UN bodies and initiatives, including UNEP and GESAMP and the need for tighter cooperation in all relevant fora.

### 11.3 Convention on Biological Diversity

*Summary of role:* *The Convention on Biological Diversity (CBD) was signed at the Earth Summit in Rio de Janeiro, Brazil in 1992 to achieve three goals, including conservation of biological diversity, sustainable use of its components, and fair and equitable sharing of benefits arising from genetic resources.*

*Summary of recommendations and work status:* *Under the CBD, an expert workshop was organised to prepare practical guidance on preventing and mitigating the significant adverse impacts of marine debris on marine and coastal biodiversity and habitats in 2014. In 2016, the COP of the CBD acknowledged and urged states to take into account the Voluntary Technical Guidance on Preventing and Mitigating the Impacts of Marine Debris on Marine and Coastal Biodiversity and Habitats.*

*Keywords/research fields:* *Convention on Biological Diversity; CBD; background and aim; work; expert workshop; preventing and mitigating the significant adverse impacts of marine debris on marine and coastal biodiversity; report "Marine Debris as a Global Environmental Problem: Introducing a solutions based framework focused on plastic"; workshop; Voluntary Technical Guidance on Preventing and Mitigating the Impacts of Marine Debris on Marine and Coastal Biodiversity and Habitats*

#### 11.3.1 Background and aim

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 (CBD COP), which meets every two years and advance implementation of the convention. All ASEAN member states are party to the CBD.

#### 11.3.2 Ongoing work

For many other intergovernmental bodies, concern with marine litter and plastic arose initially in the context of the impact of marine debris on marine biodiversity. This triggered the attention of the CBD and the preparation of the 2011 report 'Marine Debris as a Global Environmental Problem: Introducing a solutions-based framework focused on plastic' (available: https://www.cbd.int/doc/meetings/mar/mcbem-2014-03/other/mcbem-2014-03-sbstta-16-inf-15-en.pdf).

Subsequently, in 2012, the CBD COP decided to organise 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 a number of knowledge gaps including:

- 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 marine debris on habitats and/or species, as well as a focus on aquaculture.

- To increase knowledge and information on the sources, volumes and areas of accumulation, develop a risk assessment-based approach to impact by:
    - Modelling the overlap between areas of accumulations and marine species habitats and migration routes; and
    - Focusing on potential hotspots of different debris types and sources to understand and quantify impact.

- 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, on 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.

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

In 2016, the 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 (available: https://www.cbd.int/doc/publications/cbd-ts-83-en.pdf) focuses on actions to address:

- Land-based sources of marine debris through the prevention of waste from reaching the ocean, including via 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; and

- Emerging issues including wet storage, recreational fishing and tourism sector and inclusion of marine debris considerations in labelling and certification schemes.

In 2018, the CBD COP reiterated earlier decisions and emphasised the importance of consultation and cooperation among relevant bodies. The next CBD COP is scheduled for the last quarter of 2020.

### 11.4 The United Nations Development Programme (UNDP)

***Summary of role:*** *The United Nations Development Programme (UNDP) is the UN agency in charge of the eradication of poverty and reduction of inequalities and exclusion. It focuses on implementation of the 2030 Agenda for Sustainable Development.*

***Summary of recommendations and work status:*** *UNDP supports activities relating to the protection of the marine environment in Southeast and East Asia through and with PEMSEA. UNDP also partners with local actors to promote awareness about plastics such as in Thailand and Cambodia.*

***Keywords/research fields:*** *United Nations Development Programme; UNDP; background and aim; SGDs; promoting awareness about plastics, 2030 Agenda for Sustainable Development.*

#### 11.4.1 Background and aim

The United Nations Development Programme (UNDP) is the UN agency in charge of the eradication of poverty and reduction of inequalities and exclusion. It focuses on the implementation of the 2030 Agenda for Sustainable Development which set out the Sustainable Development Goals (SDGs). The SDG relevant to marine plastics is SDG 14 in the context of pollution of the marine environment.

#### 11.4.2 Ongoing work

UNDP also contributes to UN work on waste management to prevent marine litter. Along with UNEP, UNDP has been involved in the protection of the marine environment in Southeast Asia for decades, including through and with the Partnerships in Environmental Management for the Seas of East Asia (PEMSEA).

UNDP has partnered with local actors to promote awareness about plastics, for example in Thailand and Cambodia. See: https://www.asia-pacific.undp.org/content/rbap/en/home

/presscenter/pressreleases/2019/undp-unveils-nationwide-campaign-to-combat-single-use-plastics--.html and https://www.kh.undp.org/content/cambodia/en/home/projects/our-action-for-plastic-pollution-in-cambodia/what-we-re-doing-to-combat-plastic-0.html.

### 11.5 World Health Organisation (WHO)

***Summary of role:*** *World Health Organisation (WHO) is a specialised agency of the United Nations in charge of international public health. Its objective is the attainment of the highest level of health for all people.*

***Summary of recommendations and work status:*** *WHO has highlighted pollution from marine plastics and participated in the UN call to "beat plastic pollution" on 2018 World Environment Day. In August 2019, WHO released research results on "Microplastics in drinking water" on the level of microplastics in drinking water*

***Keywords/research fields:*** *World Health Organisation; WHO; background and aim; public health; marine plastic; beat plastic pollution; microplastics in drinking water*

#### 11.5.1 Background and aim

The World Health Organisation (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.

#### 11.5.2 Work

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

In August 2019, the WHO released a research paper on 'Microplastics in drinking water'. The research concluded that with the current level of microplastics, drinking water does not yet pose any significant risk to human health. However, it does recognize limitations in the evidence for drawing a firm conclusion. Available: https://www.who.int/water_sanitation_health/publications/microplastics-in-drinking-water/en/.

These conclusions are challenged by more recent reports which highlight the numerous sources of exposure of humans to plastics and microplastics, including airborne pollution.

## 11.6 World Meteorological Organisation (WMO)

*Summary of role:* *The World Meteorological Organisation (WMO) provides a framework for international cooperation for the development of meteorology, climatology and operational hydrology. Its focused areas include environment, oceans and public health.*

*Summary of recommendations and work status:* *In 2018, WMO participated in the UN "beat plastic pollution" campaign.*

*Keywords/research fields:* *World Meteorological Organisation; WMO; background and aim; framework for international cooperation; World Environment Day; beat plastic pollution*

### 11.6.1 Background and aim

The World Meteorological Organisation (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 the environment, oceans and public health.

### 11.6.2 Work

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

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

## 12. COMPARATIVE ANALYSIS

The global bodies focused on here are those that have a particular interest in pollution from marine plastic and have been reviewed in this section. These bodies, their corresponding instruments and actions form specialised functional regimes linked to their mandate. To better understand their work, these regimes can be grouped according to their focus area (upstream or downstream research on pollution from marine plastics) and whether they adopt binding or non-binding legal norms and policy directions. See Figure 1.3.12.1. This figure shows that only three specialised regimes have as of now mechanisms on pollution from marine plastics to adopt mandatory rules: the IMO, BSR, and the LC/LP. It also highlights a weakness of the UNEA/UNEP regime despite the fact that it also benefits from the most general mandate to deal with all aspects of pollution from marine plastics.

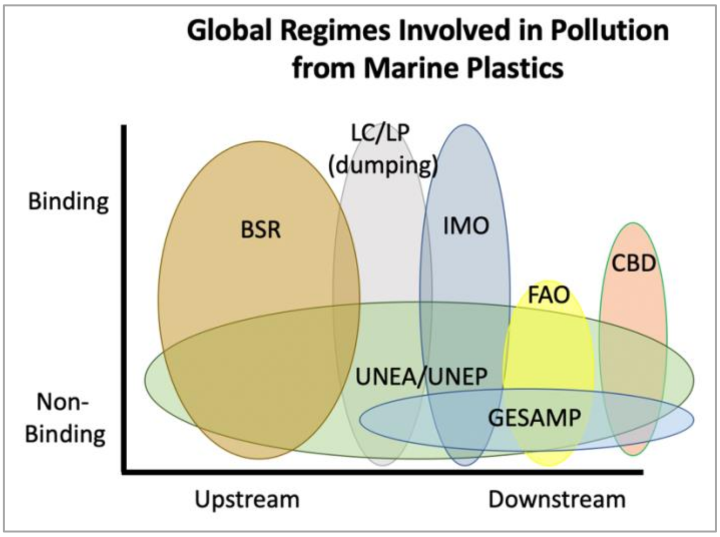



Figure 1.3.12.1. Global regimes involved in pollution from marine plastics.

Table 1.3.12.2 below shows a comparative analysis of research interest by these six global regimes that have had a particular interest in marine plastic pollution. The denomination of 'regime' is used to designate a group of institutions that are institutionally connected and work jointly under the auspices of at least one intergovernmental body. Such regimes can include one or several (related) intergovernmental bodies, bodies of international organisations and their initiatives or programmes. The comparison focuses on the bodies which have been the most active on this topic, have adopted specific and substantive response strategies, have a policy mandate or have provided documents to support the development of guidelines to respond to this pollution threat (e.g. GESAMP).

Three of these regimes stand out with interests in the most research topics considered:
(i) UNEA and UNEP; (ii) the LC/LP, the body in charge of regulating disposal of waste at sea; and (iii) GESAMP, a UN research body. Of note, ASEAN member states are members of UNEP and its work on marine plastics. BY contrast, LC/LP meetings, which also have an important interest in marine plastics and have been assessing issues raised by marine plastics for more than 10 years, are generally attended only by the Philippines. Finally, GESAMP has carried out several of the authoritative studies that provide guidance to response to pollution from marine plastic. Importantly however, whilst GESAMP can publish advisory guidelines, these guidelines are not policy unless they are endorsed by a policy body.

The fact that the other international bodies show a limited interest in some of the research topics can be explained by the specialisation of their mandate relating to particular aspects of marine plastics and sources of plastic pollution.

Nevertheless, two substantive topics stand out as research priorities on the basis that they are highlighted or covered implicitly by all of the seven bodies:

- Ecological and environment impact; and
- Organic and inorganic contaminants associated with plastic debris.

The two research topics that follow are:

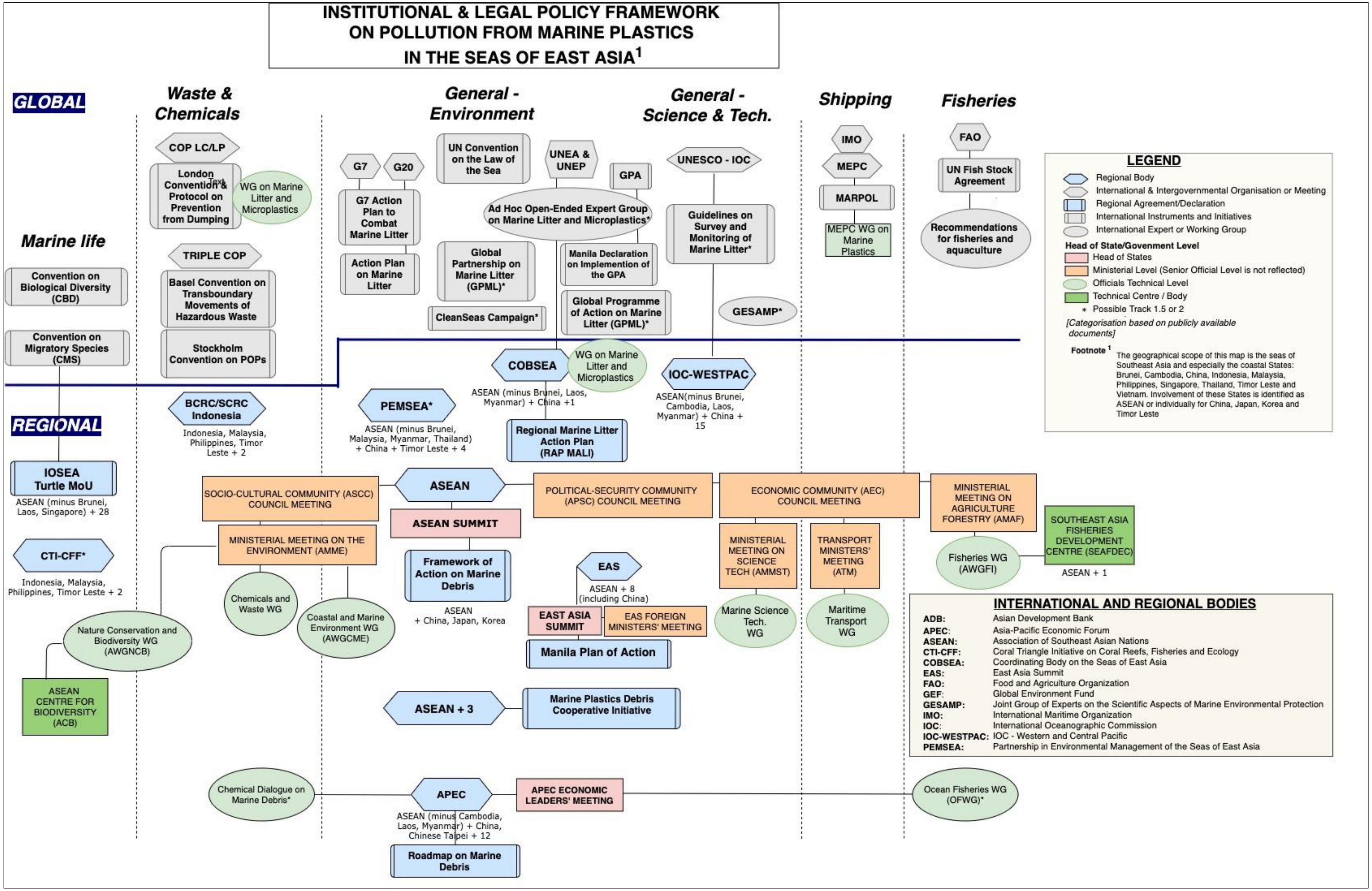
- Socio-economic impact; and
- Contribution from fisheries.

An additional point emphasised by most of the global intergovernmental bodies reviewed in this section (and not identified in Table 1.3.12.2) is the importance of a risk approach to identifying priorities and determining research agenda to respond to pollution from marine plastics.

Table 1.3.12.2. Comparison of research focus by international intergovernmental bodies.
Legend: Red = no research or interest expressed; Light-green = expressed or inferred interest; Dark-green = active or proposed research.

| Research Focus | GESAMP | IMO (Shipping) | LC/LP (Dumping) | BSR (Hazardous/ toxic waste) | UNEA/GPA/UNEP/GPML/Clean Seas | FAO | CBD |
|---|---|---|---|---|---|---|---|
| Policy, laws, adm. measures, action plans, guidelines | | | | | | | |
| Upstream research/waste management | | | | | | | |
| Methodology for monitoring of marine plastic litter, survey and monitoring, pollution status | | | | | | | |
| Accumulation zones & hotspots | | | | | | | |
| Contribution from rivers | | | | | | | |
| Source differentiation | | | | | | | |
| Discharge from offshore infrastructures (incl. aquaculture) | | | | | | | |
| Contribution of fisheries/lost and abandoned fishing gear | | | | | | | |
| Fragmentation and degradation | | | | | | | |
| Ecological and environmental impact | | | | | | | |
| Socio-economic impact | | | | | | | |
| Public outreach/beach clean-up, social perception | | | | | | | |
| Organic/inorganic contaminants associated with plastic pollutants | | | | | | | |
| Port reception facilities | | | | | | | |
| Fibreglass-reinforced plastic vessels | | | | | | | |
| Hull scraping and marine coating | | | | | | | |

Figure 1.4.1.1. Institutional and legal policy framework on pollution from marine plastics in ASEAN+3.



# SECTION 4 – REGIONAL INTERGOVERNMENTAL AND/OR TRACK 1.5 INSTITUTIONAL MECHANISMS, PROGRAMMES AND PROJECTS

## 1. CHART OF GLOBAL AND REGIONAL INTERGOVERNMENTAL BODIES

See Figure 1.4.1.1 above.

## 2. ASSOCIATION OF SOUTHEAST ASIAN NATIONS (ASEAN)

*Summary of role:* *The Association of Southeast Asian Nations (ASEAN) is a regional intergovernmental organisation that has institutionalised wide-ranging cooperation among the ten Southeast Asian states. The ASEAN also facilitates cooperation between its Member States and extra-regional nations/organisations through its ASEAN-Plus mechanisms such as the ASEAN-China Dialogue Partnership, the ASEAN Plus Three (APT), the East Asia Summit (EAS) and the ASEAN Regional Forum (ARF). The issue of marine plastics is addressed by different bodies within each mechanism.*

*Summary of work:* *The ASEAN and ASEAN-Plus mechanisms have issued a number of policy statements on marine plastics, including the 2019 Bangkok Declaration on Combating Marine Debris in the ASEAN Region, and the 2018 EAS Leaders' Statement on Combating Marine Plastic Debris. ASEAN and the APT have marine plastic-specific action plans, such as the 2019 Framework of Action on Marine Debris, and the 2019 ASEAN+3 Marine Plastics Debris Cooperative Action Initiative respectively. Generally, these mechanisms recognise that marine plastic pollution is a regional challenge and have facilitated workshops on marine plastics since 2017.*

*Keywords/research fields:* *ASEAN; ASEAN-Plus; ASEAN-China dialogue partnership; ASEAN Plus Three; ASEAN-Plus dialogue, East Asia Summit; ASEAN regional forum; initiatives; Bangkok Declaration on Combating Marine Debris; Framework of Action for Marine Debris; ASEAN working group on coastal and marine environment; ASEAN Working group on chemicals and waste; ASEAN Centre for Biodiversity; ASEAN-EU; EU-ASEAN development cooperation; Enhanced Regional EU-ASEAN dialogue instrument; ASEAN+3; Marine Plastics Debris Cooperative Action Initiative; EAS Leaders' Statement on Combating Marine Plastic Debris, Manila Plan of Action*

### 2.1 ASEAN and ASEAN-Plus mandate

#### 2.1.1 ASEAN

The Association of Southeast Asian Nations (ASEAN) is a regional cooperative intergovernmental organisation. It currently has 10 member states: Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines, Singapore, Thailand, and Vietnam. It was established in 1967 and has had its current make-up since 1999. It has a comprehensive institutional structure organised around three pillars:

(i) The ASEAN Socio-Cultural Community (ASCC)
(ii) The ASEAN Economic Community (AEC)
(iii) The ASEAN Political-Security Community (APSC)

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 then to the ASEAN Summit, the highest level. All three pillars have several bodies involved in issues related to marine environmental protection.

### 2.1.2 ASEAN-Plus

ASEAN has institutionalised interactions with a number of partner countries and international organisations through its ASEAN-plus mechanisms. Each mechanism comprises ASEAN plus a different configuration of its partners. ASEAN member states typically control the agenda for these mechanisms, which aim to harness the cooperation of ASEAN's partners to address regional issues.

The mechanisms that are of particular relevance to the protection of the marine environment in general, and marine plastics in particular, are the ASEAN-China Dialogue Partnership, the ASEAN Plus Three (ASEAN+3 / APT), the East Asia Summit (EAS), and the ASEAN Regional Forum (ARF). These mechanisms have similar reporting structures to those within ASEAN, with their working groups reporting upwards to the respective Summit bodies, or Ministerial body in the case of the ARF. (See Figure 1.4.1.1.)

Also of note in this context is the development ASEAN-UN cooperation mechanisms. Following less formal dialogue and cooperation that started in the 1970s, the ASEAN Leaders and the UN Secretary-General adopted first an MOU in 2007 and then a Joint Declaration on Comprehensive Partnership between ASEAN and the UN in Bali at the 4th ASEAN-UN Summit on 19 November 2011. Action plans have subsequently been adopted to implement this Joint Declaration. The 2016-2021 ASEAN-UN Plan of Action includes coastal and marine protection in its scope.

*ASEAN-China Dialogue Partnership*

It comprises ASEAN and China. The marine environment is discussed within the framework for ASEAN-China environmental cooperation, where officials from the ASEAN environment sectoral (i.e. ASEAN Senior Officials on Environment) meet with the Chinese officials responsible for environmental issues. Marine environmental cooperation in the South China Sea is also sometimes discussed under the ASEAN-China Senior Officials Meeting for the Implementation of the Declaration on the Conduct of Parties in the South China Sea (SOM-DOC), which reports to the ASEAN-China Foreign Ministers.

*ASEAN Plus Three (ASEAN+3 / APT)*

It comprises ASEAN and the three Northeast Asian states of China, Japan and RO Korea. Environmental cooperation is institutionalised, with the environment officials from these countries reporting to the ASEAN+3 Environment Ministers, who have met regularly every one to two years.

*Other ASEAN-Plus Dialogues*

In the context of the protection of the marine environment in general, and in particular in that of combating pollution from marine plastic debris and microplastics, two other ASEAN Dialogues are very active: the ASEAN-European Union Dialogue Partnership and the ASEAN-Japan Dialogue Partnership. Several research projects have been deployed in the context of these Dialogues that seek to provide support to the ASEAN to combat pollution from marine plastics.

*East Asia Summit (EAS)*

It comprises ASEAN and eight of its Dialogue Partners i.e. Australia, China, India, Japan, New Zealand, the RO KOREA, Russia and the USA. The EAS addresses marine environment issues under its framework for maritime cooperation, rather than environmental cooperation. Progress on cooperation is to be reported annually to the EAS Foreign Ministers and Leaders.

*ASEAN Regional Forum (ARF)*

It comprises ASEAN and 17 other countries. The ARF facilitates marine environmental cooperation through its Inter-Sessional Meeting on Maritime Security (ISM-MS) which recognises that maritime security requires tackling non-traditional security issues related to the marine environment. Unlike the other mechanisms, the ARF does not have a Leaders-level meeting. All cooperation is only reported to the ARF Foreign Ministers.

## 2.2 ASEAN's initiatives

ASEAN member states have acknowledged issues raised by pollution from marine plastics regionally and globally, and have launched a number of initiatives.

### 2.2.1 Bangkok Declaration on Combating Marine Debris in the ASEAN Region

In June 2019, the ASEAN Leaders issued the Bangkok Declaration on Combating Marine Debris in the ASEAN Region, which affirmed member states' commitments to combatting marine debris through: (i) the strengthening of actions at the national level, as well as through collaborative actions at the regional level; (ii) encouraging an integrated land-to-sea approach; (iii) promoting inter-sectoral, multi-stakeholder coordination and private sector engagement; and (iv) strengthening and promoting innovation, research, education and public awareness. The Declaration is available at: https://asean.org/storage/2019/06/2.-Bangkok-Declaration-on-Combating-Marine-Debris-in-ASEAN-Region-FINAL.pdf.

### 2.2.2 Framework of Action on Marine Debris

The Bangkok Declaration was accompanied by the Framework of Action on Marine Debris (FAMAD) (available: https://asean.org/storage/2019/06/3.-ASEAN-Framework-of-Action-on-Marine-Debris-FINAL.pdf). See also: https://asean.org/chairmans-statement-34th-asean-summit/.

The FAMAD comprises four priority areas and sub-items as follows:

(i) Policy Support and Planning
- Regional policy dialogue/discussion
- Multi-sectoral policy (including waste management and circular economy as well as extended producer responsibility (EPR))
- Implementation of relevant laws and agreements (e.g. MARPOL and Basel Convention)
- Regional action plan development

(ii) Research, Innovation, and Capacity Building
- Regional baseline on status and impact (including baseline review and bridging gaps)
- Capacity development for national action plans (including standardization of monitoring and evaluation methods and training)
- Scientific knowledge, technology transfer and innovation solution (including knowledge sharing, partnerships and sharing networks)

(iii) Public Awareness, Education, and Outreach
- Public awareness on status and impact
- Behaviour change and culture
- Platform for knowledge sharing, innovative solutions and best practices (including an ASEAN platform)

(iv) Private Sector Engagement
- Collaboration with private sector and industry for implementation measures
- Private sector investment and contribution

The FAMAD was developed at the Special ASEAN Ministerial Meeting on Meeting on Marine Debris, which was an ad-hoc meeting specially convened by ASEAN member states in Bangkok, Thailand in March 2019 to explore concrete actions to tackle the problem of marine debris in the region. Development of a draft ASEAN Regional Plan of Action on Combating Marine Plastic Debris to improve efforts in managing plastic waste pollution in the oceans and prevent illegal transport of non-reusable, non-recyclable and hazardous waste is ongoing. For more information on the ASEAN FAMAD and comparison with other regional frameworks, see Part 2, Section 1.2.

## 2.3 Relevant ASEAN working groups and centres

According to ASEAN's institutional organisation, 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 six working groups and two activity centres which deal with marine and maritime issues, including issues of marine plastics. (See Figure 1.4.1.1.) Another relevant working group which is not included in this analysis because it does not deal with coastal and marine issues is the ASEAN Working Group on Water (AWGW). However, it is a key stakeholder on river management issues. It is also the ASEAN body named as taking part in the Integrated River Basin Management Initiative jointly developed by PEMSEA, UNDP, ADB, GEF and the ASEAN (AWGW) which focuses on plastic debris taken by rivers to their mouth and into the sea.

Participation in ASEAN working group meetings is not open to the public. The meeting agendas and meeting reports are often not published. However, some of their work is made public. These are highlighted below.

### 2.3.1 ASEAN Working Group on Coastal and Marine Environment (AWGCME)

The AWGCME is the main body dealing with coastal and marine environment issues within ASEAN. Its functions are to ensure that ASEAN's coastal and marine environment are sustainably managed and that its representative ecosystems, pristine areas and species are protected. The next meeting of the AWGCME (21st Meeting), which was planned for June 2020, has been postponed due to Covid-19 crisis. Marine debris including plastics were discussed at the previous meeting as summarised below.

- 20th Meeting of AWGCME, 29–30 January 2019 in Phuket, Thailand, which 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 Multi-Stakeholder 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 with ASEAN on marine debris. ADF is an active organisation on marine debris in the Mediterranean region.

  See: http://www.pcd.go.th/file/17-01-62-01.pdf.

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

### 2.3.2 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 the Basel Convention, the Rotterdam Convention, the Stockholm Convention (see Part 1, Section 3.7 above on the work done under these Conventions), and the Minamata Convention on Mercury. The 4th Meeting of AWGCW was held on 14–15 May 2019 in Nay Pyi Taw, Myanmar.

Whilst little information is available online on the work of the AWGCW, a relevant report from 2017 is available online: Regional Programme Towards a Non-Toxic Environment in South-East Asia – Phase II (https://www.kemi.se/en/files/96b822bbbfe745deb349438afa289238/progress-report-2017.pdf).

Given the push from UNEP (see: https://www.informea.org/sites/default/files/imported-documents/UNEP-CHW-LEAFLET-PUB-Brochure-MarineLitter-2018.English.pdf) and the ongoing discussions at the global level on the regulation of plastic and microplastic through the Basel and the Stockholm Conventions (see: http://www.basel.int/Implementation/MarinePlasticLitterandMicroplastics/Overview/tabid/6068/Default.aspx), 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-associated contaminants (additives and adsorbed substances) are listed under the Stockholm Convention. Furthermore, all ASEAN member states are a party to these Conventions. For more details on these Conventions, see Part 1, Section 3.7 above.

### 2.3.3 ASEAN Centre for Biodiversity (ACB)

Pollution from marine plastic has become an important item on the ASEAN agenda and the ACB is in the right position to be a driver or repository of research on the impact of marine plastics on marine biodiversity. ACB's Director is clear on this topic.

However, the only visible project devoted to the issue, and is (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. See: http://www.pemsea.org/news/pemsea-and-acb-sign-letter-cooperation.

## 2.4 ASEAN-Plus initiatives

With the growing global awareness of the problem of marine plastic pollution, ASEAN member states have pursued initiatives with its partners to address the issue.

### 2.4.1 ASEAN-EU

A selection of notable initiatives and outcomes are set out below.

For the period of 2014–2020, the EU has allocated a fund of €170 million for development cooperation across the three ASEAN pillars. Out of this fund, €10 million has been allocated to the Biodiversity

Conservation and Management of Protected Areas in ASEAN (BCAMP, 2016-2021) project, which aims to enhance the conservation of biodiversity and effective management of protected areas in the ASEAN region. The programme is implemented in close coordination with the EU Delegation in Manila and the ACB in Los Banos, the Philippines. It is unclear whether marine plastics is included.

Cooperative initiatives in marine plastics pollution are supported under the Enhanced Regional EU-ASEAN Dialogue Instrument (E-READI), a development cooperation programme that facilitates exchanges between the EU and ASEAN in priority policy areas of interest.

The identification of paths towards a circular economy has been a particular area of focus of the ASEAN-EU partnership, and has been the subject of a number of meetings and communiques. The most recent ones are listed below.

- The EU and the ASEAN Secretariat conducted a regional gap-analysis on the state of the circular economy in ASEAN member states. The analysis, conducted by a team of experts from the Institute for Global Environmental Strategies (IGES) with support from the EU, developed a knowledge base for follow-up actions by the EU to inspire and assist circular economy approaches to plastic issues in the Southeast Asian region. See: https://www.mfa.gov.sg/Overseas-Mission/ASEAN/Latest-News-in-ASEAN/2019/07/ASEAN-EU-to-enhance-coop-on-protection-of-Env-and-Climate-Change.

- In August 2019, a Policy Brief titled 'Improved Governance of Plastics in the ASEAN Community: A Circular Economy Approach' based on the report 'Circular Economy and Plastics: A Gap-Analysis in ASEAN Member States (2019)' was published, providing an analysis of gaps in plastics management across ASEAN member states.

- On 11–12 June 2019 in Kuala Lumpur, Malaysia, the EU and ASEAN hosted a regional workshop on circular economy for marine plastics. The workshop, conducted back-to-back with the European Commission Directorate-General for the Environment's Circular Economy Mission to Malaysia, emphasised the importance of collaboration between the EU and ASEAN towards a circular economy, and contributed to the EU-ASEAN High-Level Dialogue on Environment and Climate Change. See: https://eeas.europa.eu/delegations/association-southeast-asian-nations-asean/64043/eu-and-asean-committed-towards-circular-economy-plastics-asean-region-kuala-lumpur-11-12-june_en.

### 2.4.2 ASEAN Plus Three (ASEAN+3 / APT)

In November 2018, the Heads of State/Government of the ASEAN+3 (i.e. ASEAN + China, Japan and Republic of Korea) issued the ASEAN+3 Marine Plastics Debris Cooperative Action Initiative. See: https://www.mofa.go.jp/files/000419527.pdf.

This initiative is intended to develop capacity for monitoring plastic waste in the ocean, enhance cooperation in preliminary research, and share best practices in each country. It also includes the following specific steps:

- 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

#### 2.4.3 East Asia Summit (EAS)

In November 2018, the Heads of State/Government of the EAS (i.e. ASEAN + Australia, China, India, Japan, New Zealand, RO KOREA, Russia and the USA) issued the EAS Leaders' Statement on Combating Marine Plastic Debris. The statement emphasised that regional cooperation is necessary to encourage prevention and management of marine plastic debris, including buoys for aquaculture and ghost nets. See: https://cil.nus.edu.sg/wp-content/uploads/2019/02/2018-Manila-POA-to-Advance-PP-Decl-1.pdf and https://cil.nus.edu.sg/wp-content/uploads/2019/02/2018-EAS-Stm-Marine-Plastic-Debris.pdf.

In November 2017, the EAS Heads of State/Government adopted the Manila Plan of Action to Advance the 2012 Phnom Penh Declaration on the East Asia Summit Development Initiative (2018-2022). The Plan of Action 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". See: http://www.indonesianwaste.org/6-7-september-2017-east-asia-summit-conference-on-combating-marine-plastic-debris/.

### 2.5 Events by ASEAN and partners

A selection of recent and notable events is listed below.

- 2nd and 3rd Workshop on Supporting the ASEAN Regional Action Plan for Marine Debris in January and March 2020

- 2019 4th Meeting of the ASEAN Working Group on Chemicals and Waste (AWGCW), in Myanmar

- 2019 ARF Workshop on Marine Debris Management for Sustainable Fisheries and Food Security in Southeast Asia in Nha Trang, Vietnam (13–15 May). Available: https://vietnamnews.vn/environment/519713/vn-to-host-intl-workshop-on-management-of-marine-debris.html#mDRglz7LzclSa1Du.97.

- 2019 Coordinating Meeting on ASEAN Cooperation in Addressing Marine Debris Pollution and Scoping Meeting on the ASEAN-Norway Project on Regional Capacity Building of Reducing Plastic Pollution in Phuket, Thailand (28–31 January). Available: https://www.asean2019.go.th/en/meeting/20th-asean-working-group-on-coastal-and-marine-environment/.

- 2018 ASEAN Meeting on the Management of Plastic and Packaging Waste in Bali, Indonesia (31 October–6 November) 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. Available: 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 November), 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). Available: https://www.iucn.org/news/thailand/201712/iucn-co-hosted-asean-conference-reducing-marine-debris.

- 2017 EAS Conference on Combating Marine Plastic Debris in Bali, Indonesia (September). The Conference discussed proactive ways to increase action on the issue of marine plastic debris in the region. Available: http://www.indonesianwaste.org/6-7-september-2017-east-asia-summit-conference-on-combating-marine-plastic-debris/.

## 2.6 Comparison of research focus by different ASEAN fora

Table 1.4.2.1 below summarises the extent to which the ASEAN and ASEAN-Plus bodies are involved (on the basis of publicly available documents) in the 16 research topics which have been reviewed for this report.

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 an area of interest but little as yet been implemented through active research efforts that has become public. The details of specific ongoing programmes of work being conducted under the technical bodies (AWGCME, AWGCW and ACB) are not publicly available. The general lack of visibility of work done by ASEAN specialised bodies makes their work difficult to assess by the public.

However, as shown in Part 1, Section 2 of this report on the status of scientific knowledge on pollution from marine plastics in Southeast and East Asia, states have recently adopted a series of strong waste management measures and research on the understanding of sources, leakages and impacts. These measures and research are expanding fast. In particular, media coverage shows a very large number of initiatives being launched by governments, public interest groups, industries and partnerships between them all in the ASEAN. One of the early actions taken by many Southeast and East Asian governments has been focused on limiting the use of plastic bags in supermarkets.

Table 1.4.2.1. Research focus of different ASEAN fora with respect to marine plastics.
Legend: Red = no research or interest expressed; Light-green = expressed or inferred interest; Dark-green = active or proposed research.

| Research Focus | ASEAN FAMAD | AWGCME | ACB | AWGCW | ASEAN+3 (APT) | EAS |
|---|---|---|---|---|---|---|
| Policy, laws, administrative measures, action plans, guidelines | Dark-green | Red | Red | Light-green | Dark-green | Dark-green |
| Upstream research/circular economy/waste management | Dark-green | Light-green | Red | Light-green | Dark-green | Dark-green |
| Methodology for monitoring of marine plastic litter, survey and monitoring, pollution status | Dark-green | Red | Red | Red | Dark-green | Red |
| Accumulation zones & hotspots | Light-green | Red | Light-green | Light-green | Light-green | Light-green |
| Contribution from rivers | Light-green | Red | Dark-green: *UNDP-PEMSEA-ADB-ASEAN Project (IRBMI)* | Red | Light-green | Light-green |
| Source differentiation | Dark-green | Red | Red | Red | Dark-green | Light-green |
| Discharge from offshore infrastructures (incl. aquaculture) | Light-green | Red | Red | Red | Red | Dark-green |
| Contribution of fisheries/lost and abandoned fishing gear | Dark-green | Red | Red | Red | Light-green | Dark-green |
| Fragmentation and degradation | Light-green | Red | Red | Red | Light-green | Red |
| Ecological and environmental impact | Dark-green | Light-green | Light-green | Red | Dark-green | Dark-green |
| Socio-economic impact | Dark-green | Red | Red | Red | Dark-green | Red |
| Public outreach/beach clean-up | Dark-green | Red | Red | Red | Dark-green | Red |
| Organic/inorganic contaminants associated with marine plastics | Light-green | Red | Red | Red | Red | Red |
| Port reception facilities | Light-green | Red | Red | Red | Light-green | Red |
| Fibre-reinforced plastic vessels | Red | Red | Red | Red | Red | Red |
| Hull scraping and marine coating | Red | Red | Red | Red | Red | Red |

## 3. COORDINATING BODY ON THE SEAS OF EAST ASIA (COBSEA)

*Summary of role:* *The Coordinating Body on the Seas of East Asia (COBSEA) is a regional intergovernmental forum and decision-making body for policy coordination for the East Asian Seas Action Plan. It comprises nine countries – Cambodia, China, Indonesia, RO Korea, Malaysia, the Philippines, Thailand, Singapore and Vietnam. The COBSEA Secretariat is hosted by Thailand and administered by UNEP. Key funding support has been provided by the Swedish International Development Cooperation Agency for the establishment of SEA Circular.*

*Summary of work:* *COBSEA has adopted a Regional Action Plan on Marine Litter (RAP MALI) in 2008 that has been revised in 2019, including the establishment of a Working Group on Marine Litter to guide its implementation. One of the distinctive components of this plan is that it includes the active removal of land-based and sea-based litter rather than being primarily focused on upstream management and future leakages. Other notable components include implementation of international legal instruments, the establishment of a regional expert group, strengthening and harmonisation of monitoring programmes, as well as knowledge sharing, scientific cooperation and outreach.*

*Keywords/research fields:* *The Coordinating Body on the Seas of East Asia; COBSEA; function and mandate; East Asian Seas Action Plan; Action against pollution from marine plastics, Regional Action Plan, SEA circular, RAP MALI, Regional Capacity Centre for Clean Seas, Regional Node of the Global Partnership on Marine Litter*

### 3.1 Function and mandate

The Coordinating Body on the Seas of East Asia (COBSEA) was established by the 1981 East Asian Seas Action Plan as its policy coordination and intergovernmental decision-making body. It promotes compliance with existing environmental treaties based on member countries' goodwill. The COBSEA Intergovernmental Meetings (IGM) is the decision-making body that determines the content of the East Asian Seas Action Plan, reviews its progress and approves its programme of implementation. Today, it has nine members: Cambodia, China, Indonesia, Malaysia, the Philippines, RO Korea, Singapore, Thailand, and Vietnam. Its Secretariat is based in Bangkok, hosted by the Government of Thailand and administered by UNEP.

The aims of the East Asian Seas Action Plan are:

(i) Assessment of the state of the marine environment;
(ii) 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; and
(iii) Development of suitable coordinating measures for the successful implementation of the Action Plan.

The management of marine plastics is therefore included in the mandate of COBSEA. The Strategic Directions 2018-2022 further strengthen COBSEA's mandate to address marine pollution including plastic litter, with a focus on three themes: (i) land-based marine pollution; (ii) marine and coastal planning and management; and (iii) an overarching governance theme. See: [https://bit.ly/COBSEAstrategicdirections](https://bit.ly/COBSEAstrategicdirections).

COBSEA's funding comes from different sources, depending on activities/projects and spending types (e.g. UNEP, GEF or bilateral donors including states and private actors).

### 3.2 Regional Action Plan on Marine Litter (RAP MALI)

COBSEA's work on marine plastic 'started' with the development of the 2008 Regional Action Plan on Marine Litter (RAP MALI) in January 2008. The 2008 RAP MALI was recently revised to address emerging regional priorities and global frameworks, and the 2019 RAP MALI was adopted by the 24th IGM of COBSEA in June 2019 in Bali, Indonesia. The 2019 RAP MALI provides an overarching regional framework for addressing marine litter in the East Asian Seas as a transboundary issue. It promotes consolidation, coordination and facilitation of efforts towards integrated management of marine litter, comprising actions in relation to preventing and reducing marine litter from land-based as well as sea-based sources, monitoring and assessment, and creating enabling conditions. A Working Group on Marine Litter (WGML) was established to provide strategic and technical support to the IGM and the COBSEA Secretariat, and to and facilitate information exchange and regional cooperation towards the implementation of the RAP MALI. See: https://www.unenvironment.org/cobsea/events/intergovernmental-meeting/twenty-fourth-intergovernmental-meeting-coordinating-body-seas and https://bit.ly/COBSEArapmali.

The RAP MALI comprises four main action items and proposed sub-actions for further development by the WGML:

- Action 1. Preventing and reducing marine litter from land-based sources
  - Legal and economic instruments
  - Integrated waste management
  - Removal of existing litter and its disposal

- Action 2. Preventing and reducing marine litter from sea-based sources
  - Legal and economic instruments
  - Removal of existing litter and disposal

- Action 3. Monitoring and assessment of marine litter
  - Expert monitoring group (under WGML)
  - Regional coherent national marine litter monitoring programmes (in line with regional guidance and global GESAMP guidelines)

- Action 4. Activities supporting the implementation of COBSEA RAP MALI
    - Regional and international cooperation and reporting (including synergies across regional frameworks such as ASEAN)
    - National planning and policy frameworks
    - Research activities
    - Information, education, outreach and involvement of stakeholders
    - Training and capacity building

### 3.3 SEA circular – solving plastic pollution at source

SEA circular is an initiative implemented jointly by COBSEA and the UNEP Regional Office for Asia and the Pacific, with support from the Swedish International Development Cooperation Agency (SIDA), aimed at reducing and preventing marine litter in South-East Asia through better management of the plastic value chain, strengthened scientific evidence, and improved marine litter monitoring, planning, outreach and coordination. See: www.sea-circular.org/about-sea-circular.

This 2018–2023 project (US$6.3 million) promotes a people-centred value chain approach across four outputs:

- Market-based solutions towards 'less plastic wasted';
- Strengthening the scientific basis for decision-making;
- Outreach on marine litter and plastic pollution; and
- Regional networking and multi-stakeholder constituency engagement.

More information on the project, its partners, knowledge products and events is available at: www.sea-circular.org/ and in the Project fact sheet available at: https://openaid.se/activity/SE-0-SE-6-5102017601-ASI-41010/.

### 3.4 Knowledge sharing and capacity building efforts

To support participating countries' efforts to strengthen evidence-based marine litter planning and to build capacity to assess, monitor and address sources, flows and fate of marine pollution, COBSEA is further developing its institutional mechanisms, knowledge sharing platforms and initiatives in line with the RAP MALI.

To this end, COBSEA participating countries requested the Secretariat, in consultation with the WGML, to develop the East Asian Seas Regional Node of the GPML (see Part 1, Section 3.3.3). The purpose of the Regional Node is to support implementation of the RAP MALI by providing a regional marine litter knowledge management and networking mechanism engaging a range of stakeholders addressing marine litter. The Regional Node will facilitate access to scientific evidence, tools, methodologies, training and peer learning, and will seek to catalyse research and development and leverage funding and project development opportunities to address regional needs and priorities.

COBSEA countries further requested the Secretariat to explore the establishment of the new Regional Capacity Centre for Clean Seas (RC3S) in Bali, Indonesia, as a COBSEA Regional Activity Centre to offer regional capacity building services toward reducing and preventing marine litter.

## 4. PARTNERSHIPS IN ENVIRONMENTAL MANAGEMENT FOR THE SEAS OF EAST ASIA (PEMSEA)

*Summary of role:* *The Partnerships in Environmental Management for the Seas of East Asia (PEMSEA) is a partnership arrangement including state and non-state parties, to address the "identified threats to the environment and sustainable development of the Seas of East Asia."*
*Combating marine plastics is one of the key areas of work under the Pollution Reduction and Waste Management Programme of the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA), PEMSEA's management framework.*

*Summary of recommendations and work status:* *PEMSEA's 2018-2022 implementation plan uses a source-to-sea approach. A key initiative is the UNDP/GEF Integrated River Basin Management (IRBM). Much of PEMSEA's work is focused on local governments and communities. In November 2019, the PEMSEA Network of Local Governments (PNLG) announced a Marine Debris Prevention Initiative during the PNLG General Assembly.*

*Keywords/research fields:* *Partnerships in Environmental Management for the Seas of East Asia; PEMSEA; function and mandate; relevant policy statements; work on marine plastics; Source-to-sea approach; Pollution Reduction and Waste Management; Sustainable Development Strategy for the Seas of East Asia; Integrated River Basin Management; Iloilo Ministerial Declaration; Marine Debris Prevention Initiative; PNLG; Manila Bay Area Integrated Information Management System*

### 4.1 Function and 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 IMO as an executing body. It is a partnership arrangement including state and non-state parties, to address identified threats to the environment and sustainable development of the Seas of East Asia. See: https://iwlearn.net/documents/legal-frameworks/partnerships-in-environmental-management-for-the.

PEMSEA has 11 country partners (i.e. Cambodia, China, Indonesia, Japan, DPR Korea, Lao PDR, the Philippines, Republic of Korea, Singapore, Timor-Leste and Vietnam). 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 (i.e. Thailand, Malaysia, Brunei) as members, although they can participate in meetings as observers. Thailand has been the subject of PEMSEA projects despite not being a member and Malaysia attends most meetings as an observer.

Combating marine plastics is one of the key areas of work under the Pollution Reduction and Waste Management program of the Sustainable Development Strategy for the Seas of East Asia (SDS-SEA). The SDS-SEA is the management framework used by PEMSEA and its country partners to guide the sustainable development of oceans and coasts. According to the latest Implementation Plan 2018-2022, partner countries and local governments have responsibilities to reduce marine debris, plastic and microplastics, using the 'source-to-sea' (S2S) approach. See: http://pemsea.org/publications/reports/sds-sea-implementation-plan-2018-2022.

### 4.2 Relevant policy statements by member states

On 29 November 2018, the East Asian Seas Iloilo Ministerial Declaration identified marine debris as a globally-recognized problem and committed to tacking both land and sea-based sources of marine pollution. It is signed by Cambodia, China, Indonesia, Japan, Republic of Korea, DPR Korea, Lao PDR, the Philippines, Singapore, Timor-Leste and Vietnam. See: http://pemsea.org/sites/default/files/Iloilo_Ministerial_Declaration.pdf.

In November 2019, the PEMSEA Network of Local Governments (PNLG) announced a Marine Debris Prevention Initiative during the PNLG General Assembly. See: http://www.pemsea.org/publications/agreements-and-declarations/pemsea-network-local-governments-sustainable-coastal.

### 4.3 Work on marine plastics

PEMSEA uses the 'source-to-sea' approach to combat marine plastic pollution. A key initiative in this context is the UNDP/GEF Integrated River Basin Management (IRBM) project which aims to assist local governments in ASEAN countries to reduce pollution, including those of plastic, and preserving environmental flows in the river basins of the East Asian Seas through 'Integrated River Basin Management'. This five-year project commenced in mid-2019 and concerns primarily Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, the Philippines and Vietnam. See: https://oceanconference.un.org/commitments/?id=20940.

A presentation of the project by PEMSEA's Executive Director, Aimee Gonzales is available at: https://events.development.asia/system/files/materials/2018/10/201810-opportunities-and-constraints-addressing-marine-pollution-east-asia.pdf.

With a similar approach, the Manila Bay Environmental Atlas published by PEMSEA in 2007 and the Manila Bay Area Integrated Information Management System have been further updated in 2018 by the Philippines government.

PEMSEA is also working on pilot projects specifically tailored to address marine plastic pollution through the prevention and management of such waste reaching the ocean in the Philippines. One is a partnership with The Coca-Cola Company Philippines and CARITAS aimed at recycling wastes from several municipalities in Cavite, the Philippines and converting them into school chairs and tables through a highly-scalable participatory process. The other is a partnership with ASEAN and Norway to build capacity to reduce plastic waste in the river systems in ASEAN countries. In this partnership, PEMSEA is the coordinator for the Philippine component, covering the Imus and Ylang-Ylang Rivers, a major tributary of Manila Bay.

## 5. ASIA-PACIFIC ECONOMIC COOPERATION (APEC)

*Summary of role:* *The Asia-Pacific Economic Cooperation (APEC) is a multilateral trade and economic dialogue forum. It is not intended to formulate binding commitments or treaty obligations. However, guidelines or manuals could be developed by working groups*

*Summary of work:* *Numerous projects and workshops have been sponsored and organised by APEC member states on the topic of pollution from marine plastic debris. In 2014, the Xiamen Declaration which encouraged cooperation on the reduction and mitigation of marine pollution, including from land-based sources resulted in the establishment of Virtual Working Group on Sustainable Material Management and Innovative Solutions to the Problem of Marine Debris. In 2019, APEC adopted the 2019 Roadmap on Marine Debris.*

*Keywords/research fields:* *Asia-Pacific Economic Cooperation; APEC; function and mandate; Projects; Events; Roadmap on Marine Debris; Xiamen Declaration; Virtual Working Group on Sustainable Material Management and Innovative Solutions to the Problem of Marine Debris (VWG); APEC Workshop on Innovative Marine Debris Solutions; Capacity Building; Compendium of Preventive Measures and Policies; Understanding and Addressing Marine Debris Impact in the APEC Region; Capacity Building on Global Marine Debris Monitoring and Modeling: Supports Protection of the Marine Environment; APEC Marine Debris Management Guidelines; APEC Workshop on Marine Debris and Microplastics; Report on Economic Costs of Marine Debris to APEC Region*

### 5.1 Function and 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 or otherwise, and endorsed at different levels.

There are currently 21 members who use APEC as a forum for cooperation, based on consensus through working groups and capacity building projects. Works relating to the protection of the marine environment against plastic pollution are currently carried out under two mechanisms: the Oceans and Fisheries Working Group (OFWG) and the Chemical Dialogue.

### 5.2 APEC Roadmap on Marine Debris

The APEC Roadmap on Marine Debris was adopted in Chile in August 2019 by the Third Senior Officials' Meeting. It followed on a 2014 Xiamen Declaration which encouraged cooperation on the reduction and mitigation of marine pollution, including from land-based sources. Available: https://www.apec.org/Meeting-Papers/Annual-Ministerial-Meetings/2019/2019_AMM/Annex-B.

This Roadmap emphasises four areas of cooperation and coordination for the purpose of combating pollution from marine debris:

(i) Policy development, including cross-fora dialogue relevant to APEC region and waste management;
(ii) Capacity building, including cross-fora collaboration;
(iii) Research and innovation, including knowledge sharing; and
(iv) Financing and private sector engagement.

In 2014, the Virtual Working Group on Sustainable Material Management and Innovative Solutions to the Problem of Marine Debris (VGW) was established to bring together the OFWG and the Chemical Dialogue on marine debris. The Terms of Reference of the VGW was endorsed in 2015. The VWG emphasises waste management objectives. See: http://mddb.apec.org/Documents/2015/OFWG/OFWG2/15_ofwg2_025.pdf.

The APEC Marine Debris Stakeholder Meeting on Improving Data and Coordination and Developing New Partnership was held on 2–3 November 2018 in Bali, Indonesia. The meeting's report does not appear to be available online.

### 5.3 Past projects and events

APEC countries have organised a number of APEC-workshops and sponsored projects on the topic of marine debris, including plastic, which can be tracked in APEC's project database. A selection is provided below:

- APEC Workshop on Innovative Marine Debris Solutions held in 2018 to follow up on the 2017 Workshop on Best Practices Sharing on Marine Debris Management in Coastal Cities of APEC Region (see below) to encourage continuous involvement and accelerate the marine debris solution. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2164.

- Project on Capacity Building for Marine Debris Prevention and Management in the APEC Region (Phase 2 – Implementation of Advanced Marine Debris Management Policies). This project was implemented in 2017–2018 to (i) develop training standards and public awareness materials; (ii) develop marine debris guideline/manual in the APEC region, and (iii) establish a regional network between participants and experts for continued collaboration. Of note, representatives from other regional intergovernmental bodies and NGOs were also invited (these include NOWPAP RCU, ASEAN Secretariat, World Bank and Ocean Conservancy). Whilst the project description includes an intention to develop APEC Marine Debris Management Guidelines, no such guidelines have been published yet. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2097.

- Study on the Origin and Distribution of Microplastics in Typical and Marine APEC Region. The project was planned to be undertaken during 2017–2019 to investigate the source and distribution of microplastics in the APEC region, especially in China. No report is available on the website at this stage. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2086.

- The APEC High Level Meeting on Overcoming Barriers to Financing Waste Management Systems to Prevent Marine Litter in the Asia Pacific Region was hosted in Lima, Peru on 14–15 November 2016 to examine ways of overcoming barriers to financing municipal solid waste systems in developing economies. APEC endorsed the Policy and Practice recommendations to overcome barriers to the financing of waste management projects in the APEC region. Available: https://www.apec.org/Press/News-Releases/2017/0406_Oceans.

- A project on Capacity Building for Marine Debris Prevention and Management in the APEC Region (Phase 1: 2016–2017) aimed at raising awareness and attention of the APEC economies, especially those from developing economies, through information sharing, policy formulation, social and economic impact analysis and technical training on marine debris. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=1819.

## 5.4 Ongoing work

The 13 relevant projects implemented or being implemented so far shows APEC's particular concern with the issue of pollution from marine plastics in the APEC region.

Ongoing efforts and projects that are still in progress are difficult to track. However, some are mentioned on APEC's website and/or are known to the authors. A selection of the most notable ones at the scale of the region is set out below:

- The publication of a Compendium of Preventive Measures and Policies that APEC Economies are Taking to Reduce Land-Based Marine Debris was proposed by Chile in 2019 to produce a compendium of existing instruments in APEC economies that monitor, evaluate and control land-based sources of waste which contribute to marine debris. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2378.

- The Workshop on Understanding and Addressing Marine Debris Impact in the APEC Region was proposed by the USA and Chile in 2019. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2391.

- The Project on Capacity Building on Global Marine Debris Monitoring and Modelling: Supports Protection of the Marine Environment was proposed by Indonesia in 2019. The objective is the harmonization of global monitoring tools and systems for marine debris that will support implementation of recommendations formulated in APEC's context and a more cost-effective reduction of marine debris and their impacts. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2439.

- Draft APEC Marine Debris Management Guidelines, developed under the project, Capacity Building for Marine Debris Prevention and Management in the APEC Region (Phase 2 – Implementation of Advanced Marine Debris Management Policies) mentioned above. Whilst a draft appears to have circulated, the documents from the 12th APEC OFWG held in Chile do not. The future of this work is unclear as this point.

- The APEC Workshop on Marine Debris and Microplastics: Blue Citizenship was proposed by China in 2019 to raise public awareness and share progress made by APEC economies in addressing marine debris and microplastics. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2450.

- An Update of the 2009 APEC Report on Economic Costs of Marine Debris to APEC Region project was proposed by the USA in 2018 to include the findings of the 2017–2019 project on Understanding the Economic Benefits and Costs of Controlling Marine Debris in the APEC Region. The 2009 APEC Report on Economic Costs estimated the costs of marine plastic pollution to tourism, fishing, and shipping industries in APEC to $1.3 billion. Available: https://aimp2.apec.org/sites/PDB/Lists/Proposals/DispForm.aspx?ID=2229.

## 6. CORAL TRIANGLE INITIATIVE ON CORAL REEFS, FISHERIES AND FOOD SECURITY (CTI-CFF)

*Summary of role:* *The Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) is a multilateral partnership of six countries and non-governmental members working together to sustain extraordinary marine and coastal resources by addressing crucial issues such as food security, climate change and marine biodiversity.*

*Summary of recommendations and work status:* *CTI-CFF has been focused on beach clean-up, public education and outreach.*

*Keywords/research fields:* *Coral Triangle Initiative; CTI-CFF; function and mandate; work on marine plastics; beach clean-ups; public education; outreach; Coral Triangle Day*

### 6.1 Function and mandate

At the governmental level, the Coral Triangle Initiative on Coral Reefs, Fisheries and Food Security (CTI-CFF) designates broadly the commitments of six governments in the Coral Triangle (i.e. Indonesia, Malaysia, Papua New Guinea, the Philippines, Solomon Islands and Timor-Leste) to engage in cooperative action to address threats to coral reefs, fisheries and food security. The initial commitment was made via 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.

### 6.2 Work on marine plastics

The CTI-CFF has made several communications on the impact of plastics and the need to keep it out of the Coral Triangle. It seems to be primarily focused on beach clean-ups, public education and outreach. One of CTI-CFF's most important events is the yearly Coral Triangle Day, in which the theme of pollution from marine plastic is very present. See: http://www.coraltriangleinitiative.org/news/coral-triangle-day-photo-instagram-competition-winners-announced.

Information on research projects on marine plastics under this programme is not readily available. Nevertheless, it is expected that international NGOs involved in this project (e.g. TNC, WWF and Conservation International) are looking into it.

However, there seems to be a number of local, bottom-up initiatives focused primarily on beach cleaning and awareness raising in the local community (e.g. the No-Trash Triangle Initiative NGO, https://www.no-trashtriangle.org/)

# 7. REGIONAL FISHERIES BODIES

## 7.1 Asia-Pacific Fisheries Commission (APFIC)

*Summary of role: The Asia-Pacific Fisheries Commission (APFIC) is an Article XIV FAO Regional Fishery Body in charge of promoting the full and proper utilization of living aquatic resources in the Asia-Pacific region.*

*Summary of work: No work reported on pollution from marine plastics in documents made available online by APFIC*

*Keywords/research fields: Asia-Pacific Fisheries Commission; APFIC; function and mandate*

### 7.1.1 Function and mandate

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

The APFIC was founded by the Fisheries Committee of the UN FAO in 1948. It has a wide membership which includes the majority of states in the region.

### 7.1.2 Work on marine plastics

The latest APFIC document available online is the 2017 Report of the 76th session of the APFIC Executive Committee. It does not mention pollution from marine plastics in general or from fish aggregating devices (FADs), ghost nets or abandoned, lost or otherwise discarded fishing gear (ALDFGs) as sources of such plastic marine debris.

## 7.2 Southeast Asian Fisheries Development Center (SEAFDEC)

*Summary of role:* *The Southeast Asian Fisheries Development Centre (SEAFDEC) is an autonomous inter-governmental body established in 1967 to promote and facilitate concerted actions among the Member Countries to ensure the sustainability of fisheries and aquaculture in Southeast Asia.*

*Summary of work:* *SEAFDEC has been studying the presence of microplastics in fisheries products and the loss and discard of fishing gear.*

*Keywords/research fields:* *RFB, Southeast Asian Fisheries Development Centre; SEAFDEC; plastic pollution from fisheries; ghost nets; ALDFG;*

### 7.2.1 Function and mandate

The Southeast Asian Fisheries Development Center (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, the Philippines, Singapore, Thailand, and Vietnam. It does not include China.

### 7.2.2 Work on marine plastics

SEAFDEC has been studying the presence of microplastics in fisheries products for a few years. Abandoned, lost or otherwise discarded fishing gear (ALDFG) has also been a focus area.

The Council of SEAFDEC has indicated that the 2020 Regional Plan of Action should take into consideration: marine debris and microplastics (linked to food safety issues) and environmentally friendly fishing gears. This suggests that more studies can be expected on these topics.

Although few publications are available at this point, a study of causes of gear loss in the Arafura Sea, south of Southeast Asia, provides some interesting and valuable analysis for the region. See Richardson et al. (2018), available at: https://www.sciencedirect.com/science/article/pii/S0308597X17307406.

The SEAFDEC Training Department (SEAFDEC/TD) organized the 'Technical Ad Hoc Meeting on Marine Debris in Thailand' on 29 January 2020 in Thailand. It brought together 15 participants from Japan and Thailand. The aim of this meeting was to establish collaboration between SEAFDEC and the Science and Technology Research Partnership for Sustainable Development (SATREPS) Programme, and to develop a 'Centre of Excellence for Marine Plastic Pollution Studies in the Southeast Asian Seas'. SATREPS is a Japanese government programme that promotes international joint research. The programme is a collaboration between the Japan Science and Technology Agency, the Japan Agency for Medical Research and Development and the Japan International Cooperation Agency.

## 8. IOC-WESTPAC

***Summary of role:*** *The Sub-commission for the Western Pacific of the Intergovernmental Oceanographic Commission, a UN body (IOC-WESTPAC), is in charge of promoting international cooperation and coordinating programmes in marine research, ocean observations and services, as well as capacity building in the Western Pacific and adjacent seas.*

***Summary of work:*** *The IOC-WESTPAC has an ongoing project on the distribution, source, fate and impacts of marine microplastics.*

***Keywords/research fields:*** *IOC-WESTPAC; function and mandate; projects; events; distribution; source; fate and impacts of marine microplastics; WESTPAC Workshop on Distribution; Source; Fate and Impacts of Marine Microplastics; International Symposium on Marine Microplastic Pollution and Control; Training Workshop*

### 8.1 Function and mandate

The Sub-commission for the Western Pacific of the Intergovernmental Oceanographic Commission, a UN body (IOC-WESTPAC) was established in 1989 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 comprises 22 states including those of Southeast Asia.

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

In this context, the IOC supports the UNEP Clean Seas campaign and is a sponsor of GESAMP. Available: 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 took place on 2–5 April 2019 in Manila, Philippines.

## 8.2 Work on marine plastics

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

It includes three research areas:

(i) Investigation of sampling and analysis of methodologies for microplastics
(ii) Distribution, source, transportation and fate of microplastics in the marine environment
(iii) Effects of microplastics on marine ecosystems

From this project, guidelines for methodology are under development. The principal investigator on this project is the East China Normal University. The Programme 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.

## 8.3 Events

On 6–8 November 2019, the 3rd WESTPAC Workshop on Distribution, Source, Fate and Impacts of Marine Microplastics in Asia and the Pacific was held in Shanghai, China. Available: http://iocwestpac.org/calendar/917.html.

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

The 2nd International Symposium on Marine Microplastic Pollution and Control was held in Shanghai, China on 24–25 April 2018. Available: http://ismp.ecnu.edu.cn/.

A side event on ‘Research on Marine Debris, including Plastics and Microplastics’, was held at the ‘ASEAN Conference on Reducing Marine Debris in ASEAN Region’ in Phuket, Thailand on 22–23 November 2017. Available: http://iocwestpac.org/calendar/851.html.

In 2017, the IOC-WESTPAC Training Workshop on Distribution, Source, Fate and Impacts of Marine Microplastics in Asia and the Pacific was held in Phuket, Thailand. This event was hosted by the Thai Department of Marine and Coastal Resources, Phuket Marine Biological Center, together with East China Normal University. It covered the following main themes: global and regional status of microplastic research, monitoring and management; national and/or institutional status of microplastic research, monitoring and management; and developing a joint-monitoring plan on microplastic research, monitoring and management in the Western Pacific. The Workshop saw the participation of more than 50 experts from 10 countries in the region. They reviewed the current status of plastics and microplastics pollution at global, regional, and local level, as well as attempted to harmonise protocols in sampling and analysing microplastics in beach, surface water, and marine biota. Country reports from Indonesia, Malaysia, the Philippines, Singapore, Thailand, and Vietnam were made available online. Available: http://iocwestpac.org/calendar/834.html and http://iocwestpac.org/calendar/834.html.

## 9. ARCHIPELAGIC AND ISLAND STATES FORUM

*Summary of role:* *Archipelagic and Island States Forum (AIS Forum) is a forum initiated by Indonesia for archipelagic states and island states around the world in 2018, to strengthen cooperation between members to deal with shared challenges in areas of climate change mitigation, adaptation, and disaster management; economic challenges and opportunities such as the blue economy, responsible and sustainable fisheries and aquaculture, economic growth and creation of decent working opportunities; marine plastic debris; and good maritime governance*

*Summary of work:* *One of the focus areas of the AIS Forum is marine plastic debris. Cooperation on this topic appears to have until now been focused on sharing of smart solutions*

*Keywords/research fields:* *Archipelagic Island States Forum, AIS Forum, Archipelagic States, Island States, Function and mandate, Manado Joint Declaration, marine plastic debris*

### 9.1 Function and mandate

The Archipelagic and Island States Forum (AIS Forum) was officially established by the Manado Joint Declaration adopted by the 1st Ministerial Meeting of Archipelagic and Island States Forum on 1 November 2018 in Manado, Indonesia (the AIS Manado Declaration). The idea of establishing a global forum for archipelagic and island states was an outcome of the Conference on the Archipelagic and Island States Forum initiated by and held in Indonesia in November 2017.

It is designated in the AIS Manado Declaration as an “open-ended, complementary, integrated and inclusive developmental forum, with regular meetings that is in synergy with other initiatives and serving as an avenue for collaboration and sharing of expertise to generate smart and innovative solutions”.

Its mission is to strengthen collaboration and identify specific areas for partnership on efforts linked to combating climate change impacts, as well as conserving and sustainably using the oceans, seas, coastal, and marine resources with an integrated approach. These also include specific mention of collaborative action to combat marine plastic debris. The approach adopted in the Declaration is to use “smart and innovative solutions”, including blended financing mechanisms and an integrated approach. Participating countries to the AIS Manado Declaration from Southeast and East Asia include: Indonesia, the Philippines, Singapore, Japan and Timor-Leste. The map shared on its website suggests that other partners may join the AIS Forum, even if they are not from Southeast or East Asia (www.aisforum.org/aisforum-map). Its Secretariat is located in Jakarta, Indonesia. It is coordinated by the United Nations Development Programme (UNDP). The AIS Manado Declaration is available at: https://static1.squarespace.com/static/5d285a05b4ed260001751e86/t/5d42b4f8f7232f000133fc4f/1564652793910/MANADO+JOINT+DECLARATION+ON+AIS+011118+%281%29.pdf.

The 2nd Ministerial Meeting of the AIS Forum took place on 30 October–1 November 2019 in Manado under the theme of ‘Natural Beauty and Prosperity: Marine Ecotourism Opportunity’. It discussed the progress that the AIS Forum had made, preparations for the 1st High Level Meeting of AIS Forum in 2020, and concrete cooperation among governments and businesses. Within the framework of the Meeting, an AIS Start-up and Business Summit (SBS) was also organised to involve the business sector into the cooperation. Available: https://static1.squarespace.com/static/5d285a05b4ed260001751e86/t/5dd74c71ba1dae0d81676631/1574390901136/CONCEPT%2BNOTE%2BSBS%2BFINAL.pdf.

### 9.2 Work on marine plastics

Much of the work and approach of the AIS Forum is summarised in concept notes and posters available on their website. With respect to marine plastic debris, the initial AIS Forum's Concept Note from 2018 links issues of marine plastic debris in AIS countries to shortage of land areas and resources available for safe disposal of waste, population growth, poorly managed garbage dumps and the disposal of toxic chemicals. The Concept Note is available at: https://static1.squarespace.com/static/5d285a05b4ed260001751e86/t/5d42ddcd1ac53e0001726c65/1564663247623/CONCEPT_NOTE_AIS_Rev1_%2812th_September_2018%29_copy.pdf.

The 'Smart and Innovative Solutions 2019–2020' poster indicates two activities on marine plastic debris in 2019:

- Solutions related to waste for energy, waste for asphalt mix, waste for bricks, plastic neutral policies, and the circular economy to be developed by the AIS Business Responsibility Forum in August 2019; and

- The AIS Youth 'Visualthon' Competition of ideas for zero marine plastic debris. Winners received impact investment in September 2019. The 10 top education posters are available online: https://www.aisforum.org/marine-posters.

(https://static1.squarespace.com/static/5d285a05b4ed260001751e86/t/5d9bedc7b9c85c1e7419bb38/1570500045679/Smart+and+Innnovative+Solutions.pdf)

An example of a solution presented at the SBS Panel Discussion in 2019 was that of Gringgo TrashTech, a technology start-up that seeks to transform waste management through a phone application that tracks plastic waste and puts waste managers in contact with buyers of selected types and quantities of plastic waste. It has received funding from Google and uses artificial intelligence. See: https://blog.google/outreach-initiatives/google-org/reduce-plastic-waste-indonesia/.

## 10. COMPARATIVE ANALYSIS

Table 1.4.10.1 below summarises the research foci and interests of regional intergovernmental bodies with respect to pollution from marine plastics. The AIS Forum is not included due to its early stage of development which renders premature an assessment of its approach.

While none of the bodies cover all 16 research topics we have investigated, some cover more topics. It is important to note that of the seven regional bodies considered, four have a general mandate that covers all aspects of the protection of the marine environment: ASEAN, COBSEA, PEMSEA and APEC. The other three are specialised in biodiversity and fisheries, fisheries and marine science research, respectively. Not all of them have a policy mandate, although they may draft guidelines or standards that may be later embraced by policy bodies.

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 its focus driven by UNEP on marine debris. ASEAN follow closely. 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 1.4.10.1. Research focus of non-ASEAN regional intergovernmental bodies with respect to marine plastics. Legend: Red = no research or interest expressed; Light-green = expressed or inferred interest; Dark-green = active or proposed research.

| Research Focus | ASEAN | COBSEA | PEMSEA | APEC | CTI-CFF | SEAFDEC | IOC-WESTPAC |
|---|---|---|---|---|---|---|---|
| Policy, laws, administrative measures, action plans, guidelines | | | | | | | |
| Upstream research/circular economy, waste management | | | | | | | N.A. |
| Methodology for monitoring of marine plastic litter, surveys and monitoring, pollution status | | | | | | | |
| Accumulation zones & Hotspots | | | | | | | |
| Contribution from rivers | | | | | | | |
| Source differentiation | | | | | | | |
| Discharge from offshore infrastructures (incl. aquaculture) | | | | | | | |
| Contribution of fisheries/Lost and abandoned fishing gear | | | | | | | |
| Fragmentation and degradation | | | | | | | |
| Ecological and environmental impact | | | | | | | |
| Socio-economic impact | | | | | | | N.A. |
| Public outreach/beach clean-up, social perspection | | | | | | | N.A. |
| Organic/inorganic contaminants associated with marine plastics | | | | | | | |
| Port reception facilities | | | | | | | |
| Fibreglass-reinforced plastic vessels | | | | | | | |

# SECTION 5 – FUNDING ORGANISATIONS TO ASEAN STATES

## 1. WORLD BANK

*Summary of role:* *The World Bank is an international donor, focusing on helping developing countries to reduce poverty, increase shared prosperity and promote sustainable development.*

*Summary of work:* *The World Bank approaches marine plastics as a barrier to development and poverty alleviation. Its work on prevention of marine plastic pollution focus on the development of waste management and upstream solutions. It supports studies and provides financial support to prevent pollution from marine plastic debris in East Asia and the Pacific.*

*Keywords/research fields:* *World Bank; engagement on marine plastics; examples of projects and initiatives; studies and reports; improving solid waste management in Indonesia; PROBlue Trust Fund; Indonesia - Marine debris hotspot rapid assessment; Solving Marine Pollution: successful models to reduce wastewater; agricultural runoff; marine litter*

### 1.1 Background and aim

The World Bank is an international donor consisting of five institutions, namely the International Bank for Reconstruction and Development, the International Development Association, the International Finance Corporation, the Multilateral Investment Guarantee Agency, and the International Centre for Settlement of Investment Dispute. Its mission is to provide funding and knowledge for developing countries to reduce poverty, increase shared prosperity and promote sustainable development.

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.

The World Bank has established marine plastics as a priority topic for support in East Asia. It is supporting several studies and providing financial support to prevent pollution from marine plastic debris in East Asia and the Pacific. A World Bank Statement made at the 2019 Special ASEAN Ministerial Meeting on Marine Debris reveals that it has adopted a Regional Marine Plastics Framework and Action Plan to align its engagements across sectors and countries. The Statement also indicates that at the national level, the World Bank has been working with regional governments such as Thailand, Indonesia, Myanmar, Cambodia and Vietnam to support the development and implementation of policies and regulations, enhance analytic capacity, and finance critical investments. Available: https://www.worldbank.org/en/news/speech/2019/03/11/world-bank-statement-at-the-special-asean-ministerial-meeting-on-marine-debris.

### 1.2 Activities and projects

On 5 December 2019, the World Bank approved a $100 million loan for Indonesia to improve solid waste management services for selected cities and districts across the country. Available: https://www.worldbank.org/en/news/press-release/2019/12/05/cleaning-up-indonesias-urban-solid-waste.

The World Bank created PROBLUE, an Umbrella Multi-Donor Trust Fund in 2018 to support implementation of SDG 14 on Life Below Water. One of the four key themes of the Fund is to address the threats posed to ocean health by marine pollution, including litter and plastics. In 2019, the World Bank made available considerable grant resources under the PROBLUE Trust Fund for ASEAN 2019 to further the agenda on marine plastics. Available: https://www.worldbank.org/en/topic/environment/brief/the-world-banks-blue-economy-program-and-problue-frequently-asked-questions.

### 1.3 Reports

The World Bank published a report in 2018 on solving marine pollution, which includes a long section on marine plastics globally, with an emphasis on Southeast Asia. Available: http://documents.worldbank.org/curated/en/651521537901259717/pdf/130154-WP-PUBLIC-SolvingMarinePollution.pdf.

Together with funding from the embassies of Denmark and Norway in Jakarta, the World Bank conducted in 2018 a marine debris hotspot assessment for Indonesia, at the request of and with the support of relevant Indonesian government agencies. This report provides an informed and focused analysis of land-based leakage of solid waste, particularly plastics, into 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 the world's oceans.
Available: 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. Information on ongoing projects is available at: https://www.worldbank.org/en/who-we-are/news/campaigns/2019/east-asia-pacific-marine-plastic-pollution.

## 2. SUPPORT TO ASEAN STATES PROVIDED BY THE COMMONWEALTH

***Summary of role:*** *The Commonwealth is an association of states with declared shared goals such as development, democracy and peace. It has now 53 Members with a total population of about 2.4 billion people. The Commonwealth adopted the Blue Charter in 2018 which recognises marine pollution from plastic as an ocean challenge across the Commonwealth.*

***Summary of work:*** *A number of initiatives are being developed to support research in and limitation of marine plastic pollution such as the Commonwealth Clean Ocean Alliance, Commonwealth Marine Plastics Research and Innovation Framework and the Commonwealth Litter Programme and ACU Blue Charter fellowships.*

***Keywords/research fields:*** *Commonwealth; Commonwealth Blue Charter; The Common Clean Ocean Alliance; Commonwealth Marine Plastics Research and Innovation Framework; Commonwealth Litter Programme; ACU Blue Charter fellowships*

### 2.1 Background and aim

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 organisations. The mandate of the Commonwealth is stipulated in the Charter of the Commonwealth, signed in 2018, which includes 16 values: democracy; human rights; international peace and security; tolerance; respect and understanding; freedom of expression; separation of powers; rule of law; good governance; sustainable development; protecting the environment; access to health; education; food and shelter; gender equality; importance of young people in the Commonwealth; recognition of the needs of small states; recognition of the needs of vulnerable states; and the role of civil society. Available: https://thecommonwealth.org/our-charter.

### 2.2 The Commonwealth Blue Charter

The Blue Charter of the Commonwealth was adopted in 2018. It focuses more specifically on the protection of the marine environment including from plastics. Available: http://thecommonwealth.org/sites/default/files/inline/CommonwealthBlueCharter_0.pdf.

At the 2018 meeting of the Commonwealth Heads of Government, the following issues were highlighted: the importance of sustainable development of the oceans; threats posed from a number of sources including plastic pollution; and the importance of the Commonwealth Blue Charter. Available: 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.

### 2.3 The Commonwealth Clean Ocean Alliance (CCOA)

The CCOA focuses on plastic reduction. Led by the UK and Vanuatu and managed by the UK's Department for Environment, Food and Rural Affairs (Defra), this Alliance was first joined by New Zealand, Sri Lanka and Ghana and subsequently by Australia, Fiji, Kenya and St Lucia. This brought the total support to nine Commonwealth countries. In Southeast Asia, Malaysia, a Commonwealth country, does not appear to have formally joined alliance. CCOA members are asked to sign up to (and implement) the London Protocol, the UN Clean Seas campaign, and the GGGI as a means of meeting their commitments to SDG 14. Available: https://bluecharter.thecommonwealth.org/action-groups/marine-plastic-pollution/.

The Commonwealth Marine Plastics Research and Innovation Framework and the Commonwealth Litter Programme (CLiP) is delivered by CEFAS (see Part 1, Section 6.3.1).

The Commonwealth awards ACU Blue Charter fellowships to 10 emerging scientists to spend six months in an Association of Commonwealth Universities to explore innovative ways to tackle plastic litter in the ocean. The second cohort of ACU Blue Charter was announced on 24 July 2019. None are from Southeast Asia.

## 3. THE ASIAN DEVELOPMENT BANK (ADB)

*Summary of role:* *The Asian Development Bank (ADB) is a development bank focused on the promotion of social and economic development in the Asia-Pacific region.*

*Summary of work:* *ADB launched the Action Plan for Healthy Oceans and Sustainable Blue Economies for the Asia and Pacific region in May 2019. It signed a Letter of Intent with the Ministry of National Development of Indonesia to outline commitment on "South-South and Triangular Cooperation" on the reduction of marine plastic debris. In December 2019, ADB issued a tender on a new project titled "Promoting Action on Plastic Pollution from Source to Sea in Asia and the Pacific" for a knowledge and support technical assistance cluster.*

*Keywords/research fields:* *Asian Development Bank, (ADB); Asia-Pacific; loans; assistance; grants; Action Plan for Healthy Oceans and Sustainable Blue Economies, South-South and Triangular Cooperation, Promoting Action on Plastic Pollution from Source to Sea*

### 3.1 Background and aim

The Asian Development Bank (ADB) was established in 1966 to provide loans, technical assistance, grants, and equity investments to promote the social and economic development in the Asia-Pacific region. It currently has 68 members, of which 49 are from the Southeast and East Asian region (including Brunei Darussalam, Cambodia, China, Hong Kong SAR, Taiwan, Indonesia, Japan, Lao PDR, Malaysia, Myanmar, Philippines, Korea, Thailand and Vietnam).

### 3.2 Action Plan for Healthy Oceans and Sustainable Blue Economies for the Asia and Pacific Region

Whilst ADB's projects on pollution from marine plastic were initially outside Southeast Asia, this has changed. In May 2019, ADB launched the Action Plan for Healthy Oceans and Sustainable Blue Economies for the Asia and Pacific Region, and announced a commitment to expand its investments and technical assistance in ocean health and the blue economy to US$5 billion between 2019–2024. Available: https://www.adb.org/sites/default/files/related/145036/Action%20Plan%20for%20Healthy%20Oceans%20and%20Sustainable%20Blue%20Economies.pdf.

ADB also signed a Letter of Intent with the Ministry of National Development Planning of Indonesia to outline commitment on 'South-South and Triangular Cooperation' on the reduction of marine plastic debris in Indonesia and the wider region of ASEAN and Pacific countries. The collaboration is planned to include technical assistance and knowledge sharing for marine plastic debris solutions. Available: https://www.adb.org/news/adb-indonesia-join-forces-tackling-plastic-debris-sea.

On December 2019, ADB issued a tender on a new project titled 'Promoting Action on Plastic Pollution from Source to Sea in Asia and the Pacific' for a knowledge and support technical assistance cluster

(TA). The initial focus of this project is Southeast Asia (Indonesia, Myanmar, Thailand and Vietnam). This TA is estimated to cost US$5,700,000 with financing from ADB, Japan, RO KOREA and the GEF. The implementation period is December 2019 to July 2023. Available: https://www.adb.org/sites/default/files/project-documents/53068/53068-001-tar-en.pdf.

## 4. NORWEGIAN PUBLIC FUNDING AGENCIES: NIVA AND NORAD

***Summary of role and work:*** *NIVA is conducting fundamental and applied research on marine and freshwaters. NIVA is looking at the effects of microplastics on agricultural systems and power environments. NORAD is the Norwegian Agency for Development Cooperation. NORAD is in charge of the Norwegian Development Programme to Combat Marine Litter.*

***Keywords/research fields:*** *Norwegian Institute for Water Research; NIVA; IMPASSE project; measuring microplastics in blue mussels; soils dumps for microplastics of urban origin; microplastics in the marine environment*

### 4.1 NIVA

#### 4.1.1 Background and aim

The Norwegian Institute for Water Research (NIVA) is conducting fundamental and applied research on marine and freshwaters. Specific areas of research under NIVA include, inter alia, environmental chemistry and technology, oceanography, ecotoxicology and risk assessment, freshwater ecology, marine biology, environmental contaminants, and catchment biogeochemistry. (For more details, see: https://www.niva.no/en/research.) Relating to plastics, NIVA is looking at the effects of microplastics on agricultural systems and power environments (see IMPASSE project: https://www.niva.no/en/research/environmental-chemistry-and-technology and http://www.waterjpi.eu/joint-calls/joint-call-2016-waterworks-2015/impasse).

#### 4.1.2 Activities and projects

NIVA has published a number of research papers relating to microplastics:

- Measuring microplastics in blue mussels, 2017: https://www.niva.no/en/reports/measuring-microplastics-in-blue-mussels.
- Are Agricultural Soils Dumps for Microplastics of Urban Origin, 2016: https://www.niva.no/en/news/microplastics-in-agricultural-soils-a-reason-to-worry.
- Microplastics in the marine environment, 2015: https://www.niva.no/en/reports/95-of-fulmars-in-the-north-sea-had-plastic-in-their-stomachs.

NIVA has contributed to projects in more than 70 countries, including China (where it opened its NIVA China office in 2017: https://nivachina.com/) and the ASEAN. Relating to plastic, NIVA is implementing the ASEAN-Norwegian Cooperation Project on Local Capacity Building for Reducing Plastic Pollution in the ASEAN Region (ASEANO), which was launched on 5 December 2019. This is a regional capacity building project in collaboration with PEMSEA and the ASEAN Secretariat, funded by the Norwegian Development Programme to Combat Marine Litter and Microplastics for the period 2019–2022 (https://www.niva.no/en/projectweb/aseano).

## 4.2 NORAD

### 4.2.1 Background and aim

Norway announced in November 2018 that it has set aside $200 million for the next four-year period to assist developing countries in combating marine litter, through the Norwegian Agency for Development Cooperation (NORAD) and the Norwegian Development Programme to Combat Marine Litter and Microplastics. The main objective of the Programme is to prevent and greatly reduce the extent of marine litter from large sources in developing countries. The focus of the programme is on populous and economically fast-growing countries in Asia with long coastlines (as this is where the problem of marine litter is the most serious). In addition, countries with rapidly-growing economies in Africa and small developing island states also receive support.

### 4.2.2 Activities and projects

Many projects have received funding from this programme, a number of which are being implemented in Asia. These include:

- *Ocean Plastic Turned into an Opportunity in Circular Economy (OPTOCE)*: launched in 2019, the Project is led by SINTEFF in China, India, Thailand, Myanmar and Vietnam to involve local energy-intensive industry, such as cement manufacturing, in using non-recyclable plastic waste as a coal substitute in their production (https://optoce.no/).

- *No Plastic in Nature*: a WWF campaign launched in 2019 to achieve no plastic in nature by 2030, with projects in cities in China, the Philippines, Indonesia, Malaysia, Vietnam, Thailand, and Hong Kong.

- *Clean Oceans through Clean Communities*: launched in 2019 in Indonesia (other possible Asian countries include Vietnam, Cambodia and India), the Project is led by Avfall Norway to reduce emissions of plastics to the ocean through improved waste management through: (i) training programmes focused on system understanding and waste management plans; (ii) support with the preparation and implementation of locally adapted waste management plans; (iii) start-up support for projects working to increase the use of collected waste to its highest possible value; (iv) networking for participants from different geographical areas; and (v) other relevant actors.

- *STOP Marine Plastic (Project STOP)*: launched in 2017 by Borealis and SYSTEMIQ, Project STOP aims to help a city design and then implement a low-cost waste management system in which all households and institutions benefit from collection, and plastics are kept out of the environment. The first city partnership of the project is with Muncar, Indonesia (https://www.stopoceanplastics.com/).

- *Bali Partnership on Marine Debris Action*: launched in 2019, the Bali Partnership aims to stop ocean plastics pollution through circular waste management solutions and contribute to Indonesia's National Action Plan on Marine Plastic Debris, a commitment to reduce ocean plastics by 70% by 2025. Its participants include the Bali Governor's Waste

Management Task Force, the Norwegian Ministry of Foreign Affairs, the Environmental Agency of Bali Province, the University of Udayana, the University of Leeds, the International Solid Waste Association (ISWA), and SYSTEMIQ. So far, the Bali Partnership published a report revealing that just over 48% of waste generated in Bali is managed responsibly, either through recycling or landfill, while the rest is burned or pollutes land, waterways and the ocean. The next phase will be a pilot project using a multi-stakeholder approach in one of the highest leakage sub-districts to ensure comprehensive waste management and stop ocean plastics pollution (https://www.systemiq.earth/bali-governor-announces-initiative-to-end-ocean-plastic-pollution/).

- *ASEAN-Norwegian Capacity Building Project for Reducing Plastic Pollution in the ASEAN Region (ASEANO)*: launched in December 2019, the Project is led by NIVA and the Centre for Southeast Asian Studies (CSEAS) of Indonesia to build capacity to tackle plastic pollution from key sources in the ASEAN region through improved knowledge on sources, releases, transport, and fate of plastic pollution (https://www.niva.no/en/projectweb/aseano)

- *Scaling Up a Socialised Model of Domestic Waste and Plastic Management in Five Cities*: launched in September 2019, the Project is implemented by UNDP Vietnam to develop integrated models to improve domestic waste and plastic management in five cities of Vietnam (i.e. Ha Long, Qui Nhon, Mui Ne, Da Lat and Binh Duong).

Besides the above, NORAD has also provided funding to support international institutions in their action against marine plastic pollution as well as national initiatives in the ASEAN:

- *Marine Litter and Microplastics*: supporting UNEP for action in prevent marine plastic pollution in Asia, Africa and Small Island Developing States (SIDS) countries.

- *MARINFORSK/NORGLOBAL*: supporting Research Council of Norway to strengthen research knowledge on marine litter and pollution in Asia.

- *Marine Pollution Enforcement Project Phase II*: supporting INTERPOL to strengthen global, regional and national law enforcement responses to prevent and reduce marine pollution crime from sea- and land-based sources.

- *PROBLUE*: supporting the World Bank to prevent and reduce marine litter and pollution, as well as to contribute to the rehabilitation of coastal and marine ecosystems with impact area focused on East Asia, South Asia, Africa and SIDS.

- *The Potential Human Health Impacts of Microplastic in the Environment*: supporting the WHO to assess the current state of knowledge on the occurrence of microplastics in the environment, consequent human exposure and potential health impacts.

- *The Indonesia Oceans, Marine Debris, and Coastal Resources Multi-Donor Trust Fund (OMC-MDTF)*: supporting the World Bank to provide technical assistance, analytical support, pilot activities and financing to assist the Indonesian government in developing and implementing its National Oceans Agenda, including support to achieving the country's targets for reduction of marine debris and ocean plastic.

- *IMO Marine Environment Protection of the Southeast Asian Seas (MEPSEAS) Project*, which includes the adoption and implementation of MARPOL Annex V in Cambodia and Thailand. This includes the management of all plastic waste by ships.

- Support of a project proposal concerning the environmentally sound management of plastic wastes 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.

- Support of work on marine plastic debris in Indonesia. For more details, see https://jakartaglobe.id/context/denmark-boosts-funding-indonesia-curb-ocean-waste.

## 5. SWEDISH INTERNATIONAL DEVELOPMENT COOPERATION AGENCY (SIDA)

*Summary of role and work:* *SIDA is Sweden International Development Agency. SIDA is funding a project to combat marine litter and plastic pollution in Southeast Asia to be implemented by UNEP and COBSEA since 2018.*

*Keywords/research fields:* *Swedish International Development Agency (SIDA); project to combat marine litter and plastic pollution in Southeast Asia; MARPLASTICCs*

### 5.1 Background and aim

The Swedish International Development Cooperation Agency (SIDA) is Sweden's government agency for development cooperation. It aims to reduce world poverty by allocating resources and knowledge with the goal of making a difference for people in Africa, Asia, Europe and South America. To achieve this, SIDA collaborates with actors from civil society and universities, as well as the public and private sector. SIDA's activities are funded through Swedish tax revenue.

### 5.2 Activities and project

SIDA is funding a project to combat marine litter and plastic pollution in SEA that has been implemented by UNEP and COBSEA since 2018 (see Part 1, Section 4.3.3).

SIDA has also funding the Marine Plastics and Coastal Communities (MARPLASTICCs) project since 2017 under the IUCN Marine and Polar Programme (see Part 1, Section 6.1.3 and https://www.iucn.org/theme/marine-and-polar/our-work/close-plastic-tap-programme/projects).

# SECTION 6 – NOTABLE PARTNERSHIPS, NON-INSTITUTIONAL RESEARCH PROGRAMMES AND PUBLIC-PRIVATE INITIATIVES IN THE REGION

## 1. GLOBAL HYBRID PARTNERSHIP WITH INTERNATIONAL ORGANISATIONS

### 1.1 Addressing Marine Plastics: A Systemic Approach (AMPSA)

*Summary of role:* *'Addressing Marine Plastics: A Systematic Approach' is a partnership led by the UNEP to develop a strategic roadmap to help guide transition to circular plastic economies.*

*Summary of work:* *A project with four components are currently being implemented: global alliance platform for circular economy; mobilising investment in waste management infrastructure and advance waste management solutions; developing a roadmap for GEF engagement and strategy development; facilitating knowledge sharing and project coordination.*

***Keywords/research fields:*** *Addressing Marine Plastics; UNEP; New Plastics Economy; Ocean Conservancy; GRID-Adrenal; Global Environment Facility; circular economy; global alliance platform; investment; waste management; roadmap; strategy development; knowledge sharing; project coordination; role of gender*

#### 1.1.1 Background and aim

Addressing Marine Plastics: A Systematic Approach is a thematic partnership led by UNEP in collaboration with the New Plastics Economy, Ocean Conservancy and GRID-Arendal, and with funding from GEF. The project aims to develop a strategic roadmap to help guide transition to circular plastic economies at local, national and global scales. Available: http://gefmarineplastics.org/partners.

#### 1.1.2 Activities and projects

- 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 the Asia-Pacific
- Component 3 by UNEP (Economy and Ecosystems Divisions): To develop a roadmap for GEF engagement and strategy development, including the identification of intervention points
- Component 4 by GRID-Arendal: To facilitate knowledge sharing and project coordination for effective delivery

#### 1.1.3 Reports

In June 2019, the report 'The Role of Gender in Waste Management: Gender Perspectives on Waste in India, Indonesia, the Philippines and Vietnam' was released by UNEP in partnership with Ocean Conservancy, the New Plastics Economy and GRID-Arendal and with funding from GEF (GEF Project ID No. 9681). This report analyses the role of women in developing countries of the South and

Southeast Asia in reducing mismanagement of plastic waste in the region (see Part 1, Section 6.2.2.3 and Part 1, Section 6.4.1.3). Available: https://gefmarineplastics.org/news/ocean-conservancy-report-to-tackle-ocean-plastic-crisis-engage-women-in-south-and-southeast-asia and https://oceanconservancy.org/wp-content/uploads/2019/06/The-Role-of-Gender-in-Waste-Management.pdf.

### 1.2 Global Plastic Action Partnership (GPAP)

*Summary of role:* *The Global Plastic Action Partnership (GPAP) is hosted by the World Economic Forum in collaboration with the World Resources Institute to tackle plastic waste from source to sea by fast-tracking circular economy solutions through identification of investable solutions.*

*Summary of work:* *The GPAP has launched pilot initiatives in key regions (Indonesia, Vietnam and Ghana) to accelerate the transition towards circular economy on the ground.*

*Keywords/research fields:* *Global Plastic Action Partnership (GPAP); World Economic Forum; World Resources Institute; plastic waste; circular economy; National Plastic Action Partnership (NPAP)*

#### 1.2.1 Background and aim

The Global Plastics Action Partnership (GPAP) was launched in September 2018. It is hosted by the World Economic Forum (WEF) in collaboration with the World Resources Institute (WRI) and networks of experts, civil society, government and industry leaders. It aims to tackle plastic waste from source to sea by fast-tracking circular economy solutions through identification of investable solutions. Initial funding of US$10+ million was provided by the UK, Canada, The Coca-Cola Company, Dow Chemical and Pepsi-co. The Japanese Suntory Group joined on 15 November 2019.

#### 1.2.2 Activities and projects

In 2019, GPAP launched several pilot initiatives in key regions to accelerate the transition towards a circular economy on the ground. Learning from these pilots and local leaders, new initiatives will be deployed and scaled into other regions committed to tackling pollution from marine plastics. GPAP indicated that it would build a model in three countries: Indonesia, Vietnam and Ghana.
Available: https://www.nspackaging.com/analysis/gpap-ghana-vietnam-indonesia/.

In March 2019, Indonesia joined forces with GPAP to launch the first National Plastic Action Partnership (NPAP). More than 200 leaders and experts came together to pledge their commitment to collaboration and action, which included the ambitious target of reducing 70% of Indonesia's marine debris by 2025. Since then, Indonesia NPAP has built its local governance structure consisting of a Steering Board and an Expert Panel, and is developing a model analysis that will form the basis for policy recommendations, industry guidelines and investment plans. Implementation began in 2020 under the leadership of NPAP decision-makers and with the support of the global GPAP community. Available:

https://www.weforum.org/press/2020/04/indonesia-unveils-action-plan-to-prevent-16-million-tonnes-of-plastic-from-entering-the-ocean/ and https://www.weforum.org/press/2019/03/indonesian-government-and-partners-announce-next-steps-to-tackle-plastic-pollution/.

For Vietnam, the Ministry of Natural Resources and Environment and GPAP are currently preparing for the launch of Vietnam NPAP.

### 1.3 IUCN: Close the Plastic Tap Programme (IUCN - CPTP)

*Summary of role:* *International Union for Conservation of Nature (IUCN) is a hybrid environmental network established in 1948 composing of both civil society and government organisations.*

*Summary of work:* *The IUCN's programme of work on marine plastics, titled "Close the Plastic Tap", focuses on tackling pollution at its source. Several projects run within this programme in different parts of the world and ocean basins.*

*Keywords/research fields:* *International Union for Conservation of Nature (IUCN); Close the Plastic Tap; MARPLASTICCS; workshops; tackling marine plastics in Thailand; PWFI, Ha Long - Cat Ba Alliance; report; review of plastic footprint methodologies*

#### 1.3.1 Background and aim

The International Union for Conservation of Nature (IUCN) was established in 1948. It is a membership union comprising both government and civil society organisations. It is therefore a hybrid of intergovernmental and non-governmental organisations and functions as an environmental network. The IUCN's programme of work on marine plastics is named 'Close the Plastic Tap'. It focuses primarily on tackling pollution at its source.

#### 1.3.2 Activities and projects

Several projects are run within this programme that focus on different parts of the world and ocean basins. Available: https://www.iucn.org/theme/marine-and-polar/our-work/close-plastic-tap-programme/projects.

*Marine Plastics and Coastal Communities (MARPLASTICCS)*

MARPLASTICCS is a 3-year initiative launched in 2017 and funded by the Swedish International Development Agency (SIDA). The overall goal is for governments and regional bodies within the Eastern and Southern African and Asian regions to promote, enact and enforce legislation and other effective measures that contain and reduce marine plastic pollution. MARPLASTICCS has been deployed in Thailand and Vietnam. Available: https://www.iucn.org/sites/dev/files /marplasticcs_factsheet_final.pdf.

Under the MARPLASTICCS programme and funding, there have been several workshops held in Vietnam as follows:

- IUCN, together with the Legal Department of the Ministry of Natural Resources and Environment of Vietnam, organised a workshop on 10 June 2019, entitled 'Plastic Pollution in Vietnam: from Science to Policy'. This workshop aimed to identify knowledge and legal gaps, explore impactful solutions, and define policy recommendations to reduce the ocean plastics pollution. Available: http://vietnam.ird.fr/media/ird-sites-de-representation/vietnam/pdf/pdf-2019/plastic-pollution-workshop.

- IUCN, in collaboration with the French Institute of Research for Development (IRD), held a workshop on 10 December 2019 in Vietnam on the theme of national guidance for identifying plastic pollution hotspot and working solutions. Available: https://en.vietnamplus.vn/workshop-provides-guidance-for-identifying-plastic-pollution-hotspots/165260.vnp.

*Tackling Marine Plastics in Thailand: From Community-based Actions to Policies*

Phase 1 of this project (2018-2019) was funded by The Coca-Cola Company Foundation. It works from community-based actions to policies and aims to raise transformative awareness and change people's behaviour towards solid waste management in key strategic locations in Thailand. As part of the project, 30 representatives from the Koh Yao Yai Subdistrict community went on a learning visit to Haad Nopparat Tara-Moo Koh Phi Phi National Park and Tarnbokorani National Park on 10 April 2019. This learning visit was organised by IUCN Thailand to understand approaches on solid waste management and how to reduce marine litter. Available: https://www.iucn.org/news/thailand/201907/koh-yao-yai-community-learns-solid-waste-management-approaches-marine-national-parks.

*Ha Long–Cat Ba Alliance in Vietnam*

This project was a 3-year initiative (2014–2017) that involved coastal clean-ups. It was funded by the United States Agency for International Development (USAID). It aimed to foster partnerships between the Vietnam government, businesses and civil society, to catalyse actions in order to improve environmental management and protect the natural integrity of the Ha Long Bay World Heritage Site, including the Cat Ba Archipelago. Available: https://www.iucn.org/asia/countries/viet-nam/ha-long-cat-ba-alliance.

### 1.3.3 Reports

The IUCN also published a number of reports relating to marine plastics that are not specific to the Southeast and East Asia region, but are relevant. One report is the 2019 publication titled 'Review of plastic footprint methodologies: Laying the foundation for the development of a standardised plastic footprint measurement tool'. It provides governments, industry and other important stakeholders a full review of existing and emerging methodologies that help identify the abundance, distribution, types, sources, pathways and sinks of plastic pollution at various scales (national, regional and global). Available: https://portals.iucn.org/library/node/48510.

Among the list of draft motions to be adopted at the IUCN World Congress scheduled in Marseille, France on 11–19 June 2020, draft motion no. 022 calls for the stopping of the global plastic pollution crisis in marine environments by 2030. Available: https://www.iucncongress2020.org/motion/022.

### 1.4 The Global Ghost Gear Initiative (GGGI)

***Summary of role:*** *The Global Ghost Gear Initiative (GGGI) is a cross-sectoral alliance launched by the World Animal Protection in 2015 to achieve a net reduction of ghost gears in the ocean by 2030.*

***Summary of work:*** *The GGGI consists of a series of projects reviewed by the GGGI Project Review Board and approved by the GGGI Steering Group: Global Ghost Gear Portal and Ghost Gear Reporter, Best Practice Framework for the management of fishing gear, Myanmar Ocean Project - Ghost Gear Removal in the Myeik Archipelago, Gear Marking in Indonesian Small Scale Fisheries, Thai Union Ghost Gear Work Plan and Philippines: the Steveston Harbour Net Recycling Initiative.*

***Keywords/research fields:*** *Global Ghost Gear Initiative (GGGI); GGGI Review Board and GGGI Steering Group; Global Ghost Gear Portal and Ghost Gear Reporter; Best Practice Framework for the management of fishing gear; Myanmar Ocean Project - Ghost Gear Removal in the Myeik Archipelago; Gear Marking in Indonesian Small Scale Fisheries; Thai Union Ghost Gear Work Plan; Philippines: the Steveston Harbour Net Recycling Initiative*

#### 1.4.1 Background and aim

The Global Ghost Gear Initiative (GGGI) is a cross-sectoral alliance founded and launched in 2015 by the World Animal Protection. It focuses on abandoned, lost and otherwise discarded fishing gear (ALDFG) with the aim of achieving a net reduction in ghost gears in our oceans by 2030. On 17–18 November 2019, GGGI held its 6th annual meeting in Panama City, Panama. Available: https://www.ghostgear.org/news/2019/11/19/2019-gggi-annual-meeting-draws-to-a-close.

#### 1.4.2 Activities and projects

The GGGI consists of a series of projects reviewed by the GGGI Project Review Board and approved by the GGGI Steering Group. Participants to the projects include 14 governments, two international organisations (regional organisations from the Pacific Ocean), 23 private sector participants, 15 corporates, 55 NGOs and two academic institutions. Participants from Southeast Asia include Myanmar Ocean Project (Myanmar) and Thai Union (Thailand). Available: https://www.ghostgear.org/members.

*Global Ghost Gear Portal and Ghost Gear Reporter*

One major operation of GGGI is the development of a robust platform for the global reporting of ALDFG, which can be done through the GGGI 'Global Ghost Gear Portal' online or through the 'Ghost Gear Reporter' mobile application. Whilst the extent of participation of states from the ASEAN+3 at GGGI still seems limited at this stage, valuable ALDFG data from the ASEAN+3 are still collected and reported (Figure 1.6.1.1 below).

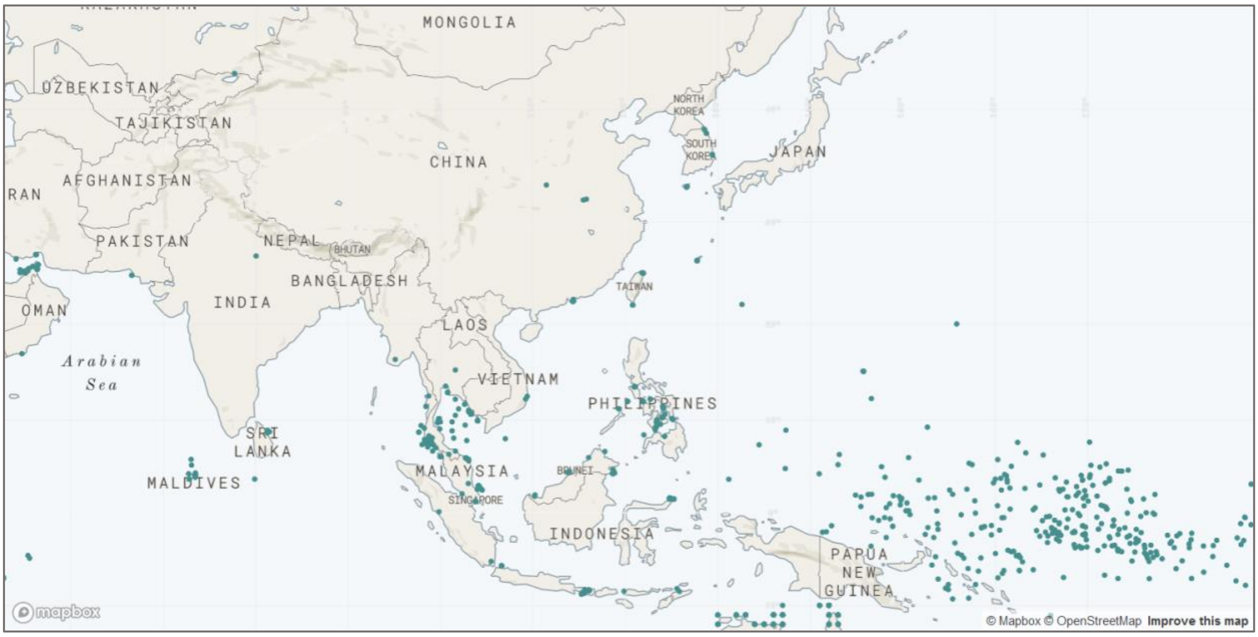



Figure 1.6.1.1. 'Map of gear events' from the GGGI global data portal.
Green dots mark out areas where there are ALDFG reported. (Available: https://globalghostgearportal.net/dp/gearmap.php.)

*Best Practice Framework (BPF) for the management of fishing gear*

GGGI has published its Best Practice Framework (BPF) on ALDFG. The purpose of the BPF is to provide guidance to fishing industry and related stakeholders to prevent lost fishing gear and its impacts, as well as mitigate those impacts when gear is accidentally lost.

The work plan spans key areas identified by the GGGI to tackle ALDFG, particularly 4 key areas as follows:

(i) End of life fishing gear;
(ii) Habitat destruction;
(iii) Non-entangling FADs; and
(iv) Removal of fishing gear from the oceans.

Available:
https://static1.squarespace.com/static/5b987b8689c172e29293593f/t/5bb64b578165f5891b931a6b/1538673498329/wap_gear_bp_framework_part_2_mm_lk-2017.10.23.pdf

*Myanmar Ocean Project – Ghost Gear Removal in the Myeik Archipelago*

In 2019, the Myanmar project completed its first phase in assessing the prevalence of ALDFG in the archipelago, specifically in three locations identified as ALDFG hotspots. In this first phase, ALDFG was indeed prevalent in the archipelago as the project successfully removed more than 1000 kg of ALDFG from the sites. As the next step, the project is developing more efficient ways of removal by better locating ALDFG through aerial and underwater drones and remotely operated vehicles. Available: http://www.myanmarocean.org/.

*Gear Marking in Indonesian Small-Scale Fisheries*

In this study, fishing gears in small-scale fisheries were marked to combat ALDFG through traceability and recovery of lost gear. This study revealed the feasibility of a gear marking system but identified a need for a greater understanding of the benefits of this system and difficulties in retrieving gear. Moving into its next phase, more environmentally-friendly tags will be developed and expansion into different gear types will be explored. Available: https://static1.squarespace.com /static/5b987b8689c172e29293593f/t/5bd6e743a4222f4430aabf3b/1540810590236/Casestudy-INDONESIA.mk2.single.pdf.

*Thai Union Ghost Gear Work Plan*

Thailand joined the GGGI in 2018 and applies the BPF in tackling the ALDFG issue. There are four work streams under the plan as follows:

(i) Promote and raise global awareness of the issue through new initiatives;
(ii) Fishery Improvement Projects (FIPs) for purse seine tuna in the eastern Atlantic Ocean and Indian Ocean, in line with the GGGI Best Practice Framework and the FAO Voluntary Guidelines on the Marking of Fishing Gear;
(iii) Increase the number of vessels involved and the capacity to remove lost FADs under the FAD Watch programme in the Indian Ocean; and
(iv) Improve management practices for ALDFG in Thailand to reduce and prevent pollution into the marine environment.

Available: https://www.thaiunion.com/files/download/sustainability/policy/Thai-Union-and-the-Global-Ghost-Gear-Initiative-Work-Plan-2018-2020-Overview.pdf.

*Philippines: the Steveston Harbour Net Recycling Initiative*

This initiative involved the shipping of discarded fishing nets (that had been retrieved by the fishing communities in the Philippines) to Slovenia to be recycled into nylon yarn for product manufacture. The first shipment of nets for recycling revealed that only nets made of nylon 6 could be recycled. This is only a subset of a full seine net. Other parts of the net are made of other types of plastics that cannot be recycled in the context of this project, such as the polyethylene-based border web and the polypropylene ropes. New options are being explored for these. Available: https://www.ghostgear.org/projects/2018/10/10/steveston-harbour-net-recycling-initiative.

## 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.

### 2.1 Fauna and Flora International (FFI): Marine Plastics Programme

*Summary of role:* *Fauna and Flora International (FFI) was established in 1903 in the UK to conserve threatened species and ecosystems worldwide.*

*Summary of work:* *In 2012, FFI officially launched FFI Marine Plastics Programme to raise awareness of marine microplastics and its threats and stop the direct source of microbeads and pre-production pellets.*

*Keywords/research fields:* *Fauna and Flora International (FFI); FFI Marine Plastics Programme; Ridge to reef conservation in Tanintharyi, Myanmar; plastic pollution; mismanaged plastic waste; Cambodia's Marine and Coastal Programme; coastline plastic debris; No Time to Waste report*

#### 2.1.1 Background and aim

The Society for the Preservation of the Wild Fauna of the Empire (later to become FFI) was first established in 1903 in the UK. While FFI focuses on biodiversity protection in all terrestrial and marine habitat types, it has since 2009 identified marine microplastics as a direct risk to marine life. In 2012, it officially launched the FFI Marine Plastics Programme. It aims to raise awareness of marine microplastics and its threats, and to stop the direct source of microbeads and pre-production pellets. Available: https://api.fauna-flora.org/wp-content/uploads/2018/02/FFI_2018_-Marine-Plastics-Informed-solutions-to-an-ocean-emergency.pdf.

#### 2.1.2 Activities and projects

Several projects of FFI have focused on the marine environment in several ASEAN+3 member states including Myanmar, Cambodia and Indonesia. The projects range from the conducting of surveys to reveal prevalence and sources of marine microplastics, the reviewing of local context on the legislation on plastic use, and the suggesting of site-specific solutions to the marine microplastic issue. Concerns of pollution from marine plastics along the coast are also considered in the context of impact on marine turtle populations that use these beaches as nesting habitat.

*FFI's ridge to reef conservation in Tanintharyi, Myanmar*

FFI runs a project in Tanintharyi, a small town that borders the Andaman Sea. The project uses a landscape- and seascape-level approach to conservation and identifies high conservation value areas in the most-urgent need of protection.

According to a study undertaken by FFI and Thant Myanmar in July 2019, the delta of the Irrawaddy River transports 119 tons of plastic pollution every day. The majority of the plastic found in the River is likely to be mismanaged plastic waste. The most commonly encountered items were made of hard plastics, mainly comprising bottle caps, a threat to, among others, new-born turtles on their way out to sea. Available: https://www.fauna-flora.org/news/plastic-pollution-piles-pressure-myanmars-troubled-turtles.

*FFI's Cambodia Marine and Coastal Programme*

FFI has worked in Cambodia over the last 20 years and has developed an ongoing project on tackling plastic pollution for communities and coral reefs in coastal Cambodia. Teaming up with local researchers from the Royal University of Phnom Penh, Prek Leap National College of Agriculture and Kuda Divers, marine plastic research was conducted through a beach debris survey, waste sorting survey and household interviews.

Preliminary work revealed that plastics account for 80% of coastline pollution debris on mainland islands, where single-use plastic bags and bottles are a major component of the plastic entering Cambodian waters. Other components include food packaging, disposable cutlery, straws and fishing gear. Available: https://www.fauna-flora.org/news/tackling-plastic-pollution-communitiesi-coral-reefs-coastal-cambodia.

### 2.1.3 Reports

A report published on 14 May 2019 by FFI, Tearfund, WasteAid and the Institute of Development Studies found that 400,000 to one million people in the developing world are dying every year as a result of mismanaged waste including plastic. At the upper end of this estimate, that's one person every 30 seconds. Available: https://www.fauna-flora.org/news/plastic-pollution-crisis-new-report-highlights-health-impacts-worlds-poorest and https://assets.fauna-flora.org/wp-content/uploads/2019/05/2019_No-time-to-waste-report.pdf.

## 2.2 Ocean Conservancy (OC)

***Summary of role:*** *Ocean Conservancy is an NGO established in 1972 to protect the ocean, its wildlife and dependent communities.*

***Summary of recommendations and work status:*** *Ocean Conservancy has initiated a number of global initiatives and participated in other UN initiatives to combat marine plastics such as the International Coastal Cleanup and Trash Free Sea Alliance.*

***Keywords/research fields:*** *Ocean Conservancy; International Coastal Cleanup (ICC); ICC report; Trash Free Seas Alliance; stemming the tide report; the next wave; role of gender in waste management report; plastic policy playbook*

### 2.2.1 Background and aim

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 origin of several global initiatives. It is involved in a number of UN initiatives to combat marine plastics under the leadership of UNEP.

### 2.2.1 Activities and projects

*The International Coastal Cleanup (ICC)*

The ICC is one of the first effort of its type as it started 30 years ago. It now operates throughout the world 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 coasts.

According to the ICC's 2019 Report, among the top 25 participating locations in the initiative, seven are in Southeast Asia: the Philippines, Hong Kong, Taiwan, China, Thailand, Indonesia and Malaysia. Available: https://oceanconservancy.org/trash-free-seas/international-coastal-cleanup/ and https://oceanconservancy.org/wp-content/uploads/2019/09/Final-2019-ICC-Report.pdf.

*The Trash Free Seas Alliance (Alliance)*

The Alliance was launched in 2012. It includes a number of private companies, academics, public and civil society partners. This Alliance includes members such as large corporations and industry bodies of industries which produce plastic and/or use large quantities of it in packaging (e.g. The Coca-Cola Company, Dow Chemical, DANONE, Pepsi-Co, P&G and the American Chemistry Council), the financial industry as well as NGOs (e.g. WWF). The Alliance operates as a dialogue forum and opportunity for joint efforts and projects. Available: https://oceanconservancy.org/trash-free-seas/plastics-in-the-ocean/trash-free-seas-alliance/.

In this context, members of the Alliance and Ocean Conservancy, with further support from the McKinsey Centre for Business and Environment, led a study in 2015 on '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. Available: https://oceanconservancy.org/wp-content/uploads/2017/04/full-report-stemming-the.pdf.

### 2.2.3 Reports

Apart from the ICC and Alliance reports, in 2017, Ocean Conservancy also released a report titled 'The Next Wave: Investment Strategies for Plastic Free Seas' which lists participants from a number of countries including two ASEAN member states as shown in Table 1.6.2.1 below. Available: https://oceanconservancy.org/wp-content/uploads/2017/05/the-next-wave.pdf.

Table 1.6.2.1. Participants involved in "The Next Wave: Investment Strategies for Plastic Free Seas" report.

| Country | Participants |
|---|---|
| Indonesia | In-country partner: Sustainable Waste Indonesia<br>Organisations consulted:<br>- Bank Sampah Bina Mandiri, Bali Focus; Cita Bina Insania Foundation; City Cleansing Department – Jakarta Capital City; CV.Peduli Bali, Bali Recycling; DANONE; EnviroPallets; Green School, Bali; PT Hatfield Indonesia; Indonesia Solid Waste Association (InSWA); International Waste Platform; Eco Flores Organisation; PT Irditech Ecojos Plastindo; Role Foundation; PT Sarana Multi Infrastruktur (Persero) (SMI); Unilever Foundation; Yayasan Pengembangan Biosains dan Bioteknologi (YPBB)<br>- Ministry of Energy and Mineral Resources of the Republic of Indonesia; Ministry of Environment and Forestry of the Republic of Indonesia; Ministry of Environment and Forestry of the Republic of Indonesia - Directorate of Coastal and Marine Pollution and Degradation Control) |
| Philippines | - Asian Development Bank; BENRO; Dragon King Plastic Grinding; Environment Management Bureau (Q.C. DENR); GAIA; Greenergy Solutions, Inc., Mother Earth Foundation; Philippines Plastic Industry Association, Manila; Siliman University; SURE; Waste Picker Cooperative; and various junk shops and recyclers/pelletizers<br>- City Environment Natural Resources Officer (CENRO); |
| Singapore | - Morgan Stanley Alternative Investment Partners; Olympus Capital |
| Vietnam | - Da Nang College of Technology; Da Nang River Watch NGO; Dragon Capital; ENDA-Project Office in Vietnam NGO; Ho Chi Minh City Technical University and DONRE; PHAP Viet Environmental Technology JSC; Urban Environmental Company (URENCO), Danang City; The University of Danang; Vietnam Environment Corporation; Vietnam Waste Solutions (VWS), HCMC; Vietstar Joint Stock Company, HCMC<br>- Department of Natural Resources and Environment (DONRE), Ho Chi Minh City (HCMC); Environment Protection Agency, DONRE, Danang; |
| China | - Goldman Sachs |

In June 2019, Ocean Conservancy released a report on the 'Role of Gender in Waste Management', which explores the role of women in waste management in Indonesia, Philippines and Vietnam. (see Part 1, Section 6.4.1.3). Available: https://oceanconservancy.org/trash-free-seas/take-deep-dive/role-gender-waste-management/.

In October 2019, Ocean Conservancy launched a 'Plastic Policy Playbook' to provide a framework for public and private sector measures to improve the economics of the collection of waste. The research focused on five Asian countries: China, Indonesia, Philippines, Thailand and Vietnam. Available: https://oceanconservancy.org/wp-content/uploads/2019/10/Plastics-Policy-Playbook-10.17.19.pdf.

### 2.3 Trash Hero (TH)

***Summary of role:*** *Trash Hero is a global volunteer movement with the mission to bring the communities together to clean and reduce waste.*

***Summary of recommendations and work status:*** *Trash Hero's activities consist of cleaning trash, educating children, creating long-term programmes that help communities to reduce and better manage waste, and helping companies to reduce waste through Trash Hero @Work.*

***Keywords/research fields:*** *Trash Hero; Trash Hero World; weekly clean-up programme; Trash Hero @ Work; annual reports*

#### 2.3.1 Background and aim

Trash Hero is a global volunteer movement led by Trash Hero World, a non-profit association established in Switzerland. Trash Hero started in Southeast Asia in 2013 with weekly clean-ups in Thailand. It now extends (in the region) to Indonesia, Myanmar, Malaysia, Singapore and China. This network involves civil societies and businesses in clean-up activities, and provides education and outreach.

Trash Hero's mission is to bring communities together to clean and reduce waste. They do it through the following ways:

- Organising weekly clean-up programmes;
- Providing stainless steel water bottles to local business at cost price;
- Providing materials to engage children and motivating them to complete a series of challenges to clean and reduce waste in their everyday lives;
- Providing garbage receptacles and volunteer-driven waste pick-ups in rural and small communities that currently do not have publicly-provided waste management services; and
- Encouraging companies to reduce office waste.

Available: https://trashhero.org/.

#### 2.3.2 Reports

Trash Hero releases annual reports to give an overview for the organisation's growth and how it has been accommodated each year. It shares highlights from its core programmes (Action & Awareness, Bottles & Bags, Kids & Education), as well as its financial activity over the course of the year.

The 2018 report is available at: https://trashhero.org/wp-content/uploads/2019/03/Trash Hero World Annual Report 2018.pdf and the 2017 report is available at: https://trashhero.org/wp-content/uploads/2018/08/Trash-Hero-World-Annual-Report-2017.pdf.

## 2.4 The Ocean Cleanup (TOC)

***Summary of role:*** *The Ocean Cleanup is a non-profit legal entity founded in 2014 in the Netherlands with the overall objective of removing marine plastics*

***Summary of work:*** *In October 2019, the Ocean Cleanup announced an oceanic clean-up attempt using a modified and refined engineering system to capture marine debris. Another objective of the Ocean Cleanup is to create a value chain on the basis of the collected plastic debris. In prevention of new wastes from entering the ocean, the Ocean Cleanup designed a different clean-up system, "The Interceptor", to trap plastics from rivers.*

***Keywords/research fields:*** *The Ocean Cleanup; marine debris; cleanup system; floating arrays; floating boom system; The Interceptor*

### 2.4.1 Background and aim

The Ocean Cleanup is a non-profit legal entity founded in 2014 in the Netherlands. The idea of its mission was first presented in a 2012 TEDex conference with a vision that still stands: "to rid the world's oceans of plastic waste".

The Ocean Cleanup as three main objectives as follows:

(i) *Removing existing ocean plastic waste.* Existing oceanic plastic waste, such as those in large accumulation areas in the Great Pacific Garbage Patch, are targeted. An initial plan of a passive, static and very long clean-up system has evolved to smaller floating boom systems that are still under review and development. In October 2019, the Ocean Cleanup announced an oceanic clean-up attempt using a modified and refined engineering system to capture marine debris with ranges from macro- to micro-debris and even ghost nets and fishing gear. Available: https://news.mongabay.com/2019/10/the-ocean-cleanup-successfully-collects-ocean-plastic-aims-to-scale-design/.

(ii) *Creating a value chain on collected plastic debris, with the aim of funding clean-up operations.* The first products made fully using plastic debris collected from the Great Pacific Garbage Patch have been announced for launch in September 2020. Available: https://theoceancleanup.com/updates/mission-one-completed-the-plans-to-make-products-from-the-plastic-catch/.

(iii) *Better understand the root issue of ocean plastic pollution through research collaborations*. Research collaborations are done between the Ocean Cleanup's in-house research team and external scientific institutions. Their findings are published on their webpage. Available: https://theoceancleanup.com/scientific-publications/.

#### 2.4.2 Activities and projects

In the prevention of new waste from entering the oceans, the Ocean Cleanup has designed a different clean-up system, 'The Interceptor', to be deployed in rivers to trap, direct and convey plastic for collection and management.

An Interceptor is operationally active in Jakarta, Indonesia and in Klang, Malaysia. In Southeast Asia, plans are also being developed for the deployment of an Interceptor in the Mekong Delta, Vietnam and in Bangkok, Thailand. The Ocean Cleanup aims to tackle the 1,000 most polluting rivers before the end of 2025. These rivers are believed to contribute around 80% of ocean plastic pollution.

### 2.5 4ocean (4O)

*Summary of role:* *4ocean is a private profit-driven business founded in the United States, which provide donations to ocean-related non-profits.*

*Summary of work:* *Merchandise sales provide donations to the works of marine and coastal clean-up effort.*

***Keywords/research fields:*** *4ocean; plastic crisis; purpose-driven business model*

#### 2.5.1 Background and aim

4ocean is a private profit-driven business founded in 2017 in Boca Raton, Florida, which aims to end the ocean plastic crisis. Its purpose-driven business model centres around the works of marine and coastal clean-up effort from the funding of its merchandise sales. Buyers are promised that "for every product you purchase, we'll pull another pound of trash from the ocean and coastlines". Merchandise sales provide donations to other ocean-related non-profits (e.g. 1% for the Planet, Project Seahorse, Monterey Bay Aquarium Sea Otter Program, and Guy Harvey Ocean Foundation) and are used in building an organisational infrastructure to support future growth of 4ocean.

#### 2.5.2 Work status

Since 2017, a total of 7 million pounds of ocean plastic debris and other harmful debris have been recovered from its clean-up sites across Florida (USA), Bali (Indonesia) and Haiti.

## 2.6 Project AWARE (PAware)

*Summary of role:* *Project AWARE is a registered non-profit organisation which advances policies on plastic debris and sharks and rays.*

*Summary of recommendations and work status:* *Project AWARE flagship science-citizen programme is Dive Against Debris, which has scuba divers remove marine debris from the ocean and report data on the types, quantities and locations of materials collected.*

*Keywords/research fields:* *Project AWARE; dive against debris; adopt a dive site*

### 2.6.1 Background and Aim

Project AWARE is a registered non-profit organisation which advances policies on plastic debris, sharks and rays. With respect to plastic debris, Project AWARE works to reduce the underwater impacts of debris and prevent trash from entering the ocean.

### 2.6.2 Activities and projects

*Dive Against Debris*

Project AWARE's flagship science-citizen programme 'Dive Against Debris' launched in 2011. It is a concerted effort among SCUBA divers to remove marine debris from the ocean. It reports the collected data (i.e. on types, quantities and locations of materials collected) on a single digital map on 'Dive Against Debris Map'. Since its launch to date, more than 50,000 SCUBA divers have participated in the programme in 114 countries worldwide (including in Southeast Asia). It has also reported removing over one million pieces of trash. Project AWARE aims to have two million items of debris removed and reported by 2020. Available: https://www.projectaware.org/diveagainstdebrismap.

*Adopt a Dive Site*

Under this project, participants make a commitment to carry out monthly 'Dive Against Debris' surveys, while reporting types and quantities of marine debris found each month from the same location. Available: https://www.projectaware.org/adoptadivesite.

*Participant in Global Partnerships*

Project AWARE is also part of several global partnerships against marine plastic pollution such as the GPML, Global Ghost Gear Initiative (GGGI), Seas at Risk and Trash Free Sea Alliance.

### 2.6.3 Reports

Annual impact reports are also released, which highlight the key events of the year and the yearly data report from 'Dive Against Debris' surveys.

The 2019 Impact Report reported that in 2019, 269,397 items of debris have been removed from the seafloor and reported on the global database, and a total of 533 Dive Sites were adopted around the world. See: https://www.projectaware.org/news/2019-clamshell and https://www.projectaware.org/news/2019-impact-infographic.

The 2018 Impact Report announced the top three countries that had reported data from the 'Dive Against Debris' surveys for the year. Two of these countries were from ASEAN: Thailand was at the second position with 180 surveys (or 7.6% of all global surveys), while Indonesia was at the third position, with 156 surveys (or 6.6% of all global surveys). Plastic accounted for 65% of all debris items collected in 2018 and of this, the top three debris items were plastic fishing lines (18.6%), plastic fragments (10.84%) and fishing gears (i.e. sinkers/lures/hooks) (5.29%).
Available: https://issuu.com/projectaware/docs/2018_impact_report?fr=xGAEoATABPf-cYAA.

## 3. VISIBLE SCIENTIFIC RESEARCH INSTITUTIONS AND EFFORTS

This section attempts to collate the names of national development agencies and research centres that appear in several research projects on marine plastics and the protection of the marine environment in Southeast Asia.

### 3.1 Centre for Environment, Fisheries and Aquaculture Science (CEFAS)

*Summary of role and work:* *CEFAS is the UK government's centre for applied marine and freshwater science and research.*

*Summary of work:* *Marine litter, including marine plastics, is 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 plastics. CEFAS is in charge of the delivery of the UK-funded Commonwealth Litter Programme (CLiP).*

*Keywords/research fields:* *Centre for Environment, Fisheries and Aquaculture Science; CEFAS; Commonwealth Litter Programme; CLiP*

#### 3.1.1 Background and aim

The Centre for Environment, Fisheries and Aquaculture Science (CEFAS) is the UK government's centre for applied marine and freshwater science and research. It also carries out research for other governments and entities.

One of CEFAS' research focus is marine litter (including marine plastics), with an emphasis on waste management, reducing sea-based sources of litter, and developing a more sustainable life cycle for plastic.

#### 3.1.2 Activities and projects

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 with Vanuatu and the Solomon Islands. In May 2019, it began work in Belize and in September 2019, in South Africa. It is expected to later work in Commonwealth countries in Asia and other parts of the world. Available:

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/.

### 3.2 Commonwealth Scientific and Industrial Research Organisation (CSIRO)

*Summary of role:* *CSIRO is an independent Australian federal government agency responsible for scientific research with marine debris as a focus area.*

*Summary of recommendations and work status:* *CSIRO has carried out many projects relating to plastic and waste management.*

*Keywords/research fields:* *Commonwealth Scientific and Industrial Research Organisation; CSIRO; projects; global plastic losses; ALDFG; commercial fishing lines; marine pollution; modelling and monitoring marine litter movement; transport and accumulation; microplastics*

#### 3.2.1 Background and aim

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, plastic waste management and outreach activities. Whilst much of this research is focused on Australia, CSIRO collaborates with partner organisations around the world, including Vietnam. Researchers of CSIRO also carry out marine plastic research in several ASEAN member states. Available: https://research.csiro.au/marinedebris/.

#### 3.2.2 Activities and projects

CSIRO has been implementing since 2017 a project on quantifying flows of plastic and other debris from land-land based sources to the ocean, based on field sampling and mathematical modelling to document the distribution of plastic in the ocean, on the coast and in the nearshore environment (Global Plastic Losses). On this project, CSIRO is collaborating with the following partner organisations from ASEAN+3: China, Indonesia, RO Korea and Vietnam.

In September 2019, Kelsey Richardson published a study analysing 40 years of data to show that a quarter of the world's commercial fishing lines are lost or abandoned every year. Publications from 32 countries and territories were reviewed, including from the RO Korea and Indonesia. Available: https://onlinelibrary.wiley.com/doi/full/10.1111/faf.12407.

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.

With support from UNEP, 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 the most informative. Workshops were organised and a report was published at 'Hardesty et al. (2016), Modelling and Monitoring Marine Litter Movement, Transport and Accumulation.' Available: https://research.csiro.au/marinedebris/projects/modelling-monitoring-marine-litter-movement-transport-accumulation/.

## 3.3 East China Normal University (ECNU)

***Summary of role and work:*** *East China Normal University (ECNU), China, has a plastic marine debris research center and has visible publications in marine plastic research.*

***Keywords/research fields:*** *East China Normal University (ECNU); plastic marine debris research center; hotspot monitoring; marine plastic waste forum*

### 3.3.1 Background and aim

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

### 3.3.2 Activities and projects

ECNU hotspot monitoring methodologies have gained particular visibility through the technical consultations they provide under funding by the UNEP, as well as presentation of their work to COBSEA. Available: http://web.unep.org/environmentassembly/technical-consultation-hotspot-monitoring-methodologies.

From 4–5 November 2019, ECNU co-hosted the 'Combating Marine Plastic Waste-2019 Shanghai Forum' with UNESCO/IOC Regional Training and Research Center on Plastic Marine Debris and Microplastics (RTRC-PMDMP) on Chongming Island. The Forum adopted the 2019 Declaration of Combating Marine Plastic Waste Shanghai Forum. Available: http://english.ecnu.edu.cn/e1/1e/c1703a254238/page.htm?fbclid=IwAR0wrhLcJh_k6oRikyJARztiLR7AfDvBU_Tc_xCAetmusEgt2I2PBkiT9fI.

### 3.4 The International Environmental Technology Centre (IETC)

***Summary of role and work:*** *The International Environmental Technology Centre (IETC) is a think-tank to promote the collection and dissemination of knowledge on Environmentally Sound Technologies with a focus on waste management.*

***Keywords/research fields:*** *International Environmental Technology Centre; IETC; think-tank; waste management*

#### 3.4.1 Background and aim

The International Environmental Technology Centre (IETC) is based in Osaka, Japan. It is a think-tank and partners with UNEP to promote the collection and dissemination of knowledge on environmentally sound technologies with a focus on waste management.

The IETC-UNEP partnership organises events and produces publications with other partners worldwide.

#### 3.4.2 Activities and projects

*Notable global publications and activities*

- 2nd Global Waste Management Outlook, to be released in 2020 and prepared jointly with the International Solid Waste Association (ISWA). IETC-UNEP and ISWA had also published the previous Global Waste Management Outlook. Available: https://www.unenvironment.org/ietc/news/story/unep-ietc-has-signed-overarching-agreement-iswa.

- In collaboration with the Ministry of the Environment Japan, Ministry of Foreign Affairs Japan, Osaka City and the Global Environment Centre Foundation, IETC-UNEP convened the 'Global Dialogue with the Private Sector: Technology Solutions for Holistic Waste Management' to showcase technological solutions for waste management in Osaka, Japan on 21–23 May 2019. Available: https://www.unenvironment.org/ietc/events/summit/technology-solutions-holistic-waste-management-global-dialogue-private-sector.

- IETC-UNEP organised the UNEP Symposium on Plastic Waste Problems on 22 May 2019 (as a side event to the abovementioned Global Dialogue) to share information of the current status of plastic waste issues and expertise on good practices to manage plastic waste in an environmentally sound way. The Symposium produced a message to the G20 Osaka Summit (28–29 May 2019). Available: https://www.unenvironment.org/ietc/resources/other/message-unep-symposium-plastic-waste-problems-g20-osaka-summit-g20-ministerial.

*Regional publications and activities*

IETC has published a number of studies relating to waste management (including plastics) relating to regional countries including:

- Asia Waste Management Outlook (2017). Available: http://wedocs.unep.org/bitstream/handle/20.500.11822/27289/Asia_WMO.pdf?sequence=1&isAllowed=y.
- Waste Management in ASEAN Countries: Summary Report (2017). Available: https://wedocs.unep.org/bitstream/handle/20.500.11822/21134/waste_mgt_asean_summary.pdf?sequence=1&isAllowed=y.
- Regional Study on Mercury Waste Management in the ASEAN Countries (2017). Available https://wedocs.unep.org/bitstream/handle/20.500.11822/21135/reg_study_mercury_waste_mgt_asean.pdf?sequence=1&isAllowed=y.
- Mapping of Waste Management Initiatives (2016). Available: https://www.unenvironment.org/ietc/resources/report/mapping-waste-management-initiatives-global-and-regional-level-and-major-national.
- Managing Post-Disaster Debris: the Japan Experience (2015). Available: https://wedocs.unep.org/bitstream/handle/20.500.11822/8136/-Managing%20post-disaster%20debris_%20%20the%20Japan%20experience-20121122.pdf?sequence=3&isAllowed=y.

More publications are available at: https://www.unenvironment.org/ietc/resources.

The IETC also participated in the formulation of waste management strategies and action plans in Cambodia and Myanmar in 2018. Available: http://wedocs.unep.org/bitstream/handle/20.500.11822/27516/IETC_2018AR.pdf?sequence=1&isAllowed=y.

### 3.5 GRID-Arendal

***Summary of role and work:*** *GRID-Arendal is a Norwegian governmental foundation established in 1989 to support environmentally sustainable development, with a research focus on marine debris (including marine plastics).*

***Keywords/research fields:*** *GRID-Adrenal; marine debris; marine plastics; maps; graphics; controlling transboundary trade in plastic waste; addressing marine plastics; stock-taking report*

### 3.5.1 Background and aim

GRID-Arendal is a Norwegian governmental foundation established in 1989 that works closely with UNEP and other partners. It aims to support environmentally sustainable development and for a number of years, marine debris (including marine plastics) has been one of their research foci. Available: http://www.grida.no/search?query=marine+litter.

None of its 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. Available: https://wedocs.unep.org/bitstream/handle/20.500.11822/9798/-Marine_litter_Vital_graphics-2016MarineLitterVG.pdf.pdf?sequence=3&isAllowed=y.

### 3.5.2 Activities and projects

The most recent studies that have been published in the context of global programmes that GRID-Arendal participates in are:

- Controlling Transboundary Trade in Plastic Waste, 2019, graphic maps. Available: http://www.grida.no/resources/13333.
- 'Addressing Marine Plastics - A Systemic Approach', the 2018 Stock-taking report. Available: http://gefmarineplastics.org/files/2018%20Stock%20taking%20report%20on%20marine%20plastics%20-%20final%20version.pdf.

## 3.6 Our Seas of East Asia Network (OSEAN)

***Summary of role and work:*** *Our Seas of East Asia Network (OSEAN) is a RO Korean non-profit organisation active in research, education promotion, policy development and international co-operation to protect the marine environment with a focus on marine debris.*

***Keywords/research fields:*** *Our Seas of East Asia Network; OSEAN; marine debris; research; education promotion; policy development; international cooperation; coastal cleanup*

### 3.6.1 Background and aim

Our Seas of East Asia Network (OSEAN) is a Korean non-profit organisation that registered with the RO Korea's Ministry of Oceans and Fisheries in 2009 for research, education promotion, policy development and international cooperation to protect the marine environment with a focus on marine debris issues.

### 3.6.2 Activities and projects

OSEAN produces and distributes research results and education promotional materials relating to marine debris. Available: http://osean.net/gallary/gallary.php.

In 2019, OSEAN, in co-operation with the RO Korea Coast Guard, conducted a questionnaire survey on 470 ships to understand the amount of waste generated by these vessels. They found that approximately 90 kg of solid waste is generated in a round trip. Available: http://osean.net/bdlist/activity.php?ptype=view&idx=6814&page=1&code=activity.

OSEAN also participates in organising national and international seminars, conferences and training workshops relating to marine debris as well as coastal clean-ups. Its recent activities include:

- The Asia Pacific Marine Garbage Expert Training Workshop, which was organised in Busan, RO Korea in October 2019 to train trainees with the skills needed to be marine litter specialists. A total of 14 trainees (from Cambodia, Taiwan, Indonesia, Lao PDR, Malaysia, Peru, the Philippines, Russia, Timor-Leste, Singapore, and RO Korea) participated in the Workshop. Available: http://osean.net/bdlist/activity.php?ptype=view&idx=6695&page=1&code=activity

- A coastal clean-up in Busan, RO Korea in September 2019 with support from companies such as Nike, Taekwang, Changsin INC. A total of 70 people participated in the event. Available: http://osean.net/bdlist/activity.php?ptype=view&idx=6692&page=2&code=activity.

## 3.7 Plastics in Society Hub

***Summary of role and work:*** *Plastics in Society Hub is a UK-led society that aims to establish a multi-national, multi-disciplinary and multi-stakeholder research and innovation hub to solve the global challenge of plastics in society.*

***Keywords/research fields:*** *Plastics in Society Hub; research; innovation*

### 3.7.1 Background and aim

The Plastics in Society Hub is led by Brunel University London in the UK, and is joined by several international partners and leading experts in fields surrounding plastic pollution. It provides a unique platform for research, knowledge transfer and innovation. The Hub aims to establish a multi-national, multi-disciplinary and multi-stakeholder research and innovation hub to solve the global challenge of plastics in society. There are partners from the Southeast Asia region, including Indonesia, Malaysia and Thailand (see Table 1.6.3.1 below). Available: http://www.plasticsinsociety.global/.

Table 1.6.3.1. Southeast Asian Partners of the Plastics in Society Hub.

| Country | Partners |
|---|---|
| Indonesia | Institute Technology Bandung (ITB) - Indonesia Network Hub; University of Indonesia; University National Indonesia; Sempulah Nopember Institute of Teknologi; Hasanuddin University; Padjadjaran University; Uduyana University; Canara Plastics Manufacturer & Traders; Surabaya City Government; Coordinating Ministry of Maritime Affairs, Indonesia; Intera Lestari Polimer; Indonesian Waste Platform |
| Malaysia | University of Malaysia; Sabah Parks, Malaysia |
| Thailand | Prince of Songkhla University, Phuket; SEEK Phuket |

### 3.7.2 Activities and projects

Out of its 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 relevant to combating pollution from marine plastics are on re-designing the plastic system, designing and testing solutions, social and behavioural change in geographic areas other than Southeast Asia.

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

## 4. PUBLIC-PRIVATE AND PRIVATE-DOMINATED PARTNERSHIPS

A number of initiatives have developed recently in the ASEAN+3, at regional level. A selection of seven visible public-private and private-dominated partnerships and initiatives are set out below.

Of note, there may be other plastic industry groups in the region that could be comparable to the following industry groups in Europe:

- PlasticsEurope, an association of plastics manufacturers. Available: https://www.plasticseurope.org/en/about-us/who-we-are.
- European Plastics Converters (EuPC), a professional representative body of plastics converters. Available: https://www.plasticsconverters.eu/.
- European Plastics Recyclers (PRE), an organisation representing plastics recyclers. Available: https://www.plasticsrecyclers.eu/.
- European Plastics and Rubber Machinery (EUROMAP), an organisation representing the plastics and rubber machinery industry. Available: http://www.euromap.org/en/.

These entities also participate in initiatives to prevent pollution from marine plastics. They can provide some interesting ideas:

- Operation Clean Sweep (http://www.opcleansweep.eu/);
- Marine Litter Solutions (https://www.marinelittersolutions.com/); and
- Zero Plastics to landfill (https://www.plasticseurope.org/en/focus-areas/circular-economy/zero-plastics-landfill).

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

### 4.1 GA Circular

*Summary of role:* *GA circular is a private initiative that provides services to companies, investors, global foundations and government agencies in reaching a circular economy in Asia.*

*Summary of work:* *The work of GA circular includes particular expertise in post-consumer packaging and food waste, through providing services in research and data analytics, strategy and policy advisory, technical assistance and stakeholder engagements to its clients.*

*Keywords/research fields:* *GA circular; circular economy; post-consumer packaging; food waste; research and data analytics; strategy and policy advisory, technical assistance; stakeholder engagements; EPR; MRFs*

### 4.1.1 Background and aim

GA Circular, based in Singapore, is a private initiative founded in 2011 with the vision of developing a circular economy in Asia. It has a particular expertise in post-consumer packaging and food waste. GA Circular's purpose is to enable companies, investors, global foundations and government agencies to unlock business opportunities from fast-growing streams of food and packaging waste.

GA Circular proposes four types of services as follows:

- Research and data analytics;
- Strategy and policy advisory;
- Technical assistance; and
- Stakeholder engagement.

Available: https://www.gacircular.com/services/.

Its clients include private partners such as the Coca-Cola Company, DANONE, Dole, Borouge, Amcor as well as the European Commission.

GA Circular's statistics indicate that, to date, it has organized 4,672 stakeholder meetings, 64 events, 462 waste audits, and has produced six research reports.

### 4.1.2 Projects

Examples of projects undertaken by GA Circular for its clients include:

- For the Coca-Cola Company: studying EPR systems in developing markets around the world, researching the existing conditions in the six large ASEAN markets that would influence EPR implementation (i.e. Indonesia, Philippines, Vietnam, Thailand, Myanmar and Malaysia), and structuring implementation plans for industry-led EPR systems in these countries. Phase I of the project ended with results published in July 2018. Phase II is currently ongoing. Available: https://www.gacircular.com/portfolio_page/coca-cola-asean/.

- For Dole Foods: studying the post-consumer waste landscape in the Philippines and creating one of the country's first recycling pilot programmes in schools, where Materials Recycling Facilities (MRFs) were set up and educational workshops were organised to teach children about the need to segregate their waste. The project was conducted between September 2016 to December 2018. Available: https://www.gacircular.com/portfolio_page/dole-foods/.

- For Nestlé Waters: mapping in detail the existing waste management value chain in Ho Chi Minh City and Hanoi, Vietnam in June 2018. Available: https://www.gacircular.com/portfolio_page/nestle-waters/

- For Borouge: conducting in-depth research, interviews with various stakeholders and technology providers on the technical and financial aspects of available technologies for municipal waste management and technological solutions for recycling in Indonesia, 2018. Available https://www.gacircular.com/portfolio_page/borouge/.

- With National Geographic Live: developing a four-year partnership since January 2018 for National Geographic Society and Singapore's Nanyang Technological University (NTU) to bring leading National Geographic explorers working at the cutting-edge of human knowledge across various fields such as Circular Economy, Science and Engineering to NTU. Available: https://www.gacircular.com/portfolio_page/national-geographic-packaging-waste/.

- For Amcor: analysing the challenges and opportunities for collection and circularity of post-consumer flexible packaging in India, Indonesia and the Philippines in November 2017. Available: https://www.gacircular.com/portfolio_page/amcor-flexibles/.

#### 4.1.3 Reports

Reports that GA Circular contributed to include:

- 'The Role of Gender in Waste Management: Gender Perspectives on Waste in India, Indonesia, the Philippines and Vietnam', June 2019. As part of the project 'Addressing Marine Plastics: A Systemic Approach' (see Part 1, Section 6.1.1.3 and Part 1, Section 6.2.2.3), the report applied gender analysis in the field of waste management in developing countries such as India, Indonesia, the Philippines and Vietnam. Available: https://oceanconservancy.org/wp-content/uploads/2019/06/The-Role-of-Gender-in-Waste-Management.pdf.

- 'Full Circle: Accelerating the Circular Economy for Post-Consumer PET Bottles in Southeast Asia', 2019. The report highlighted the current realities of PET bottles collection and provided a blueprint for the circular economy of PET bottles in the six biggest Southeast Asian countries (i.e. Indonesia, the Philippines, Vietnam, Thailand, Myanmar and Malaysia). Available: https://drive.google.com/file/d/1LweI36tvAdad7ph6b4hHnL3C2nJ9rgmm/view.

- 'The Role of Packaging Regulations and Standards in Driving the Circular Economy' 2019. The report identified the role that policy interventions play in addressing the growing environmental challenges posed by packaging and packaging waste. It also explored the regulatory landscape in each of the 10 Southeast Asian countries, and compared them to policies elsewhere, such as in the EU and Japan. Available: https://www.gacircular.com/unep-packaging-regulations-and-standards/.

- 'Towards Circularity of Post-Consumer Flexible Packaging in Asia', 2017. The report analysed the challenges and opportunities for collection and circularity of post-consumer flexible packaging in Asia. Available: https://drive.google.com/file/d/142gDQUY7IDirCXhzYjdNyIaL4ODc7bXf/view.

## 4.2 Circulate Capital

***Summary of role:*** *Circulate Capital is an investment management firm based in New York dedicated to financing companies, projects and infrastructures that prevent the flow of plastic waste to the world's ocean and advance the circular economy.*

***Summary of work:*** *The work of Circulate Capital includes the development of financing mechanisms for solutions to the problem of ocean plastic pollution in South and Southeast Asia.*

***Keywords/research fields:*** *Circulate Capital; financing mechanisms; ocean plastic pollution; flow of plastic waste; circular economy; waste stream; solid waste management; capture and reuse; USAID partnership; Circulate Capital Ocean Fund; reports; Handbook for Action: Investing on reduce plastic pollution in South & Southeast Asia*

### 4.2.1 Background and aim

Circulate Capital is based in New York, USA and was founded in 2018. To note, Rob Kaplan, the CEO and founder of Circulate Capital, is based in Singapore. Circulate Capital 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 oceans and aid in advancing the circular economy". Its work includes the development of financing mechanisms for solutions to the problem of ocean plastic pollution in South and Southeast Asia (US$100+ million announced). Targeted countries in Southeast Asia include Indonesia, Thailand, the Philippines and Vietnam.

The mission of Circulate Capital is three-fold as follows:

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

Circulate Capital has partnerships with Closed Loop Partners, the Ocean Conservancy and companies including 3M, the Coca-Cola Company, Kimberley-Clark, Dow, Pepsi-Co and P&G. One of the investors in Circulate Capital is the Alliance to End Plastic Waste (AEPW) (see Part 1, Section 6.4.7 below). AEPW members include private sector companies that make, use, sell, process, collect and recycle plastic products.

### 4.2.2 Activities

In June 2019, Circulate Capital announced a blended finance partnership with the U.S. Agency for International Development (USAID) to combat ocean plastic pollution. Through this new agreement, USAID is expected to provide up to US$35 million, 50% loan-portfolio guarantee through the Development Credit Authority to incentivise private capital investment and new business development in the recycling value chain in South and Southeast Asia. Available: https://docs.wixstatic.com/ugd/77554d_22da52669b3a45b0a042c1b9e8d8add6.pdf.

In 4 December 2019, Circulate Capital created an investment fund called the ‘Circulate Capital Ocean Fund’ and aimed at tackling Asia’s ocean plastic crisis. The fund investors include Pepsi-Co, P&G, Dow, DANONE, Unilever, the Coca-Cola Company and Chevron Phillips Chemical Company. The debut investment was at US$106 million and it is targeting to reach US$150 million. Available: https://www.dealstreetasia.com/stories/circulate-capital-ocean-plastic-fund-165335/.

### 4.2.3 Reports

In March 2019, the Circulate Capital published a handbook termed ‘Handbook for Action: Investing on reduce plastic pollution in South & Southeast Asia’. Available: https://docs.wixstatic.com/ugd/77554d_3bb19c2c7b75435f8d2817edfc15a28f.pdf.

## 4.3 The Circulate Initiative

*Summary of role: The Circulate Initiative is a U.S. registered initiative non-profit organisation founded in 2019 with support from Circulate Capital to help address the ocean plastic issue through education, support and finance of innovation in waste management and incubation of investable businesses that can bring those innovations to market*

*Summary of work: The Circulate Initiative has three core activities: incubate, measure and amplify.*

*Keywords/research fields: Circulate Initiative; innovations; waste management; incubate; measure; amplify; The Incubation Network (TIN); Ocean Plastic Prevention Accelerator; Plastic Data Challenge*

### 4.3.1 Background and aim

The Circulate Initiative is a U.S. registered non-profit organisation founded in 2019 with support from Circulate Capital. The aim of the initiative is to help achieve the broader mission of addressing the ocean plastic crisis through education, support and finance of innovations in waste management and incubation of investable businesses that can bring those innovations to market.

The initiative has three core activities as follows:

- *Incubate*: increasing the number and quality of innovators in the waste and recycling sector and creating the conditions they need to succeed through The Incubation Network (TIN) developed in partnership with Second Muse

- *Measure*: developing open-source metrics for all investors to track environmental and social impacts

- *Amplify*: sharing success stories and impacts of entrepreneurs, leaders and organisations to encourage replication and scaling

Available: https://www.thecirculateinitiative.org/.

### 4.3.2 Activity – The Incubation Network (TIN)

The Incubation Network (TIN) is the Circulate Initiative's flagship programme to help strengthen the circular economy by developing, promoting and incubating technologies, business models and entrepreneurs that prevent ocean plastic pollution in South and Southeast Asia, and building an enabling environment for its success.

TIN aims to create a connected network of innovators, investors, civil society organisations, and government leaders across South and Southeast Asia. In addition to Circulate Initiative, TIN also receives support from Second Muse, the U.S State Department and corporate partners such as Unilever, P&G, the Coca-Cola Company and DANONE.

TIN is currently undertaking two initiatives in Southeast Asia:

- 'Ocean Plastic Prevention Accelerator': managed jointly by the Circulate Initiative and Second Muse with funding from Australia's Department of Foreign Affairs and Trade to create a collaborative network for innovative solutions in local waste management systems and the recycling sector in Surabaya, Indonesia. Available: https://oppa.id/en/.

- 'Plastic Data Challenge': an invitation to innovators worldwide (including academic institutions, start-ups, companies, and data scientists) to submit their innovative data solutions that would advance plastic waste management and the circular economy in South and Southeast Asia. Available: https://www.incubationnetwork.com/plastics-data-challenge.

More details available at: https://www.incubationnetwork.com/about.

## 4.4 Food Industry Asia (FIA)

***Summary of role:*** *Food Industry Asia (FIA) founded in 2010, is the representative of the food industry in Asia. Its members include suppliers, manufacturers and retailers of food.*

***Summary of work:*** *FIA deals with plastic under the framework of sustainable packaging. It released a study in 2018 on tackling plastic and packaging waste in Southeast Asia.*

***Keywords/research fields:*** *Food Industry Asia (FIA); F&B; background and aim; Sustainable Packaging; plastic waste; packaging waste; Tackling Plastic Waste in Asia*

### 4.4.1 Background and aim

Food Industry Asia (FIA), based in Singapore, was founded in July 2010 by a group of leading F&B companies to enable major food manufacturers to speak with one voice in Asia. Its members are suppliers, manufacturers and retailers of food (Amcor, the Coca-Cola Company, DANONE, McDonalds, Ferrero, Indofood, etc.). Available: https://foodindustry.asia/about.

### 4.4.2 Activity – Sustainable Packaging

FIA deals with plastic waste under its 'Sustainable Packaging' pillar. In 2018, FIA released 'Sustainable Packaging – Tackling Plastic Waste in Asia', a study on tackling plastic and packaging waste in Southeast Asia, which focused on Indonesia, the Philippines, Vietnam and Thailand.

The report identified 31 potential levers to support sustainable packaging in four areas as follows:

- Reducing inputs into the system;
- Enhancing collection rates for after-use plastics;
- Plugging leakage in post collection; and
- Creating value for waste use.

Available: https://foodindustry.asia/documentdownload.axd?documentresourceid=30711.

## 4.5 Ocean Plastics Charter

*Summary of role: The Ocean Plastics Charter was approved by five G7 states (Canada, France, Germany, Italy and the UK) and the EU in June 2018 to demonstrate commitments to take measures to address the plastic problem. It lays the groundwork for reuse and recycling.*

*Summary of role: The Charter's Action Plan has five categories of actions, including coastal and shoreline action, which focuses on outreach and education.*

*Keywords/research fields: Ocean Plastics Charter; action plan; Ocean Plastics Charter's Action Plan*

### 4.5.1 Background and aim

The Ocean Plastics Charter was agreed to by five G7 states (i.e. Canada, France, Germany, Italy and the UK) and the EU in June 2018. It has also been endorsed by 22 states and 64 businesses and organisations, including a number of large corporations such as the Coca-Cola Company, Unilever and Nestlé. Southeast Asia is an important market for some of these companies. With the UK and the EU being important donors to Southeast Asia, the work of this initiative is expected to be aligned with the projects that they would be funding. Available: https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/international-commitments/ocean-plastics-charter.html.

### 4.5.2 Action plan

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

- 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.

Of these, the coastal and shoreline action, which is focused on education and outreach, is relevant to marine plastic. It also aims to accelerate the implementation of the 2015 G7 Leaders' Action Plan to Combat Marine Litter through the Regional Seas programmes. This includes adopting initiatives led by regional fisheries management organisations (RFMOs) where appropriate, and targeted investments for clean-up activities that prove to be environmentally sound in global hotspots and priority areas, particularly on ALDFG and wastes generated and collected by fishery activities. Available: https://international.gc.ca/world-monde/assets/pdfs/international_relations-relations_internationales/g7/2018-06-09-healthy_oceans-sante_oceans-annex-en.pdf.

Following the establishment of the Charter, Canada, considered the Champion of the Charter, announced that the country would ban single-use plastic by 2021. Available: https://www.aa.com.tr/en/americas/canada-to-ban-single-use-plastics-by-2021-trudeau/1500520.

### 4.6 New Plastics Economy – Ellen MacArthur Foundation

*Summary of role:* *New Plastics Economy is an initiative launched by the Ellen MacArthur Foundation in 2016 to build momentum towards a circular economy for plastics, starting with packaging.*

*Summary of work: In 2017, the Ellen MacArthur Foundation launched the New Plastic Economy Innovation Prize. In 2018, the Foundation launched the New Plastics Economy Global Commitment. It has implemented a number of Pioneer Projects which bring together stakeholders from across the plastics value chain to address the system challenges that no organisation can face alone. It also created Plastics Pact, a network of national implementation initiatives aligned around a common vision and set of ambiguous targets.*

*Keywords/research fields: New plastics economy; Ellen MacArthur foundation; background; aim; activities; projects; New Plastics Economy Innovation Prize; New Plastics Economy Global Commitment; pioneer*

#### 4.6.1 Background and aim

New Plastics Economy is an initiative aimed at bringing together key stakeholders to build momentum towards a circular economy for plastics, starting with packaging. The initiative was launched by the Ellen MacArthur Foundation in May 2016 in collaboration with a broad group of leading companies, cities, philanthropists, policymakers, academics, students, NGOs, and citizens. Core partners of the initiative include Amcor, Borealis, DANONE, L'Oréal, Nestlé, the Coca-Cola Company, Unilever and Walmart. On 4 December 2019, Google joined the initiative as a technological partner. Available: https://www.newplasticseconomy.org/participants.

#### 4.6.2 Activities and projects

In May 2017, the Ellen MacArthur Foundation launched a US$2 million New Plastics Economy Innovation Prize for innovative solutions in materials, clever product designs and new, circular business models. The Circular Design Challenge winners were announced at the Our Ocean Conference in Malta on 5 October 2017. The Circular Materials Challenge winners were announced at the World Economic Forum annual meeting in Davos on 23 January 2018. Together, the winners joined a 12-months accelerator programme, in collaboration with Think Beyond Plastic, where they could work with experts to make their innovations marketable at scale. Among the winners, Evoware is from Indonesia. Available: https://www.newplasticseconomy.org/projects/innovation-prize.

In 2018, the Ellen MacArthur Foundation, in collaboration with UNEP, launched the New Plastics Economy Global Commitment which are a set of targets towards elimination and reduction of plastic by 2025. So far, it has been able to gather signatures from over 400 signatories which include companies representing 20% of all plastic packaging produced globally (such as L'Oréal, Mars, Nestlé, the Coca-Cola Company), governments, financial institutions, education and research institutions. Except for governments, many of the above institutions are from Asia or have activities in Southeast Asia.

Available: https://www.newplasticseconomy.org/assets/doc/GC-Report-June19.pdf.

Participants of the New Plastics Economy are also involved in pre-competitive collaborations, and lead and run several projects known as 'pioneer projects'. These projects bring together stakeholders from across the plastics value chain to address the systematic challenges that no organisation can face alone. Such projects include:

- Holy Grail (2017–May 2019): tagging packaging for accurate sorting and high-quality recycling; speeding up the transition to a circular economy for plastics by focusing on an important pillar to increase recycling rates, namely improved sorting of post-consumer packaging with the help of chemical tracers and digital watermarks. Available: https://www.newplasticseconomy.org/assets/doc/Holy-Grail.pdf.

- Lodestar (ongoing): a case study for plastics recycling; investigating the potential advantages of combining mechanical and chemical recycling in a single facility through desktop modelling exercise of an advanced Plastics Reprocessing Facility (a-PRF). Available: https://www.newplasticseconomy.org/assets/doc/Lodestar.pdf.

- Proof (November 2017–May 2019): prototyping of a packaging solution in the pre-competitive stage to demonstrate proof of concept and tangible outcomes. Available: https://www.newplasticseconomy.org/.

The Plastics Pact, a network of national implementation initiatives and organisations aligned around a common vision and set of ambitious targets, has also been formed. Presently, the Plastic Pact global network includes the UK, France, Chile, the Netherlands, Africa and Portugal. This may not have been implemented in Asia yet. Available: https://www.newplasticseconomy.org/projects/plastics-pact.

### 4.6.3 Reports

The first annual 'New Plastic Economy Global Commitment Progress Report' was released in October 2019. In this Report, indicators to a circular economy were included as follows:

- Phasing out of PS, EPS or PVDC
- Reuse pilots for all packaging
- Reusable, recyclable or compostable packaging in practice and at scale
- Capacity of recycling company
- Targets to reduce virgin plastic consumption in absolute terms

Available: https://www.newplasticseconomy.org/assets/doc/Global-Commitment-2019-Progress-Report.pdf.

Apart from the Global Commitment Progress Report, the New Plastics Economy has also published several reports on plastics and its role in the global economy. These include 'Rethinking the future of plastics' (launched in January 2016), 'Catalysing Action' (2017) and 'Reuse: rethinking packaging' (2019). Available: https://www.newplasticseconomy.org/about/publications.

### 4.7 The Alliance to End Plastic Waste (AEPW)

*Summary of role:* *The Alliance to End Plastic Waste is made up of more than 40 companies worldwide which produce, use, sell, process and recycle plastics and the World Business Council for Sustainable Development, which committed one billion USD with the goal of investing 1,5 billion USD in the next five years to help end plastic waste in the environment.*

*Summary of work:* *The Alliance hosted the first international forum in Tokyo, Japan in July 2019 and the first forum in Southeast Asia in August 2019. It launched a partnership with project STOP to support development and launch of a waste management recycling system in the regency of Jembrana, Indonesia. It also entered into partnership with Plug and Play to create an accelerator program focused on the plastics value chain to identify startups with different innovations to address plastic waste in the environment.*

*Keywords/research fields:* *The Alliance to End Plastic Waste; AEPW; background; activities, partnership with Project STOP; partnership with Plug and Play*

#### 4.7.1 Background and aim

The Alliance to End Plastic Waste (AEPW) is made up of more than 40 companies worldwide which produce, use, sell, process and recycle plastics (such as P&G, Dow Chemical, Total, Veolia and more) and the World Business Council for Sustainable Development. These companies committed US$1 billion, with the goal of investing US$1.5 billion in the next five years to help end plastic waste in the environment. The Alliance appointed Jacob Due as President and CEO. Available: https://endplasticwaste.org/.

#### 4.7.2 Activities and projects

AEPW hosted the first international forum at the Japanese Business Federation in Tokyo, Japan in 22 July 2019. The forum introduced AEPW to Japan, and focused on sharing best practices for raising awareness and advancing solutions for tackling the issue.

On 15 August 2019, the member companies of AEPW participated in the 5th Annual Sustainability and Circular Economy Summit in Washington, USA.

On 27 August 2019, AEPW held its first forum in Southeast Asia during the 'Circular Economy: Collaboration for Action' Conference in Bangkok, Thailand.

On 23 August 2019, AEPW launched a partnership with Project STOP to support the development and launch of a waste management recycling system in the regency of Jembrana, located on the northwest coast of Bali, Indonesia. Over the next three years, AEPW and Project STOP will collaborate on financial support, technical expertise and a feasibility study to assess how to extend the approach launched in Jembrana to achieve zero ocean-plastics leakage.

On 23 October 2019, AEPW entered into a partnership with Plug and Play to create an accelerator programme focused on the plastics value chain to identify start-ups with different innovations to address plastic waste in the environment.

## 5. COMPARATIVE ANALYSIS

The comparative Table 1.6.5.1 shows the difference in breadth of the 26 visible non-governmental efforts established to combat 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) as well as clean-up of hotspots.

Another clear observation is that, comparatively, some specialised and 'newer' research areas have received less attention (e.g. plastic-associated contaminants, port reception facilities, fibre-reinforced plastic vessels, hull scrapping and marine coating, etc.).

Table 1.6.5.1. Research focus by research institutions and non-governmental initiatives with respect to marine plastics.
Legend: Red = no research or interest expressed; Light-green = expressed but general interest without specific research or inferred interest; Dark-green = active/proposed research.

| Research Focus | Global Hybrid Partnerships with IOs (AMPSA, GPAP, IUCN, GGGI) | Non For Profit – Sustained Clean-up efforts (FFI, OC, TH, TOC, 4O, PAware) | Scientific Research Institutions (CEFAS, CSIRO, ECNU, IETC, GRID-Arendal, OSEAN, PSHub) | Pub-Private partnership and purely private initiatives (GA Circular, Circulate Capital, The Circulate Initiative, FIA, OPC, EMAF, AEPW) |
|---|---|---|---|---|
| Policy, laws, administrative measures, action plans, guidelines | IUCN, IUCN | OC | OSEAN | |
| Upstream research/waste management, circular economy | AMPSA, GPAP, IUCN | FFI, OC | CEFAS, IETC, PSHub | GA Circulate, Circular Capital, The Circulate Initiative, OPC, FIA, EMAF, AEPW |
| Methodology for the monitoring of marine plastic litter, surveys and monitoring, pollution status | IUCN *(plastic footprint methodology)* | OC | CEFAS, CSIRO, ECNU, PSHub, GRID-Ar | |
| Accumulation zones & hotspots | IUCN | FFI, OC, TOC, PA *(seabed)* | CEFAS, ECNU, PSHub, GRID-Ar | OPC |
| Contribution from rivers | | OC, TOC | GRID-Arendal | |
| Source differentiation | | FFI, OC | CEFAS, OSEAN *(shipping)*, GRID | |
| Discharge from offshore infrastructures (incl. aquaculture) | | | GRID-Arendal | |
| Contribution of fisheries/lost and abandoned fishing gear | GGGI | OC | GRID-Arendal | OPC |
| Fragmentation and degradation | | OC | GRID -Arendal | |
| Ecological and environmental impact | IUCN | FFI, OC | CEFAS, CSIRO, PSHub, GRID-Arendal | |
| Socio-economic impact | IUCN | OC | GRID-Arendal | |
| Public outreach/ clean-up, social perception | AMPSA, GPAP, GGGI | FFI, OC, TH, 4O, PA *(seabed)* | CEFAS, ECNU, PSHub | OPC, AEPW |
| Organic/ inorganic plastic-associated contaminants | | | CEFAS, CSIRO, ECNU | |
| Port reception facilities | | | GRID-Arendal | |
| Fibre-reinforced plastic vessels | | | GRID-Arendal | |
| Hull scraping and marine coating | | | GRID -Arendal | |

# PART 2 – GAP ANALYSIS, OVERALL FINDINGS AND RECOMMENDATIONS

This part is designed as a gap analysis between action plans to combat pollution from marine plastics in ASEAN+3, with the global legal and institutional framework and with the findings and ongoing research efforts on pollution from marine plastics.

It is divided into seven sections. The first five sections provide a gap analysis of policy developments to combat marine plastics in ASEAN+3 in five regional institutions where action plans are being adopted (i.e. ASEAN, COBSEA, ASEAN+3, EAS and APEC), through a comparison of their respective scope and content, and a gap analysis with the international legal framework, the status of regional scientific knowledge, and a discussion of a selection of regulatory barriers. Section 6 brings together the findings of Part 1 and the gap analysis to identify overall findings to be considered, and to make recommendations on the way forward in the development of the GPML node. Finally, Section 7 offers recommendations for the conceptual development of a regional node for Southeast Asia.

# SECTION 1 – REGIONAL FRAMEWORKS OF ACTION

## 1. GOALS, OBJECTIVES AND ACTIONS OF THE COBSEA RAP MALI

The revised 2019 COBSEA Regional Action Plan on Marine Litter (RAP MALI) seeks to guide consolidated and coordinated action in the region towards integrated management of marine litter, including preventing and reducing marine litter from land-based and sea-based sources, promoting regionally coherent monitoring and assessment approaches, and creating enabling conditions for marine litter action. It seeks to address marine litter as a transboundary issue and to support COBSEA countries in their delivery of Sustainable Development Goal (SDG) target 14.1. This target aims to prevent and significantly reduce marine pollution of all kinds, particularly from land-based activities, including marine debris and nutrient pollution, as well as the relevant targets.

### 1.1 Objectives

Specific objectives of the COBSEA RAP MALI are to:

(i) ***Prevent and reduce to the minimum marine litter pollution*** in the marine and coastal environment of the East Asian Seas Region;
(ii) ***Foster sustainable consumption and production*** in a multi-stakeholder whole ***lifecycle approach*** to prevent and reduce leakage at source;
(iii) ***Remove*** to the extent possible ***already existent marine litter*** by using environmentally acceptable methods;
(iv) ***Improve monitoring and assessment*** of marine litter and its impacts for a science-based approach;
(v) ***Enhance knowledge sharing and awareness*** about marine litter and its impacts amongst all stakeholders and all groups of society in the East Asian Seas Region; and
(vi) ***Support national efforts*** towards adequate institutional, policy and implementation frameworks, cross sector coordination and regional and international cooperation.

A clear characteristic of the RAP MALI is its holistic approach to combatting marine litter pollution from upstream measures in sustainable consumption and production, waste management, monitoring, removal and education.

### 1.2 Guiding modalities for implementation

Eight guiding principles have been agreed:

(i) *The integration principle* by virtue of which marine litter management shall be addressed across relevant sectors and as an integral part;
(ii) *The prevention principle* by virtue of which measures should prioritize addressing the prevention of marine litter generation at source;
(iii) *The precautionary principle* by virtue of which where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation;
(iv) *The polluter-pays principle* by virtue of which the costs of pollution prevention, control and reduction measures are to be borne by the polluter, with due regard to the public interest;

(v) *The ecosystem-based approach* by virtue of which the cumulative effect of marine litter on the marine and coastal ecosystem, habitats and species with other contaminants and substances that are present in the marine environment should be fully considered in management of marine litter;
(vi) *The principle of public participation and stakeholder involvement* by virtue of which the general public including local communities, private sector, civil society organisations and local authorities will be involved in the development and implementation of efforts;
(vii) *The sustainable consumption and production principle* by virtue of which current unsustainable patterns of consumption and production must be transformed to circular lifecycle models that decouple human development from environmental degradation; and
(viii) *The science-based approach* by virtue of which marine litter management measures should be based on the best available scientific evidence.

## 1.3 Key actions

For achieving the specific objectives on regional marine litter management in the Seas of East Asia, the COBSEA RAP MALI provides for four key actions with guiding description (see Table 2.1.1.1). Table 2.1.1.2 below sets out examples of activities for each key action to guide the development of detailed biennial workplans for implementation of the RAP MALI, as developed by the COBSEA Working Group on Marine Litter (WGML).

Table 2.1.1.1. Key actions and guiding descriptions for marine litter management in COBSEA RAP MALI.

| Key action | Guiding description |
|---|---|
| Action 1: Preventing and reducing marine litter from land-based sources | 1.1) Legal and economic instruments |
| | 1.2) Integrated waste management |
| | 1.3) Removal of existing marine litter and its disposal |
| Action 2: Preventing and reducing marine litter from sea-based sources | 2.1) Legal and economic instruments |
| | 2.2) Removal of existing marine litter and its disposal |
| Action 3: Monitoring and assessment of marine litter | 3.1) Expert Group |
| | 3.2) Regional and national marine litter monitoring programmes |
| Action 4: Activities supporting the implementation of COBSEA RAP MALI | 4.1) Regional and international cooperation and reporting |
| | 4.2) National planning and policy frameworks |
| | 4.3) Research activities |
| | 4.4) Information, education, outreach and involvement of stakeholders |
| | 4.5) Training and capacity building |

## 1.4 Envisaged activities

Table 2.1.1.2. COBSEA RAP MALI – Overall table.

| | | |
|---|---|---|
| **Action 1** PREVENTING AND REDUCING MARINE LITTER FROM LAND-BASED SOURCES | 1.1) Legal & economic instruments | 1.1.1) Enhance leadership, implementation and quality of government efforts |
| | | 1.1.2) Solid waste management policies and agency coordination through policy-making mechanism |
| | | 1.1.3) Develop and adopt instruments prevent/manage waste and towards circular economies including single-use plastics and deposit refund systems |
| | 1.2) Integrated waste management | 1.2.1) Develop Industry dialogues for measures |
| | | 1.2.2) Reduction, reuse & recycle as well as replacement to reduce amounts to landfill or incineration without energy recovery |
| | | 1.2.3) Waste collection & separation systems |
| | | 1.2.4) Take necessary measures to address illegal dumping |
| | | 1.2.5) Cooperation with river authorities |
| | 1.3) Removal of existing litter and its disposal | 1.3.1) Programmes & activities such as coastal clean-ups |
| **Action 2** PREVENTING AND REDUCING MARINE LITTER FROM SEA-BASED SOURCES | 2.1) Legal & economic instruments | 2.1.1) Encouragement to develop & adopt instruments consistent with UNCLOS & MARPOL |
| | | 2.1.2) Reinforcement of national legal instruments on MARPOL Annex V, London and Basel Conventions & FAO Code of Conducts of Responsible Fisheries |
| | | 2.1.3) Assistance on requirements of MARPOL Annex V on improving port reception facilities |
| | | 2.1.4) Sectoral prevention & reduction guidelines on fisheries & tourisms |
| | | 2.1.5) Legislation on identified fishing gears |
| | 2.2) Removal of existing litter and its disposal | 2.2.1) Programmes & activities |
| **Action 3** MONITORING AND ASSESSMENT OF MARINE LITTER | 3.1) Expert group | 3.1.1) Setup of Marine Litter Monitoring Expert Group under COBSEA Working Group on Marine Litter |
| | 3.2) Regional & national marine litter monitoring programmes | 3.2.1) Regional guidance on harmonization in line with international standards e.g. GESAMP |
| | | 3.2.2) Regional training & data management |
| | | 3.2.3) National monitoring & assessment on marine plastic & microplastic |
| | | 3.2.4) Report preparation for SDG target 14.1 |
| | | 3.2.5) Database management |
| **Action 4** ACTIVITIES SUPPORTING THE IMPLEMENTATION OF COBSEA RAP MALI | 4.1) Regional & international cooperation and reporting | 4.1.1) Setup of COBSEA Working Group on Marine Litter |
| | | 4.1.2) Institutional cooperation e.g. MARPOL, London Convention, Basel Convention, CBD, GPA & FAO |
| | | 4.1.3) City partnership for knowledge transfer |
| | | 4.1.4) Regional conferences e.g. ASEAN |
| | 4.2) National planning & policy frameworks | 4.2.1) National action plan development & implementation or on equivalent GPA land-based |
| | | 4.2.2) Regional sectoral guidelines on waste management, tourism and plastic manufacturing |
| | | 4.2.3) Reporting format of national planning & policy frameworks |
| | 4.3) Research activities | 4.3.1) Research & development on technology as well as social & behavioural sciences |
| | | 4.3.2) Research on marine litter impacts |
| | | 4.3.3) Effectiveness on market-based instruments |
| | | 4.3.4) Trajectory modelling on marine litters |
| | | 4.3.5) Plastic flows and relative contribution |
| | 4.4) Information, education, outreach & involvement of stakeholders | 4.4.1) Stakeholder involvement |
| | | 4.4.2) Regular clean-ups for education, awareness, certain responsibility areas & international initiatives |
| | | 4.4.3) Awareness raising campaigns |
| | | 4.4.4) Information translated into national languages |
| | 4.5) Training & capacity building | 4.5.1) Regional education & training for targeted groups |
| | | 4.5.2) Technical capacity buildings to relevant staffs |

Appendix 2 of the RAP MALI (see Table 2.1.1.2 above) encompasses further detailed description of key actions to serve as a guide for the development of biennial workplans for implementation of the RAP MALI to be discussed by the COBSEA WGML. This initial prioritization of actions identifies where countries agreed to collectively pursue more specific activities through COBSEA, within its mandate, in line with the East Asian Seas Action Plan and the COBSEA Strategic Directions 2018–2022.

Of note, the RAP MALI envisages the development of some specific regional outputs such as the following guidelines, guidance documents, expert groups, report and research areas:

- Sectoral guidelines on the prevention and reduction of marine litter, particularly for fisheries, marine/coastal tourism, waste management and plastic manufacturing;
- Regional guidance on the development of harmonized national marine litter and microplastic monitoring programmes;
- COBSEA Working Group on Marine Litter (WGML) (with national focal points and experts);
- Marine Litter Monitoring Expert Group under the COBSEA WGML;
- Regional report for SDG 14.1;
- Regional marine litter and microplastic monitoring meta-database to support periodic regional reports;
- Regional sectoral guidelines on the prevention and reduction of marine litter from land-based pollution;
- Regional education and training;
- Regional format on national planning and policy frameworks; and
- Research focus on social and behavioural science, impact on the coastal and marine environment and economy.

## 2. THE ASEAN FRAMEWORK OF ACTION FOR MARINE DEBRIS (FAMAD)

The ASEAN Leaders adopted the Bangkok Declaration on Combating Marine Debris and the ASEAN Framework of Action on Marine Debris (FAMAD) at the 34th ASEAN Summit on 23 June 2019 in Bangkok, Thailand. For further information on the context of their adoption, refer to Part 1, Section 4.2. The ASEAN FAMAD is summarized in Table 2.1.2.1 below.

The overall structure of ASEAN FAMAD contrasts with that of the COBSEA RAP MALI in that it is structured very differently. Whereas the COBSEA RAP MALI is divided into four main categories focusing on the final objective of the action plan (i.e. reduction of land-based sources of marine plastics, reduction of sea-based sources of plastic, monitoring and assessment, and a general category of mixed activities necessary to support implementation), the four categories of the ASEAN FAMAD are structured around types of government engagements (i.e. policy support and planning, research and capacity building, public education and outreach, and private sector engagement). This difference in approach makes the conceptual comparison challenging. Each of the four categories of government engagement can be included in each of the four objectives of the COBSEA RAP MALI.

The comparison and gap analysis below are therefore dependent on the examples of actions provided for in each sub-category of action in both action plans.

Table 2.1.2.1. ASEAN FAMAD – Overall table.

| | | |
|---|---|---|
| 1) POLICY SUPPORT & PLANNING | A. Regional policy dialogue | 1.A.1) Regular regional policy dialogue/discussion |
| | B. Multi-sectoral policy | 1.B.1) Long-term waste management & circular economy<br>1.B.2) Extended Producer Responsibility (EPR) policies e.g. design for environment, deposit refund and take-back for reusing and recycling<br>1.B.3) Government & business to promote product sustainability addressing single-use plastics<br>1.B.4) Upstream policies on land-based & sea-based leakages<br>1.B.5) Inter-sectoral initiatives through ASEAN-led mechanisms<br>1.B.6) Prioritization for national & local governments |
| | C. Implementation of relevant laws & agreements e.g. MARPOL Annex V, Basel Convention & UNEA Resolution on marine litter & microplastic | 1.C.1) Incorporation of international laws and agreements related to waste management into regional platforms<br>1.C.2) Enabling conditions for implementation<br>1.C.3) Regular dialogue on Basel Convention Regional Centre on SE Asia (BCRC-SEA) |
| | D. Regional action plan development through integrated land-to-sea policy | 1.D.1) Taskforce on the development of regional action plan<br>1.D.2) Best practices from Regional Seas Programme<br>1.D.3) Feasibility of ASEAN Agreement<br>1.D.4) Feasibility of ASEAN Centre on combatting marine debris<br>1.D.5) Contribution to East Asia Summit effort on regional action plan |
| 2) RESEARCH, INNOVATION & CAPACITY BUILDING | A. Regional baseline on status & impacts | 2.A.1) Baseline review & report development<br>2.A.2) Assessment & bridging gaps |
| | B. Capacity development for national action plans/activities implementation | 2.B.1) Standardize monitoring & evaluation methods<br>2.B.2) Capacity assessment of ASEAN member states and needs<br>2.B.3) Trainings on monitoring and management |
| | C. Scientific knowledge, technology transfer & innovation solution | 2.C.1) Research & knowledge sharing<br>2.C.2) Cooperation & Partnership across institutions<br>2.C.3) Innovative solutions by cities<br>2.C.4) Research & studies on plastics & microplastics<br>2.C.5) Possible sharing networks<br>2.C.6) Research on environmentally - friendly alternatives |
| 3) PUBLIC AWARENESS, | A. Public Awareness on status & impacts | 3.A.1) Science-based communication materials<br>3.A.2) Information dissemination to the public |
| | | 3.B.1) Communication plan development |

| | | |
|---|---|---|
| EDUCATION & OUTREACH | B. Behaviour change & culture | 3.B.2) Best practices & campaigns<br>3.B.3) Sharing of alternative solutions & practices<br>3.B.4) Integration of scientific findings<br>3.B.5) Multi-stakeholder engagement |
| | C. Platform for knowledge sharing, innovative solutions & best practices | 3.C.1) Expert exchange platforms and/or study trips<br>3.C.2) Establish ASEAN information platform |
| | D. Integration of scientific knowledge for science-based decisions | 3.D.1) Science-policy interface<br>3.D.2) Dissemination of scientific knowledge<br>3.D.3) Involvement of Scientists into policy-making process<br>3.D.4) Incorporation of policy making views in scientific communications |
| 4) PRIVATE SECTOR ENGAGEMENT | A. Collaboration with private sector & industry association | 4.A.1) Support to private sector for implementation measures |
| | B. Private sector investment & contribution | 4.B.1) Private sector engagement with circular economy, product life-cycle management, sustainability & 3R<br>4.B.2) Mainstream private sector to support research & as well as CSR activities<br>4.B.3) Private sector investment for product redesign/packaging & alternative materials<br>4.B.4) Value chain stakeholders for increasing waste recovery & recycling rates |

Like the RAP MALI, the FAMAD also envisages the development of some specific regional outputs, in particular:

- Best practices from Regional Seas Programme;
- Feasibility study of an ASEAN Agreement;
- Feasibility study of ASEAN centre on combatting marine debris;
- Regional baseline report on impacts of marine plastics in the ASEAN;
- Standardization of methods for the measurement and monitoring of marine debris;
- Network for sharing marine debris data (tentative);
- Communication materials on status and impacts of marine debris;
- Expert exchange platforms (tentative); and
- ASEAN information platform to exchange information and share innovative solutions and best practices.

## 3. THE ASEAN+3 (APT) MARINE PLASTIC DEBRIS COOPERATIVE ACTION INITIATIVE

In parallel to the ASEAN work on the FAMAD, the ASEAN+3 (or APT, see institutional mandate in Part 1, Section 4.2.1.2), adopted their own Marine Plastics Debris Cooperative Action Initiative in 2018 with the triple aim of:

- Improving management of plastic waste by environmentally sound waste management and 3R (reduce, reuse and recycle);
- Promoting awareness, research and education on marine plastic debris; and
- Strengthening regional and international cooperation.

This Declaration of ASEAN+3 is short and focuses on the development of capacity and cooperation processes. However, it also includes some specific objectives:

- Delivering ASEAN's initiatives and actions to the G20 process spearheaded by Japan;
- Developing the capacity for monitoring of marine plastic debris and introduction of harmonised and standardised methods;
- Leveraging institutions such as the Regional 3R Forum in Asia and the Pacific and Economic Research Institute for ASEAN and East Asia (ERIA);
- Holding a Special ASEAN Ministerial Meeting on Marine Debris in March 2019; and
- Seeking the possibility of establishing a regional knowledge hub on marine plastic debris.

## 4. THE EAS MANILA PLAN OF ACTION, 2018 LEADER'S STATEMENT ON COMBATING MARINE PLASTIC DEBRIS AND 2019 CHAIRMAN STATEMENT OF THE 14TH EAS

Following the 2017 EAS Manila Plan of Action to Advance the Phnom Penh Declaration on the EAS Development Initiative (2018–2022), the EAS Leaders' Statement on Combating Marine Plastic Debris was adopted in November 2018 in Singapore (see Part 1, Section 4.2.1.2).

This Leaders' Statement is structured like a legal instrument with a preamble and operative provisions. Importantly, the preamble emphasizes implementation of international law including UNCLOS as well as the SDGs. Operative provisions include the same three components as the ASEAN+3 Marine Plastic Debris Cooperative Action Initiative, with more specific content:
(i) improvement of management of plastic waste; (ii) promotion of awareness, research and education; and (iii) strengthening of regional and international cooperation. It also adds reference to incentivization of the private sector, an element which is common to all action plans in ASEAN+3.

In November 2019, the Chairman Statement of the 14th EAS noted that a draft EAS Regional Plan of Action on Combating Marine Plastic Debris (RPoA) is currently being developed as a follow-up to the EAS Leaders' Statement on Combating Marine Plastic Debris. The RPoA is framed as complementing the ASEAN-led initiatives and aiming to:

- Improve communication and collaboration among countries and multi-stakeholder entities at the regional and international scale; and
- Facilitate the transition to a more systems-based approach to marine plastic debris management.

See: https://www.mofa.go.jp/files/000535021.pdf

It also emphasises ongoing work to enhance cooperation in preventing illegal transboundary movement of hazardous chemicals and wastes, working towards the goals set in the G20's 'Osaka Blue Ocean Vision', as well as the establishment of the Regional Capacity Centre for Clean Seas in Bali, Indonesia.

## 5. THE 2019 APEC ROADMAP ON MARINE DEBRIS

The APEC Roadmap on Marine Debris (for further details on the institutional setting for this instrument, refer to Part 1, Section 5.1) articulates the objective of a collective and coordinated vision which includes regional cooperation, research and innovation, sharing of best practices and increased access to financing. Cross-fora collaboration is envisaged in particular within the APEC mechanism and specifically for monitoring methodologies.

# SECTION 2 – COMPARISON OF REGIONAL FRAMEWORKS

In this section, the five regional frameworks are compared, with a particular focus on COBSEA RAP MALI and the ASEAN FAMAD that are more detailed and include suggested activities. The comparison is undertaken with three approaches: first, the goals and objectives; second, the activities envisaged; and third, the cooperation processes.

It is important to note at the outset the significant overlap of all these frameworks and the cross-references they contain to each other. There appears to be continued efforts from COBSEA, ASEAN, ASEAN+, and their members countries to align actions and coordinate initiatives in different fora. In the context of the ASEAN processes that refer to other regional processes, this includes UN-led mechanisms in the spirit of the ASEAN-UN Plan of Action. See ASEAN Secretariat note on this and the 2016-2020 ASEAN-UN Action Plan at: https://www.unaprcm.org/sites/default/files/ASEAN-UN_Plan_2016-2020.pdf. See also Part 1, Section 4.2.1 above.

## 1. GOALS AND OBJECTIVES

To compare the goals and objectives of each regional instrument on marine litter, Parts 1 and 2 of the COBSEA RAP MALI on the background, rationale, goals and objectives are compared first with those of the ASEAN FAMAD as set out in the 2019 Bangkok Declaration on Combating Marine Debris in ASEAN Region and the four framing components of the ASEAN FAMAD. Elements of the shorter instruments from the other three intergovernmental processes (i.e. ASEAN+3, EAS and APEC) have also been compared. Table 2.2.1.1 below provides the findings of this comparison.

In a nutshell, the ASEAN FAMAD and the other regional processes are consistent with the two goals and six objectives of the COBSEA RAP MALI, except for the objective of removal of already existing marine litter by using environmentally sustainable methods mentioned in the latter. Removal of litter is not envisaged in the current version of the ASEAN Bangkok Declaration or the FAMAD.

Of note is the reference made in COBSEA RAP MALI, ASEAN FAMAD and EAS Leaders' Statement in Combatting Marine Plastic Debris to sustainable integrated management of marine litter and to the SDGs, in particular SDG 14.1 (on marine pollution prevention and reduction) and its associated targets. However, omission of this in the other two instruments is not seen as necessarily substantive as there are specific documents with very short or no preambles that are focused on the development of processes to combat pollution from marine litter.

Table 2.2.1.1. Comparison of goals and objectives of COBSEA RAP MALI and ASEAN FAMAD.
Legend: Goals and objectives that are met are in green; goals and objectives that are not met are in red; goals that are not specifically mentioned but can be implied are in light green.

| COBSEA RAP MALI 2019 | ASEAN Bangkok Declaration and FAMAD | ASEAN+3 / MPDCAI | EAS / SCMPD | APEC / RMD |
|---|---|---|---|---|
| **GOALS** | | | | |
| 1- Sustainable and integrated marine litter management in the East Asian Seas region | | | | |
| 2- Delivery of SDG 14.1 on marine pollution prevention and reduction and associated targets | | | | |
| **OBJECTIVES** | | | | |
| 1- Prevent and reduce to the minimum marine litter pollution in the marine and coastal environment of the East Asian Seas Region | | | | |
| 2- Foster sustainable consumption and production in a multi-stakeholder whole lifecycle approach to prevent and reduce leakage at source | | | | |
| 3- Remove to the extent possible already existent marine litter by using environmentally acceptable methods | | | | |
| 4- Improve monitoring and assessment of marine litter and its impacts for a science-based approach | | | | |
| 5- Enhance knowledge sharing and awareness about marine litter and its impacts amongst all stakeholders and all groups of society in the East Asian Seas Region | | | | |
| 6- Support national efforts towards adequate institutional, policy and implementation frameworks, cross sector coordination and regional and international cooperation | | | | |

## 2. ACTIONS AND ACTIVITIES

This section seeks to identify the extent to which each action in the COBSEA RAP MALI has comparable actions or activities envisaged so far under the ASEAN FAMAD and the other shorter regional instruments, as applicable. The results of this analysis are summarised in Table 2.2.2.1 below. It is important to note at this point that none of the lists of priority actions or priorities are exhaustive; they are indicative of priority actions identified. Others are to be added later on. Three situations have been distinguished:

(i) Actions or activities that are identical or comparable between both action plans (in green in Table 2.2.2.1 below);
(ii) Actions or activities in COBSEA RAP MALI that are not specifically mentioned in the ASEAN FAMAD but could be included in actions that are described in more general terms in ASEAN FAMAD (in orange in Table 2.2.2.1 below); and
(iii) Actions or activities in COBSEA RAP MALI that are not included in the ASEAN FAMAD (in red in Table 2.2.2.1 below).

A fourth category of actions are those that focus on specific outputs.

### 2.1 Comparable actions

This comparison shows that actions envisaged in the COBSEA RAP MALI and in the ASEAN FAMAD are generally aligned, which is expected. However, as priority actions of COBSEA RAP MALI are often more specific than those of the ASEAN FAMAD, a number of more general actions of the ASEAN FAMAD may later develop into similar specific actions; this may be clarified when an action plan is adopted by the ASEAN (ASEAN FAMAD D.1.3). Of note also is that whereas COBSEA refers specifically to partnership and coordination with the ASEAN, the ASEAN FAMAD does not specifically mention COBSEA or its RAP MALI, although it refers to regional platforms and best practices from Regional Seas programmes.

Some specific activities or outputs that are focused on by both COBSEA and the ASEAN are as follows:

- Moving towards the circular economy with a similar approach focused on inter-sectoral initiatives, engagement of the private sector, market-based initiatives, deposit refund and take-back for reusing and recycling (however, whereas extended producer responsibility (EPR) policies seem central to the ASEAN FAMAD, they are not mentioned specifically in COBSEA RAP MALI);
- Possible establishment/feasibility of the establishment of a centre on combatting marine debris;
- Standardisation of methods for the measurement and monitoring of marine debris: baseline and monitoring programme; and
- Knowledge management and sharing of information.

Table 2.2.2.1. Comparison of actions and activities in COBSEA RAP MALI and ASEAN FAMAD.
Legend: Actions and activities in green are included in both COBSEA RAP MALI AND ASEAN FAMAD; in red, not included in ASEAN FAMAD; in orange possibly included in ASEAN FAMAD.

| COBSEA RAP MALI 2019 | | | ASEAN FAMAD |
|---|---|---|---|
| **Action 1** PREVENTING AND REDUCING MARINE LITTER FROM LAND-BASED SOURCES | 1.1) Legal & economic instruments | 1.1.1) Enhance leadership, implementation and quality of government efforts | |
| | | 1.1.2) Solid waste management policies and agency coordination through policy-making mechanism | |
| | | 1.1.3) Develop and adopt instruments prevent/manage waste and towards circular economies including single-use plastics and deposit refund systems | |
| | 1.2) Integrated waste management | 1.2.1) Develop Industry dialogues for measures | |
| | | 1.2.2) Reduction, reuse & recycle as well as replacement to reduce amounts to landfill or incineration without energy recovery | *Without mention of incineration* |
| | | 1.2.3) Waste collection & separation systems | |
| | | 1.2.4) Take necessary measures to address illegal dumping | *No specific mention* |
| | | 1.2.5) Cooperation with river authorities | *No specific mention* |
| | 1.3) Removal of existing litter and its disposal | 1.3.1) Programmes & activities such as coastal clean-ups | |
| **Action 2** PREVENTING AND REDUCING MARINE LITTER FROM SEA-BASED SOURCES | 2.1) Legal & economic instruments | 2.1.1) Encouragement to develop & adopt instruments consistent with UNCLOS & MARPOL | |
| | | 2.1.2) Reinforcement of national legal instruments on MARPOL Annex V, London and Basel Conventions & FAO Code of Conducts of Responsible Fisheries | *No mention of FAO but mention of waste from fishing vessels*<br>*No mention of London Convention* |
| | | 2.1.3) Assistance on requirements of MARPOL Annex V on improving port reception facilities | *No specific mention of port reception facilities* |
| | | 2.1.4) Sectoral prevention & reduction guidelines on fisheries & tourisms | |
| | | 2.1.5) Legislation on identified fishing gears | *Action on fishing gear may not involve legislation* |
| | 2.2) Removal of existing litter and its disposal | 2.2.1) Programmes & activities | |
| **Action 3** MONITORING AND ASSESSMENT OF MARINE LITTER | 3.1) Expert group | 3.1.1) Setup of Marine Litter Monitoring Expert Group under COBSEA WG on Marine Litter | *Similar approach to an expert exchange platform* |
| | 3.2) Regional & national marine litter monitoring programmes | 3.2.1) Regional guidance on harmonisation in line with international standards e.g. GESAMP | |
| | | 3.2.2) Regional training & data management | |
| | | 3.2.3) National monitoring & assessment on marine plastic & microplastic | |
| | | 3.2.4) Preparation of regional report for SDG target 14.1 | *Not envisaged at regional level* |
| | | 3.2.5) Database management | *Unclear scope of regional database, sharing platform, or ASEAN information platform* |
| **Action 4** ACTIVITIES SUPPORTING THE IMPLEMENTATION OF COBSEA RAP MALI | 4.1) Regional & international cooperation and reporting | 4.1.1) Setup of COBSEA Working Group on Marine Litter | *Expert exchange platform and regional action plan task force* |
| | | 4.1.2) Institutional cooperation e.g. MARPOL, London Convention, Basel Convention, CBD, GPA & FAO | *Only dialogue with Basel Regional Centre* |
| | | 4.1.3) City partnership for knowledge transfer | *No mention of direct city partnerships* |
| | | 4.1.4) Regional conferences e.g. ASEAN | |

| | | | |
|---|---|---|---|
| | 4.2) National planning & policy frameworks | 4.2.1) National action plan development & implementation or on equivalent GPA land-based | |
| | | 4.2.2) Regional sectoral guidelines on waste management, tourism and plastic manufacturing | *No guidelines mentioned although standardised approach is emphasised* |
| | | 4.2.3) Reporting format of national planning & policy frameworks | *No format mentioned* |
| | 4.3) Research activities | 4.3.1) R&D on technology as well as social & behavioural sciences | |
| | | 4.3.2) Research on marine litter impacts | |
| | | 4.3.3) Effectiveness on market-based instruments | *Different language but engagement of private sector emphasised* |
| | | 4.3.4) Trajectory modelling on marine litters | |
| | | 4.3.5) Plastic flows and relative contribution | *Regional baseline report* |
| | 4.4) Information, education, outreach & involvement of stakeholders | 4.4.1) Stakeholder involvement | |
| | | 4.4.2) Regular clean-ups for education, awareness, certain responsibility areas & international initiatives | *Education and outreach emphasised but not regular clean-ups* |
| | | 4.4.3) Awareness raising campaigns | |
| | | 4.4.4) Information translated into national languages | *No mention of translation but implied* |
| | 4.5) Training & capacity building | 4.5.1) Regional education & training for targeted groups | |
| | | 4.5.2) Technical capacity buildings to relevant staffs | |

## 2.2 Actions or activities that are not included in ASEAN FAMAD

Four actions or suggested activities of the COBSEA RAP MALI are not included in the current version of the ASEAN FAMAD. Most notably, the priority action of marine debris removal on land and at sea is not envisaged in the ASEAN FAMAD. The other two priority actions that are not mentioned are (i) the preparation of reports for SDG target 14.1 at the regional level, and (ii) the establishment of institutional cooperation mechanisms with relevant treaty bodies. The ASEAN FAMAD only mentions dialogue with the Basel Regional Centre.

Other actions or suggested activities that are not specifically included could fit within some general actions, such as measures to address illegal dumping of waste on land and at sea (which would contribute to marine litter), extent and nature of communication with river authorities in the measures for integrated waste management, and city partnerships for knowledge transfer as a means of regional cooperation.

With respect to comparable priority actions, different language is used to describe potential cooperation mechanisms at the regional level. Streamlining between COBSEA and the ASEAN is expected to optimise resources, time and effectiveness. This is particularly true of knowledge sharing platforms, reporting mechanisms and regional experts' participation through working groups or regional task forces. In this context, the work of the COBSEA Working Group on Marine Litter and Microplastics may provide a building block for the ASEAN. Institutionally, this may be particularly feasible as seven of the nine participating countries of COBSEA are ASEAN member states, and the other two states are members of ASEAN+3 (see Diagram 1 in Part 1, Section 1 on Methodology). Furthermore, the same government departments/officials appear to be generally involved in COBSEA meetings on marine plastics and ASEAN meetings on the same topic. The ASEAN FAMAD also specifically refers to the best practices of Regional Seas programmes to combat marine debris.

Whilst COBSEA RAP MALI is generally more specific than the ASEAN FAMAD, some actions from the latter may also be relevant to COBSEA's work, such as a regular dialogue with the Basel Convention Regional Centre for South-East Asia (BCRC-SEA); a consultative meeting or a feasibility study on the development of an ASEAN agreement on management of marine debris pollution; the compilation of a regional baseline; and the development of communication material. COBSEA's cooperation with the Basel Convention occurs at the global level, with the COBSEA Secretariat being a member of the Basel Convention Plastic Waste Partnership.

Also relevant to COBSEA's work is ASEAN's Culture of Prevention Initiative as an innovative approach to sustainable social and human development. See: https://www.sdg16hub.org/system/files/2019-07/The%20Culture%20of%20Prevention%20represents%20a%20crucial%20crossroads%20for%20ASEAN.pdf.

### 2.3 Specific outputs in ASEAN FAMAD

Finally, COBSEA may seek to collaborate and/or communicate in the context of the development of the following outputs by the ASEAN:

- Develop EPR policies;
- Conduct regular dialogue through webinar and/or BCRC-SEA;
- Review and analyse best practices of Regional Seas programmes to combat marine debris;
- Study of the feasibility of the development of an ASEAN agreement on management of marine debris pollution;
- Study of the feasibility of the establishment of a centre on combatting marine debris;
- Development of communication material on pollution from marine plastic; and
- Establishment of an ASEAN information platform including marine debris data.

The ASEAN+3 Marine Plastics Debris Cooperative Action Initiative focuses on marine litter management from land-based sources and in this context, emphasises, like COBSEA RAP MALI, knowledge sharing of sound waste management and 3R principles. The COBSEA RAP MALI is more comprehensive as it identifies more actions and seeks to also include marine litter management from sea-based sources. However, the mention of waste-to-energy infrastructure by ASEAN+ 3 must be noted as it is not in COBSEA RAP MALI or in the ASEAN FAMAD.

Whilst there appears to be no gap as such between the ASEAN+3 Initiative and the other regional instruments, a common specific feature is worth mentioning, namely the development of monitoring as well as harmonization of microplastics monitoring and standards in ASEAN countries. This a recurring priority in all regional plans considered. Additionally, of note are the two shared concerns of engagement with the private sector and the use of existing fora and institutions. The two institutions mentioned in this context are two Japanese research institutions: (i) the Regional 3R Forum in Asia and the Pacific based in Tokyo, and (ii) the Economic Research Institute for ASEAN and East Asia (ERIA) based in Jakarta.

## 3. INSTITUTIONAL MECHANISMS, COOPERATION PROCESSES AT GOVERNMENTAL AND NON-GOVERNMENTAL LEVELS

Establishment of a number of cooperation mechanisms is specifically considered in relation to the implementation of COBSEA RAP MALI and ASEAN FAMAD.

COBSEA RAP MALI includes:

- Institutional cooperation with global relevant multilateral environmental agreements (e.g. MARPOL, the London Convention and its Protocol, the Basel and Stockholm Conventions, etc.);
- Effort coordination with relevant partners and frameworks (COBSEA RAP MALI specifically mentions ASEAN);
- Cooperation with river authorities;
- Groups of experts such as GESAMP; and
- Engagement with relevant stakeholders.

Whilst the ASEAN FAMAD highlights cooperation through ASEAN-led mechanisms, it also includes:

- Incorporation of international law in regional platforms;
- Best practices from the Regional Seas programmes on combatting marine debris;
- Support of research and sharing of scientific knowledge, including through engaging research institutions, public and private sectors, international partners and other relevant stakeholders;
- Compilation of regional baseline on status and impacts of marine debris in ASEAN;
- Cooperation and partnership across research institutions;
- Network for the sharing marine data and information; and
- Expert-exchange platforms

## SECTION 3 – IMPLEMENTATION OF INTERNATIONAL LAW

This section examines the extent to which COBSEA and the ASEAN may provide a regional platform for implementation of international law on combating pollution from marine litter including plastics. It distinguishes the rules of international law that are expressly referred to in the regional instruments from those that are not.

## 1. UNEA RESOLUTIONS

The background of the COBSEA RAP MALI refers to UNEA resolutions on marine litter and microplastics which (i) recognize the importance of a regional approach to addressing marine litter as a transboundary problem, as well as multi-stakeholder engagement, coordination and cooperation; and (ii) stress the need to strengthen the science-policy interface, harmonize monitoring and methodologies, and prioritize a whole lifecycle approach. These UNEA resolutions also emphasise the importance of the Regional Seas conventions and programmes in this context. (For further details on this approach in UNEA resolutions, see Part 1, Section 3.2.3.)

ASEAN FAMAD also specifically mentions UNEA resolutions in particular proposed activities, including their incorporation in regional platforms, and providing support for enabling conditions for their implementation.

COBSEA RAP MALI also refers specifically to the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) to prevent and to reduce land-based marine litter by sustainable consumption, production and integrated waste management system. Members of the GPA include both states and non-states actors. (See Part 1, Section 3.4.1 for more details on the GPA, and Part 1, Section 3.3.3 on the GPML, the Manila Declaration and the Honolulu Strategy.)

## 2. UNCLOS

The key actions in COBSEA RAP MALI follow the structure and goals of the Honolulu Strategy. This global framework for the prevention and management of marine debris has three goals of reduction of amount, release at sea and impact of:

- Land-based sources of marine debris;
- Sea-based sources of marine debris (including lost cargo, ALDFG and abandoned vessels); and
- Accumulation of marine debris on shorelines, in benthic habitats and in pelagic waters.

The distinction between land-based and sea-based sources of pollution is also one that flows from states' obligations under UNCLOS. UNCLOS' binding obligations on coastal states have been formally accepted by all except one coastal state in the seas of Southeast and East Asia. (See Part 1, Section 3.1 for further details on UNCLOS).

ASEAN FAMAD also distinguishes land-based and sea-based sources of pollution. References to UNCLOS can be found all over ASEAN instruments and documents. UNCLOS is clearly identified as a framing treaty.

UNCLOS contains a specific obligation of cooperation for the protection of the marine environment at regional level (Article 197), as well specific provisions for the same in the context of land-based pollution (Article 207(3)). COBSEA and the ASEAN, in the context of the RAP MALI and the FAMAD respectively, provide a forum and a possible implementation framework for states' obligations to prevent, reduce and control pollution from land-based and sea-based activities as well as for their obligation of cooperation at the appropriate regional level.

Of note also is the UNCLOS provision that laws and regulations adopted "to prevent, reduce and control pollution of the marine environment from land-based sources … shall include those designed to minimize, to the fullest extent possible, the release of toxic, harmful or noxious substances, especially those which are persistent, into the marine environment" (Article 207(5)). Although UNCLOS does not refer specifically to 'plastic', numerous polymers and associated contaminants would qualify as toxic, harmful or noxious substances that are persistent in the marine environment.

Guidelines may be useful at the regional level to clarify which plastic substances would qualify. Plastic additives that would meet this definition include polymers such as PVC and EPS as well as associated contaminants (additives or sorbed compounds) such as lead, PCB, flame retardants of polybrominated diphenyl ethers and plasticizers of phthalates. (See Part 1, Sections 2.14.1 and 3.1)

## 3. OTHER MULTILATERAL ENVIRONMENTAL AGREEMENTS

COBSEA RAP MALI and ASEAN FAMAD both refer to many more international treaties and instruments which are relevant to pollution from sea-based sources. These include the International Convention for the Prevention of Pollution from Ships (MARPOL), the London Convention and its Protocol, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposals, the Convention on Biological Diversity, as well as the Food and Agriculture Organisation (FAO) Code of Conduct for Responsible Fisheries. Each of these instruments contains provisions that are applicable to different sources or aspects of release of plastic pollution at sea. (For further details on each of these instruments and relevant provisions, see Part 1, Section 3.)

Implementation of MARPOL Annex V (on prevention of pollution from garbage from ships) is specifically mentioned in the context of support for the implementation of the MARPOL provisions to improve reception facilities for all types of ship-generated waste.

In conclusion, COBSEA RAP MALI and ASEAN FAMAD refer to the most relevant international legal instruments and institutions. However, they do not spell out the mechanisms or processes for their regional implementation, or reporting at the regional context for pollution from marine litter and microplastics.

# SECTION 4 – REGIONAL FRAMEWORKS AND PUBLISHED RESEARCH

## 1. SUPPORT PROVIDED BY PUBLIC RESEARCH TO REGIONAL FRAMEWORKS AND ACTIONS PLANS

COBSEA RAP MALI is the only regional framework which specifies substantive areas of research needed. These areas of research are therefore focused on as they are also relevant to the other regional frameworks of action. Two of the five research activities identified as key actions in the Appendix 2 to COBSEA RAP MALI refer to upstream research areas which fall outside the scope of the research inventory developed for this study. These are the development of:

- Technology and approaches to prevent marine litter input from land-based sources; and
- Research on effectiveness of market-based instruments.

The other three research areas are downstream pollution concerns:

- Impact of marine litter on the marine and coastal environment and economy (including economic costs and impacts on human health and safety);
- Marine litter trajectory modelling to identify sources and accumulation zones; and
- Analysis of plastic flows into the region and their relative contribution to marine litter generation.

The first research area, which relates to impact of marine litter on the marine and coastal environment and economy, is very wide and includes a number of more specific research areas, including in particular different aspects of ecological and environmental impact (e.g. ingestion of plastic, branchial uptake, entanglement, changes in microbial assemblages, experimental studies of physicochemical impacts and trophic transfer of plastics), economic loss, fragmentation and degradation, survey and monitoring, methodology for the monitoring and assessment of marine litter and impacts of contaminants associated with marine plastic debris.

Research efforts in each of those sub-areas of research differ, with some of these sub-areas being a lot less developed than others. Research areas identified as lagging include:

- Changes in microbial assemblages;
- Trophic transfer of plastics;
- Fragmentation and degradation;
- Impacts of contaminants associated with marine plastic debris; and
- Fouling organisms on plastic debris as a pathway for invasive species.

The second research area, which relates to marine litter trajectory modelling to identify sources and accumulation zones, is still at an early stage with unclear methodology on the criteria for accumulation zones and limited trajectory modelling.

The third research area, which relates to plastic flows into the region and their relative contribution to marine litter generation, has had limited research effort so far. This research area includes contribution from rivers, source differentiation and discharge from offshore installations including aquaculture farms and ALDFGs. Three other known sources of sea-based marine plastic litter which have not been quantified and generally studied in the region are: ALDFGs, port reception facilities, abandoned plastic-reinforced fibreglass vessels and contribution from hull scraping and self-polishing marine coatings.

## 2. RESEARCH GAPS TO SUPPORT IMPLEMENTATION OF REGIONAL FRAMEWORKS AND ACTION PLANS

A research area of particular relevance to Southeast Asia that is needed to support the objectives of COBSEA RAP MALI (though it is not specifically listed in COBSEA RAP MALI section 4.3 on research activities), and was not investigated in the research papers reviewed is:

- Methodology for clean-up.

Another research area of particular relevance to Southeast Asia that is needed to support COBSEA RAP MALI (and is mentioned to that effect in the list of proposed research activities in COBSEA RAP MALI), but not in research papers reviewed is:

- Social and behavioural science.

Methodologies for clean-up and with different technologies and their net ecological benefit do not appear to have been studied except by groups seeking to justify their approach. An example is the indiscriminate removal of all floating matter from rivers. While these include a large quantity of plastic debris, they may also include biological matter, sediments and other alluvions that may be necessary to the ecological functioning of the river system and the estuary. Given the large number of accumulation areas of plastic litter along coastline and the time that is necessary to improve waste management infrastructure, clean-up operations may be necessary to mitigate new input in marine debris. Further research on this could therefore support a national plan of adequate methodologies and technologies in different areas.

Very little research effort could be found on education and outreach to mitigate pollution from marine plastic. The few articles focus on beach clean-up operation and awareness. Research on behavioural change and barriers to these, such as language and cultural traits, is needed. Interestingly, one article published in RO Korea focuses on the public willingness to pay for the removal of marine microplastics. Similar studies would be useful in Southeast Asia.

Additional topics for research that are recommended by the authors on the basis of the review of the scientific research is discussed in Part 2, Section 6 below on the overall findings of the report.

At this stage, a general observation can already be made, which is applicable to all regional frameworks. Findings from recent research articles show that one of the key difficulties encountered in transforming scientific findings into specific policy and measures is the remaining gap in the understanding of, as well as the persistent scientific uncertainty on, the magnitude of the impacts to ecosystem functions and human health from plastic pollution. Research keeps developing our understanding of exposure to plastic debris of all sizes, but the extent of impacts is unclear.

# SECTION 5 – DOMESTIC POLICIES AND REGULATORY APPROACHES AND OBSTACLES

## 1. SCOPE OF ANALYSIS

This section considers four global reports that were commissioned by the United Nations on policy and regulatory examples and obstacles to combatting pollution from plastics. The purpose of these reports was to consider the findings and make recommendations of particular relevance to Southeast and East Asia that may be used towards the development of responses to pollution from marine plastics. The reports that have been reviewed below focus on marine plastic litter or plastic waste globally and in Southeast Asia. They therefore overlap in scope, despite each having a different framing. The first three reports are global in scope, whereas the fourth report focuses specifically on plastic in Southeast and East Asia.

First, the 2016 UNEP Report on 'Marine Litter Legislation: A Toolkit for Policymakers'. It is referred to below as UNEP Toolkit for Policymakers (available: http://wedocs.unep.org/bitstream/handle/20.500.11822/8630/-Marine_litter_legislation_A_policy_toolkit_for_policymakers-2016marine_litter_legislation.pdf.pdf?sequence=2&isAllowed=y). It focuses on regulatory approaches taken to combat pollution from marine litter at international and domestic levels, with a particular focus on issues that are later expanded on by the remaining three reports referred to. These issues include: plastic bags and other single-use plastic items; biodegradability; taxes and levies; EPR; as well as waste management approaches for land-based and sea-based sources of marine litter, including the management of marine litter in the marine environment and removal efforts.

Second, the 2018 UNEP Report on 'Single-Use Plastics: A Roadmap to Sustainability'. It is referred to below as UNEP Roadmap to Sustainability (available: https://www.unenvironment.org/resources/report/single-use-plastics-roadmap-sustainability). This report focuses on plastic bags and foamed plastic products considered as problematic single-use plastics. It expands on the earlier 2016 report by suggesting steps that may be considered to minimize their production and therefore their disposal. The report presented case studies from around the world, and provided a summary of countries that have introduced regulations on plastic bags and styrofoam products, including ASEAN+ 3 countries, with China featured in the case studies.

Third, the 2019 GPML-UNEP Report on 'Legal Limits on Single-Use Plastics and Microplastics: A Global Review of National Laws and Regulations'. It is referred to below as the Report on Legal Limits on Single-Use Plastics (available: http://wedocs.unep.org/handle/20.500.11822/27113). This report provides a global overview of national laws and regulations on bans and restrictions, taxes and levies, waste management measures, and alternative products limiting the manufacture, import, sale, use and disposal of selected single-use plastic products and microplastics which have been found to substantially contribute to marine litter. This study covered 192 countries, including all ASEAN+3 countries, and spanned a six-month period from March to August 2018. It focused on three types of plastic items (i.e. plastic bags, other single-use plastics, and microbeads). It considered regulations at three particular stages in the life cycle of plastic from fabrication to waste (i.e. market entry regulation, retail distribution regulation, and post-use or disposal regulation).
Fourth, the UNEP-GA Circular 2019 report on 'The Role of Packaging Regulations and Standards in Driving the Circular Economy' which focuses on the ASEAN. It is referred to below as the Report on the Role of Packaging Regulations and Standards (available: http://sos2019.sea-circular.org/wp-content/uploads/2019/11/FINAL_THE-ROLE-OF-PACKAGING-REGULATIONS-AND-STANDARDS-IN-

DRIVING-THE-CIRCULAR-ECONOMY.pdf.) This report reviews packaging policies and interventions for combating plastic wastes in the ASEAN region, based on adaptation of best practices from the European Union and Japan, together with reviews of existing laws and policies in ASEAN countries.

The findings and points made in these reports have been compiled and integrated below in the context of plastic pollution of the coastal and marine environment in ASEAN+3. It includes prior analysis of the status of research and priorities of intergovernmental bodies. This integration is to better inform the steps that may be considered by regional bodies at this stage to combat marine plastic pollution.

The discussion of the findings and recommendations are structured below. It concentrates first on regulatory approaches to plastic bags, single use plastics and packaging in general, prior to focusing on specific issues and challenges: upstream source restrictions, biodegradable products and recycling content as well as microbeads. Pollution of the marine environment from plastic nurdles is highlighted in the first report only and not discussed in the others and especially not in the context of ASEAN+3. Microplastocs therefore not discussed in this section. However, the review of research on marine plastic pollution in ASEAN+3 highlights a lack of understanding of distribution and baseline of pollution of the marine environment by microplastics in ASEAN+3. See Part 1, Section 2.14.2 on the regional summary of research, and Part 2, Section 6.

The 2019 Report on the Role of Packaging Regulations and Standards propose that, in order to support the development of a circular economy and therefore effectively combat pollution from plastic debris, response policies must be nested around four core components:

- Source reduction;
- Source separation and separate collection;
- Landfill; and
- National targets.

These are examined in throughout the following sections and further discussed in the conclusion.

## 2. REGULATORY APPROACHES TO PLASTIC BAGS, SINGLE-USE PLASTICS AND PACKAGING

### 2.1 Regulatory approaches to plastic bags

The Report on Legal Limits on Single-Use Plastics shows that regulatory approaches taken by states varies. Approaches may primarily target consumers, the plastic industry or retailers or waste management.

Table 2.5.2.1. Regulatory approaches to plastic bags in ASEAN+3.
(Sources: 2019 GPML-UNEP Report on 'Legal Limits on Single-Use Plastics and Microplastics: A Global Review of National Laws and Regulations' and 2018 UNEP Report on 'Single-Use Plastics: A Roadmap to Sustainability'.)

| Country | Approach to regulatory interventions to limit the number of plastic bags |
|---|---|
| Brunei | Only regulates disposal at national level (solid waste/litter regulation) |
| Cambodia | - Handle plastic bags are prohibited from importation, production, distribution and use, except for: A- the plastic bags are 0.03 mm or thicker; and B- the plastic bags have a bottom width of at least 25 cm or10 inches. All importation and local production of plastic bags in A and B above shall have permit from the ministry of environment except for non-commercial importation of less than 100 kg<br>- Customers will pay for plastic bags from supermarkets, commercial centres, and all business and service locations<br>- Legislation requires encouragement of use of renewable materials and minimization of waste generation |
| China | - Ban on the import of used plastic bags and single use plastic products<br>- Ban on non-biodegradable plastic bags <25μ and levy on consumer for thicker ones<br>- No free plastic shopping bags shall be provided at any commodities retail places, and the price of plastic shopping bags shall be clearly marked and charged separately from the commodity price<br>[different measures in different provinces for the same purpose] |
| Indonesia | - Law speaks to creation of policy directives on waste reduction, handling and minimization including the development of a road map on extended producer responsibility<br>- Measures adopted by cities<br>- Manufacturers are obliged to recycle waste by<br>(a) preparing a waste recycling programme as part of its business and / or activity;<br>(b) using recyclable production raw materials; and / or<br>(c) reclaiming garbage from product and product packaging for recycling |
| Japan | - Recycling plan instituted by law<br>- Extended producer responsibility for designated businesses who are required to reduce waste containers and packaging discharged through rationalization of use of containers and packaging by using recyclable containers and packaging and reducing the excess use of containers |
| RO Korea | - Prohibition of distribution of packaging for free: Act on the promotion of saving and recycling of resources – For Single use plastic bags and shopping bags -5 cent/bag.<br>- Requirements to put in place a recycling plan for specified products |
| Lao | - General requirements to separate waste for different purposes such as recycle, reuse, reprocess as new products and elimination with methods and techniques within identified areas base |
| Malaysia | - Investment tax allowance for use of biodegradable materials<br>- Locally, charge on bags, ban on non-biodegradable bags |
| Myanmar | - Only regulates disposal at national level (solid waste/litter regulation)<br>- Local bans |
| Philippines | - Rules on waste minimization at source and separation<br>- No specific rules on plastic bags except locally |
| Singapore | - Mandatory requirement to submit waste report and waste reduction plan |
| Thailand | - Only regulates disposal at national level (solid waste/ litter regulation)<br>- Plastic bag levy under study |

| | |
|---|---|
| **Vietnam** | - Non-biodegradable plastic bags are taxed by weight at VND 40,000 ($1.76) per kilogram (levy on retailer). Amount may be too low<br>- Environmental protection tax issues against use of plastic bags<br>- Requirements for reduction and waste minimization |

Whilst single use plastics (specific products) bans and EPR measures (e.g. product-take back schemes, deposit-refund, and waste collection and takeback guarantee) are commonly adopted globally, less examples from ASEAN+3 countries are mentioned, compared to the countries of Africa, Europe and West Asia. With respect to plastic bags, the Report on Legal Limits on Single-Use Plastics highlights that 66% of countries have adopted some kind of regulation, with the most common being a ban on free distribution within the retail sector. However, in ASEAN+3, few countries have embraced such a ban at national level, with some charging a levy for plastic bags on the consumer (i.e. Cambodia, China and RO Korea).

The most common legal measures focus on single use plastics, recycling requirements and solid waste management regulations, whether implicitly or explicitly focused on plastics. (see Table 2.5.2.1 above). Case studies from other developing and tropical countries in Africa and the Caribbean show that a ban of plastic bags is possible, with exemption for essential use, hygiene and sanitary purposes. Other approaches include bans of particular polymers and/or over certain thickness.

Ongoing work and projects on this topic in ASEAN+3 suggest that new measures are about to be adopted in most states, each with their own approach. The reports also highlight the greater success of a holistic approach that is not solely focused on legal interventions or incentives or waste management. Standardised measurements of pollution status would assist assessment of measure efficiency.

Table 2.5.2.2. Policy tools to limit the use of plastic bags.
(Adapted from the 2018 UNEP Report on 'Single-Use Plastics: A Roadmap to Sustainability', page 23.)

| Policy tools | | Features |
|---|---|---|
| **Regulatory instruments** | Ban | Prohibition of a particular Type or combination of single-use plastics (including plastic bags, foamed plastic products, etc.). The ban can be total or partial (for those of certain specifications, e.g. plastic bags |
| **Economic instruments** | Tax on/to manufacturers, importers or suppliers | Levy paid by suppliers of plastic bags (domestic producers or importers). For such a tax to be effective in inducing behavioural change, it should be fully passed on from suppliers to retailers, enticing the latter to (i) charge consumers for plastic bags or (ii) offer a rebate/reward to consumers who do not ask for plastic bags, promoting the use of reusable ones. Can be a tax on import and/or manufacture and/or distribution |
| | Tax/levy/incentives on/to retailers | Levy to be paid by the retailer when purchasing plastic bags. The retailers are not obligated to convey the tax to the consumers. Can be a tax on distribution |
| | Levy/fee/incentive on/to consumers | Charge on each bag sold at the point of sale; standard price defined by law. Can be a fee on end-user |
| **Combination of regulatory and economic instruments** | Ban and tax/levy/fee | Combination of ban and levy (for instance a ban on thin plastic bags and a levy on thicker ones) |
| **Voluntary reduction strategies** | Public campaign | Public campaigns and reward system, preferably in addition to other measures with aim of changing social behaviour |

| | | |
|---|---|---|
| | Public education | Education and awareness on issues to convince of need for social behavioural change, risks of status quo and alternatives available |
| | Private-public agreements | Choice of modalities left to the private sector such as agreement between retailer or producer and government (e.g. voluntary framework for EPR) |

The Report on Single-Use Plastics also highlights challenges linked to bans on plastic bags, such as the controversy on reusable bags due to some of them not being easily recyclable, depending on their composition. Prior to banning a product, alternative solutions must be explored. The Report points again to the benefit of addressing plastic pollution in a holistic manner that envisages all relevant stakeholders and public-private partnerships. It also presents policy tools adapted in Table 2.5.2.2 above.
Whilst plastic bags are often treated as a separate issue, all factors raised in this context are also relevant to the wider issue of single-use plastic packaging, especially the policy approaches.

## 2.2 Policy landscape on packaging regulations and EPR

### 2.2.1 General analysis

Packaging regulations include the regulation of single-use or non-reusable plastics themselves composed of a wide diversity of products such as (in addition to plastic bags) stirrers, disposable utensils, cups, cigarette butts, styrofoam (Expanded polystyrene or EPS) boxes, etc. The reports indicate that nearly 50% of plastics generated globally in 2015 are from plastic packaging but that recycling rate has stagnated at less than 10%, with the remainder going to landfills, incinerations and leakages to the environment.

Table 2.5.2.3 below provides a summary of the policy landscape for packaging regulations in ASEAN countries and Japan on the basis of the UNEP-GA Circular 2019 Report on the Role of Packaging Regulations and Standards.

Table 2.5.2.3. Policy landscape for packaging regulations in ASEAN+3.
(Source: UNEP-GA Circular 2019 report on 'The Role of Packaging Regulations and Standards in Driving the Circular Economy'. China and RO Korea were not included in the scope of this report.)
Legend: ✓ indicates adoption of different policy approaches or regulations;
Indicates that no such policy has been adopted; >60% ASEAN MS; most ASEAN MS; few ASEAN MS.

| | JPN | BRN | KHM | IDN | MYS | MMR | PHL | SGP | THA | VNM | % in ASEAN |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Source reduction by design or material restriction | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | 88% |
| Green procurement plan | ✓ | | | ✓ | | | ✓ | | ✓ | | 33% |
| Domestic trade policy on plastic waste | ✓ | | | ✓ | ✓ | | ✓ | | ✓ | ✓ | 55% |
| EPR- legislative framework (gen'l) | ✓ | | | ✓ | ✓ | | | | | | 22% |
| EPR- Reporting | ✓ | | | | | | | ✓ | | | 11% |
| EPR-Take back requirements | ✓ | | | ✓ | ✓ | | | | | | 22% |
| EPR- Taxes/fees for packaging (excl plastic bags) | ✓ | | | | | | | | | | 0% |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| EPR- Packaging marks and labels | ✓ | | | | | | | ✓ | ✓ | | 22% |
| EPR- Voluntary efforts | ✓ | | | ✓ | | | | | | | 11% |
| Waste management policy or legislation (gen'l) | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 100% |
| Source separation and collection | ✓ | | ✓ | ✓ | ✓ | | ✓ | | | ✓ | 55% |
| Recycling content policy, recycling/recovery targets | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 88% |
| Landfill regulations (incl waste to energy) | ✓ | | ✓ | ✓ | ✓ | ✓ | ✓ | | ✓ | ✓ | 77% |
| Marine litter legislation | ✓ | | | ✓ | ✓ | | ✓ | ✓ | ✓ | ✓ | 66% |
| Anti-litter legislation | | ✓ | | | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | 77% |

This analysis illustrates the general awareness of marine plastic debris in the ASEAN + Japan where most coastal states have adopted marine litter legislation in addition to general anti-litter legislation and waste management policy or legislation. While there is a strong emphasis on waste management, upstream measures are progressively being developed (such as source reduction, source separation, green purchasing and recycling targets and policy content) in order to stimulate the closing of the economic loop and avoid discharge into the marine environment.

However, the report provides a broad analysis waste management and includes an array of different measures. It therefore does not reflect on the different stages of development of waste management practices. For example, despite a theoretical source selection and separation of waste, Part 1, Section 2 has shown that the infrastructure is often insufficient to prevent accumulation areas leaking into the marine environment, especially (though not only) in ASEAN countries. In particular, the 2016 Report on Marine Litter Legislation highlights some useful components that may not be widely adopted or implemented as described across all ASEAN+3 countries, particularly:

- Landfill siting and operation;
- Planning and disaster preparedness for countries that are exposed to natural disasters such as earthquakes, flooding and typhoons; and
- Incineration.

Recycling content policies and recycling targets appear to be a focus in the ASEAN to some extent, but are at an early stage of development. Finally, the development of new 'environmentally friendly' and biodegradable plastic is raising new challenges.

The reports reviewed also highlight that whilst the ASEAN countries have all committed to a circular economy approach in a number of instruments and intergovernmental documents, modalities of implementation of this approach are still being defined. In the same way that upstream policies on source restriction are still primarily focused on plastic bags (and locally styrofoam boxes), the implementation of EPR is still in its early stage with Indonesia and Malaysia as early movers in the ASEAN on the set-up of a legislative framework.

### 2.2.2 EPR and other market-based policy approaches

EPR is generally understood as a policy approach designed to extend to the responsibility of a producer to the post-consumer stage of a product's life cycle to the producer. It encompasses a large array of possible mechanisms and varying degrees of sharing of responsibility between the consumer and the producer with respect to the end of life of the product.

Several types of EPR that are being used to combat pollution from plastic are mentioned in the previous section. From the most stringent on the producer to more flexible mechanisms, they include:

- Take back requirements;
- Taxes/fees for packaging;
- Waste management reporting by the producer;
- Packaging marks and labels; and
- Voluntary efforts.

Hybrid mechanisms can also be envisaged. For example, a tax can be applied to the distributor/dealer of non-returnable plastic containers or other packaging unless the distributer/dealer has an adequate system for the recycling of these items.

Of note, EPR can encompass additional responsibilities including the recovery and recycling of products, responsibility for return, and trade controls or lifecycle management of a range of products that includes management of the potential environmental impacts of a product in all stages of production, distribution, use, collection, re-use, recycling, reprocessing and disposal. EPR schemes generally take the form of a hybrid of regulatory and economic instruments.

The 2019 Report on Legal Limits on Single-Use Plastics and Microplastics indicates that in ASEAN+3, Indonesia, the RO Korea and Japan have an EPR regulation that involves take-back of plastic packaging. Indonesia seeks to push waste recycling through businesses having to institute a recycling programme as part of their activities, using production and raw materials that can be recycled, and reclaiming waste from products and product packaging for recycling. Similar results can be sought with a deposit-refund scheme. Indonesia and Malaysia are at the forefront of the ASEAN with EPR framework regulations with specific obligations on industries being under consideration. Case studies from these countries as well as the RO Korea and Japan could be very informative for further development of comparable schemes in the region.

## 3. CHALLENGES LINKED TO DIFFERENT APPROACHES TO PLASTIC RECYCLING AND BIODEGRADABLE PLASTICS AND OTHER PLASTIC ALTERNATIVES

### 3.1 Recycling capacity vs new plastic substitutes

The reports reviewed identify two parallel and potentially conflicting processes that are discussed in this section:

- The development of recycling capacity of solid waste in general and plastic waste in particular; and,
- The development of plastic substitutes including 'biodegradable' plastic products.

The development of recycling capacity for plastic waste through the setting of recycling targets, as well as the separation of recyclable and non-recyclable components and the separation of different waste streams prior to collection (to avoid difficult (if possible) subsequent sorting), are expected to result in greater product recovery and repurposing or recycling. This approach can be further encouraged by recycled content policies that aim to increase the proportion of recycled (rather than virgin) material for new product-making. A limit to note in this approach is the situation where plastic products contain mixtures of different plastic materials (e.g. multi-layers of different polymers) that may not be easily separated.

The parallel objective of plastic reduction at source tends to be pursued through policies that include improved design with less or no plastic, material bans and restrictions, and alternative packaging policies including biodegradable plastics. However, these approaches can result in the development of new products or increase the use and disposal of materials that waste management sorting systems are unable to deal with where the products are disposed off. This thereby creates a new open loop in the economy, rather than supporting the closing of the existing loop towards a circular economy.

### 3.2 Recycling mandate and recycling capacity

The development of national policies on recycling capacity starts with a waste management system which includes recycling of plastic products, whether implicitly or explicitly. Many countries have such mandate through solid waste management laws that explicitly include plastic products. In the ASEAN+3, Indonesia, the RO Korea, Malaysia and the Philippines have established recycling regulatory mandates that include specific measures for single-use plastic items. Recycling is also practiced in other countries to different extents under a less formal policy structure that includes local initiatives from the private sector and civil society.

Elements that need to be included in the recycling mandate to stimulate progress towards a circular economy model are:

- Separation of different recyclable products and of non-recyclables;
- Separate collection;
- Recycling and recovery technology and infrastructure;
- Most products can be reused, repurposed or recycled; and

- Recycling targets (e.g. packaging waste recovery) and recycled content policy (e.g. requirement that single-use products are made of recycled material).

Of note, EPR is a useful tool to support such a recycling policy approach and can include return, collection and recycling of single-use plastic items. Public-private agreements are also relied on in a number of countries where public institutions provide a collection infrastructure prior to handing the products back to different industries under the agreement, as an example.
However, adoption of these procedures relies on a solid understanding of the materials being used, on their recyclability, and on the existence of end-markets for these materials. In this context, for new types of materials to fit within this framework, their development must follow a consistent and rigorous approach. This would include a common understanding of what 'biodegradable' and 'compostable' mean in the context of waste treatment.

### 3.3 New biodegradable plastics and plastic substitutes

Bans of non-biodegradable plastic in plastic bags and single-use plastic items, as well as the urgency to limit products that are persistent and polluting the marine environment, have triggered the development of new types of plant-based plastic materials that are marketed as being 'biodegradable' or oxobiodegrable (e.g. from cornstarch).

Production of such new material is encouraged by a number of regulations that ban or seek to limit plastic bags and single-use plastic, which exclude 'biodegradable' plastic from these regulations. Biodegradable plastic can be defined very differently, and is an issue that needs addressing. Plastic bag thickness can for example be used to characterise biodegradability or avoid application of a ban. The Report on Legal Limits on Single-use Plastics indicates that 38 countries regulate the thickness of plastic bags with varying threshold of 10 to 100 microns and above; bags that are thinner than this threshold are within the scope of the ban or other restrictive measures. In ASEAN+3, the threshold adopted by China is 25 microns whereas Cambodia and Vietnam have adopted higher threshold. In Vietnam, environmental-friendly bags that are thicker than 50 microns are reported to be exempt from tax.

Some countries also combine a thickness threshold with a requirement of oxo-biodegradability or use 'biodegradibility' as an exemption from restrictive rules. This raises two issues: first, the definition of biodegradable; and second, the treatment of biodegradable plastic.

On the definition of biodegradability, the reports highlight the difference between biodegradability and photodegradability of plastic, which are often confused. Photodegradability is defined as the slow break down of plastic into small fragments also known as microplastics, under the effect of sun and oxygen. By contrast, biodegradability designates the breakdown of a material into the components of carbon dioxide, biomass and water.

With respect to the treatment of biodegradable plastic products, the reports on Single Use Plastics and on the Role of Packaging Regulations and Standards point to unintended consequences of biodegradable plastics on waste collection and treatment systems, on the basis that they break down completely only if they are exposed to prolonged high temperatures above 50°C and oxygen. In marine environments, biodegradable products are reported as having their degradation slowed down even further due to the lack of high temperature and oxygen. Therefore, even bioplastics derived from renewable sources (such as corn starch, cassava roots, or sugarcane) or from bacterial fermentation of sugar or lipids (PHA) do not automatically degrade in the environment and especially not in the ocean. The post-disposal journey of biodegradable or compostable plastics or bioplastics requires particular scrutiny that includes separate collection, special treatment for bioplastics and ensuring that it is effectively subject to waste treatment. Separation from traditional plastics waste streams is due to differing chemical compositions of biodegradable plastics, the need to ensure high-quality recyclates production, and the durability of plastic products made of these recyclates.

Oxo-degradable plastics raise another series of issues. They are made by blending a prodegradant-additive into the plastic during the extrusion process, and this additive causes the plastic to decompose when exposed to heat or sunlight. It is then assumed that microorganisms which can ingest this decomposed plastic can speed up the degradation by digesting it. This degradation process, however, presupposes the availability of heat and oxygen. It also raises concerns with respect to the breaking down into microplastics which are still harmful to the environment even if they address the littering issue.

Whilst biodegradability is not a common requirement in ASEAN+3, a definition that is shared between science, industry and market practices would contribute to improving the development of new ‘biodegradable’ materials, and preventing that which would defeat the aim of limiting input of new marine plastic debris. Existing standards may be considered in this context.

## 4. UPSTREAM SOURCE RESTRICTIONS

The UNEP Report on Single-Use Plastics highlights that Southeast Asia consumes less than half of single-use plastic than does Northeast Asia, a little bit less than Europe, and many times more than Africa or South America. Upstream source restriction is therefore an important area of study for the region.

Source reduction can aim to:

- Restrict the manufacturing of material: this can include the ban of particular polymers, require that material be made of recycled products or plastic bag ban of particular thickness or composition;
- Restrictions on use of material: this can include biodegradability requirements for specific items, green purchasing procurement measures, or tax on single-use plastics (e.g. special environmental tax, waste disposal fees or charges or higher excise taxes for single-use plastics); and
- Reduction by design: this can include bringing packaging weight and volume to the minimum needed for safety or hygiene and consumer acceptance of the packet product.

In ASEAN, source reduction has for now been mostly focused on plastic bags with ongoing work on single-use plastic. Bans or restrictions for dealing with single-use plastic products can be implemented across stages of manufacture, distribution, use, sale and import, and on specific products with targeted polystyrene polymer.

However, locally, there appears to have been restrictions on specific types of plastic polymers. There has been restriction on importing, trading or distributing high-density polyethylene (HDPE) in Yangon City in 2009 and PE in Mandalay in 2011. Some measures have also been adopted in Vietnam on nylon bags.

In Singapore, incentives have been given to brands to reduce their packaging and inform consumers who want to reduce their waste footprint. Examples include the granting of awards to brands for the development of products which incorporate new designs which reduce packaging waste.

## 5. MICROBEADS

Microbeads are identified as one of three important sources of plastic in the marine environment, along with plastic bags and disposable single-use plastic items. The term ‘microbeads’ is often used to designate mild abrasive plastic particles that have been intentionally added to home and personal care products such as facial cleansers, shampoos, and toothpastes since the 1990s. They are generally under 5mm in size and can vary in chemical composition, size, share and density. As they are persistent in and cannot be recovered from water through conventional water treatment systems, preventing their introduction into the marine environment is often seen as the only way to eliminate this source of marine plastic pollution. However, as of July 2018, only eight countries out of a total of 192 studied countries appear to have adopted legally-binding bans for limiting microbead manufacture and sale through national laws, with some countries including only a subset of personal care products and cosmetics. These countries consider microbeads to be a toxic substance. Exemptions can include biodegradable alternatives and medical purposes of microbeads. In the absence of such bans, voluntary measures executed by specific governments, companies, civil society organisations and regional government institutions aim to limit microbeads by future binding limits, publicized microbead lists for actions, as well as government plans and statements.

Microbeads do not appear to be a priority in ASEAN+3, unlike microplastics.

## 6. SUMMARY OF FINDINGS FOR THE REGION ON DOMESTIC POLICIES AND REGULATORY APPROACHES AND OBSTACLES

This review of domestic policies and regulatory approaches and obstacles highlights a few issues and opportunities.

First it demonstrates the global focus on plastic bags and single-use plastic whilst highlighting that ASEAN+3, as a region, has been focusing first on plastic bags with regulatory interventions at local or national levels, involving for example, general or selective bans on specific plastic bags such as extra-thin bags or taxes. This policy approach shows a strong awareness of plastic issues and a diversity of other measures are being considered. It is a dynamic area of policy work.

Second, there are areas of work for which measures have already been developed but are still at an early stage. EPR is a specific area of focus of both COBSEA RAP MALI and the ASEAN FAMAD. The reports reviewed show some measures and movements in this area. However, they also evidence the need for further work in specific regulatory measures that can durably modify the approach of producers and retailers to plastic materials. The new approach must include a greater scrutiny on their type, use, persistence and toxicity in the natural environment, as well as treatment as waste. Examples of measures that have not been widely embraced in the ASEAN+3 are reporting, taxes or fees for packaging other than plastic bags, packaging brands and labels (e.g. showing their content or certifying that they are made of a biodegradable or compostable material), and effective encouragements of voluntary efforts by producers or retailers.

Third, the reports point to issues raised by the ban of some plastic products and the development of new materials to replace them, whether they are claimed to be biodegradable or less polluting as they are reusable rather than single-use products. These create technical and policy challenges to progress towards a circular economy and close the economic loop that involve the design of new recycling frameworks. These also raise educational challenges to ensure that users use the recycling processes appropriately. Mechanisms are needed to overcome these challenges such as measures to ensure that there is a post-use market for all materials being distributed by retailers, that waste is sorted for treatment with source separation and separate collection and that users are informed adequately.

Fourth, these reports highlight that there are two areas that are still at an early stage of consideration, despite scientific studies progressively highlighting them as more and more critical: microbeads and polymer control. Research in microbeads is just starting in the ASEAN, while a lot more research on it is being done in China, Japan and the RO Korea. Similarly, restricting the types of polymer used in product component, in trade or at post-use stages on the basis that they would be more persistent or toxic, is mostly limited in ASEAN+3. The approach seems to be framed mostly through international regulations developed under the Stockholm and Basel Conventions. In this context, further understanding of and education on polymer types and their characteristics would support the development of a more effective discussion with plastic producers, traders and retailers as well as appropriate and effective measures.

Fifth, these reports highlight the need for harmonised standards, measures and reporting practices that are consistent at national, regional and global levels. The global nature of plastic production and trade, (at the stage of raw plastic, plastic as retail or plastic waste material) commands such mechanisms for the move towards circular economy to be truly successful and also benefit poorer countries. Examples of such standardised definitions and guidelines called for in numerous documents concern:

- Definition of biodegradability;
- Monitoring and evaluation of packaging reporting;
- Measures of plastic pollution;
- Labelling practices;
- Recycling (products and techniques); and
- Recovery technology.

# SECTION 6 – OVERALL FINDINGS FROM THE RESEARCH REVIEW AND THE GAP ANALYSIS

## 1. RESEARCH GAPS

The research review showed an important and ongoing research effort on pollution from marine plastics in ASEAN+3. Most of the 145 research papers analysed in the ASEAN were published after 2017. However, a more detailed analysis of the subject areas, methodology and findings of the publications (see Inventory in Appendix VI) provides a more nuanced picture.

*Research clusters*

Of 10 research clusters reviewed, the weakest research clusters relate to the following research areas:

- Understanding the interactions of plastics with the marine environment, such as the impacts of plastic-associated (organic and inorganic) contaminants to the marine environment and organisms through the leaching of contaminants from either the original plastic particle composition (e.g. additives) or adsorbed onto surfaces of plastic particles from the marine environment;
- Social perceptions and behaviour in the context of measures to combat pollution from marine plastics (e.g. willing-to-pay studies);
- Understanding the fragmentation and degradation patterns of plastic particles (e.g. photodegradation process, rate of breakdown, particle transformation and fate, sinking velocity, etc); and
- Contribution of plastics from marine fisheries (including aquaculture and ALDFGs) and shipping.

*Specific gaps within research clusters*

Areas of weaker research in ASEAN+3 are in particular:

- Of the marine environs examined, mangrove, seagrass, coral reefs, and seafloor (i.e. surface and subsurface sediments) have been the subject of less studies, with no clear baseline of distribution and abundance of plastic debris on the deep-sea seabed at the regional scale;
- Plastic polymer-specific research (e.g. PP, PE, EPS, PET) based on their presence in the marine environment and their potential environmental or ecological toxicity to marine organisms, with particular focus on the biological interactions with organic and inorganic plastic-associated contaminants;
- Research on ecological and environmental impacts has primarily focused on direct ingestion by biota; research needs to expand into assessing the physical and physiological impacts of marine debris on biota and marine habitats such as mangrove, seagrass and coral reefs, uptake and accumulation through respiratory and branchial systems, transfer of plastic particles through the food chain and impact of microbial assemblages on plastic debris in biota;
- Research on socio-economic impacts (such as human health, food safety, and economic loss) has been mostly based on inferences obtained on marine debris occurrence and distribution, with no specific impacts examined in-depth; research is needed to

quantitatively assess socio-economic costs due to marine plastic pollution in local communities.

*Research methodology and approach*

The review highlights that the following research methods and types of research have been less used so far:

- Modelling and simulation, for example hydrodynamic modelling to assess the transport of plastic particles in order to examine and identify hotspots and accumulations of marine plastic debris as well as backtrack to sources and identification of sources and pathways;
- Sustained monitoring of pollution from marine plastic spatially and temporally, with comparable measurement methodologies;
- Human surveys and social perception research that are necessary for the development of effective policies for managing pollution from marine plastics; and
- Laboratory-based research (e.g. on toxicity of relevant polymers and associated contaminants in marine organisms).

*Research gaps in supporting regional response frameworks*

The 23 research foci used to categorise the research review (see Part 1, Section 1) and a high-level review of the findings (see Part 1, Section 2.14), could suggest that there is sufficient research to address the action plans and areas of interest of intergovernmental policies.

However, several processes are limiting the guidance that this body of research can provide to the identification of specific response measures:

### (1) Perception of risk and difference in approach to knowledge in scientific research and in policy making

This difference is one of framing of the issue of pollution from marine plastics. Scientific research typically seeks to gain a clear understanding of scientific processes and reduce uncertainty. In contrast, policy makers need to balance out competing interests and approach issues on a risk assessment basis. This is exemplified by the difference in structure of research categories compared to that of the regional action plans that have been adopted (Part 1, Section 2.14 vs. Part 2, Table 2.1.2.1 and Table 2.2.2.1). At the science, policy and law interface, robust science is required to provide adequate information for a risk management approach and implementation of international law. Where the severity of a risk is in doubt, a risk-taking approach may not seem unreasonable and is certainly a less costly and therefore more popular path for policy makers, especially in developing states where risk mitigation measures can have adverse impacts on development. Progress in the scientific understanding on pollution from marine plastics is therefore critical, together with an accompanying path of transmission of this knowledge, education and outreach.

### (2) Scientific uncertainty and risk assessment

While the understanding of exposure and ingestion of plastic has progressed greatly, there remains a number of areas of uncertainty that are impediments to the adoption of effective measures. This includes in particular, an understanding with sufficient granularity of (therefore not only conceptual or modelled at global level with proxy data):

(i) The status of plastic pollution in the marine environment with adequate baselines in different environs and at a scale where policy measures can be adopted;
(ii) The transformation and fate of plastic particles in the marine environment (i.e. degradation, fragmentation, transport, sinking rate, etc);
(iii) Presence and persistence of different polymers in the marine environment and their toxicity to human health and marine ecosystems, including through associated organic and inorganic contaminants. Areas that need further research include the understanding of uptake by marine organisms through other paths than ingestion, experimental studies of physiochemical impacts, relative exposure of different species and ecosystems to entanglements, composition of microbial assemblages and tropic transfer;
(iv) Various sources and pathways of plastic debris into the marine environment which are likely to be specific to activities, local particularities and geography to adopt activity-specific measures and regulations that may be effective to decrease input of marine plastic; and,
(v) Understanding of the socio-economic drivers of leakages of land and sea-based sources of plastic debris into the marine environment; this area of uncertainty is a barrier to the identification of adequate measures to combat pollution from marine plastics.

### (3) Priority in waste management: Closing the tap

The global discourse on combatting plastic pollution emphasises the development of a circular economy in order to reduce the production of plastic that may reach the natural environment. It is a mid- to long-term goal that all the UN documents emphasise and most agree on, even if presented as a conceptual goal. Whilst regional instruments also refer to the development of a circular economy, specific actions adopted in the context of these instruments focus primarily on waste management, an immediate concern for most countries in SEA. The reports discussed in Part 2, Section 5, which review measures adopted at the national level, highlight the ASEAN+3 countries' focus on waste management and their timid steps towards an EPR approach which would make producers responsible for the full management of their product's life cycle.

The EPR measures adopted to date focus on involving private actors in the management of the post-use of the products distributed by them to consumers and may not stimulate the design change necessary for the economy to become circular. Further elaboration of the components of a circular economy in ASEAN+3 appears necessary before specific measures can be effectively adopted on this path. This should include shared definitions of the meaning of biodegradability and compostability in the context of plastic materials, as well as recyclability. Research and development in waste management, low-cost recycling technologies, biodegradability and new plastics is therefore critical. In this context, the clean-up measures highlighted in several regional action plans appear realistic and necessary until waste management measures become effective.

### (4) Research and protocol fragmentation

COBSEA RAP MALI and ASEAN FAMAD include the development of several guidelines, standards or national reporting with a coordinated approach. Common objectives include the development of regional guidance for the monitoring of marine plastic pollution and standardised methods. The ASEAN FAMAD also proposes the development of baselines for pollution from marine plastics. As a number of guidelines and protocols are being used in ASEAN+3 that suit different context and available technologies, research on comparable measures and/or bioindicators would be useful for that purpose.

The number of articles in ASEAN+3 that discuss methodologies and surveys (66%) suggests that the region is ready to develop its own adequate standardised methodology or set of methodologies that result in comparable measures of pollution. Importantly, such methodologies would have both a scientific and a policy-making aim. They would also build on existing guidelines such as those from GESAMP and IOC WESTPAC.

Such standardized methodologies have to be vetted by the specialised research community on this subject area so to ensure their use by scientists. In practice, it is therefore recommended that regional standards for survey and monitoring methodologies be developed in consultation with both the scientific community and governments. Similarly, research could better inform national policy through improved communication channels between both spheres of work, whether directly or through regional organisations. In addition, the buy-in of other relevant stakeholders is also critical to ensure implementation of policy. This suggests the need for further research cooperation that integrates public, civil society and private efforts. An example of this is the SEA of Solutions held at the UN regional headquarters in Bangkok in October 2019. COBSEA's intergovernmental mechanisms and knowledge management efforts, such as the Working Group on Marine Litter (WGML) and the Regional Node of the Global Partnership on Marine Litter (GPML) may be leveraged to strengthen the science-policy dialogue and facilitate cooperative marine litter research that address the regional priorities identified in the RAP MALI. Finally, in order to ensure monitoring of plastic pollution at global level, such regional methodology would need to build on existing guidelines such as those from GESAMP and IOC-WESTPAC.

## 2. LEGAL AND INSTITUTIONAL BARRIERS OR GAPS

In the absence of regional binding laws and regulations on the protection of the marine environment, including from marine plastics pollution, international law is particularly important. This is especially as most states of ASEAN+3 are a party to relevant treaties, or are a member of bodies that have adopted guidelines applicable to the issue of marine plastic litter.

Part 1, Section 3 identifies more than 20 bodies with an intergovernmental mandate that includes at least all or some aspects of pollution from marine plastic litter. Many have adopted binding regulations and guidelines that are intended to prevent marine plastic debris from reaching the sea. Whist there are some grey areas under international law (where additional rules appear necessary), it seems that the ongoing release of plastic debris in the marine environment is more a matter of systemic failure and weak implementation at the regional and at national levels, than one of clear gaps in international law. Potential gaps are under international scrutiny and include the loss of containers from container vessels, release of wastewater from ships that are expected to include plastic fibres, as well as the long-term toxicity of micro- and nano-plastics to the marine environment and human health. These potential gaps would need reflecting in a number of treaties such as the London Convention and its Protocol on disposal of waste at sea, and the Stockholm and Basel Conventions that limit the trade of toxic products and waste. The creation of specific rules (including through the potential negotiation of a new treaty) to prevent discharges or leakages of marine plastic debris from land-based sources and to elaborate on UNCLOS Article 207, is now in the hands of UNEA. Furthermore, a global or regional approach to land-based sources of plastic pollution would be of use to prioritise and guide national implementation.

In the meantime, should existing provisions of international law be adequately implemented, marine plastic pollution would improve (and the current state of marine plastic pollution would not have been reached). Provisions of international law themselves refer to the importance of regional mechanisms. International instruments with the most general mandate to combat all aspects of pollution from marine plastics (e.g. UNCLOS and UNEA Resolutions) include such provisions on cooperation through regional mechanisms. Furthermore, In the context of ASEAN+3, declarations, policy documents and recommendations adopted by regional bodies refer specifically to UNCLOS and other relevant international instruments. One of the key mechanisms available to remedy the situation today is therefore a better use of existing regional bodies to implement international law.

However, at regional level, the ASEAN+3 region is characterised by a number of intergovernmental regional institutions which work on the protection of the marine environment while having different membership configurations. Figure 1.4.1.1 (in Part 1, Section 4) shows more than 20 regional bodies. Some have a general mandate, others are specialised (e.g. on fisheries, waste and chemicals, marine turtles, etc.). Some have a policy mandate, whereas others are more dialogue meetings. Some are ministerial-level meetings, others are at technical working group levels. Analysis of the mandate, membership and work of these bodies with respect to pollution from marine plastics (in Part 1, Section 4) shows that they all approach the issue from a different angle and, from this perspective, their differences can actually serve a complementary purpose. This complementarity can relate to geographic, politics, substantive aspects of the issue or the fact that governments are represented by different parts of governments or agencies in different bodies (focal points). However, the difference in membership can be a barrier to work from the different bodies being joined.

Avoiding duplication of efforts across bodies, as well as optimising consistency in their efforts and recommendations, are commonly proposed. In this context, bodies with a general policy mandate such as the COBSEA and ASEAN have a critical role to play. Systemic fragmentation in governance, as a result of overlapping mandates or narrow mandates that deal with a subset of issues (such as plastic pollution from vessels or from fisheries activities), can result in
systemic failures when issues 'fall' in-between sub-regimes or bodies. Another systemic failure is one where weakness of implementation at international level leads to the same weakness at regional and local levels. Research on such gaps or failures, and monitoring of measures of pollution, are critical in bringing these difficulties back to the relevant bodies to be addressed.

In order to improve the flow of information and consistency between international and regional bodies and to avoid systemic failures, mechanisms to link regional institutions to relevant international bodies and work are needed both vertically (i.e. international to regional to national to local and vice versa) and horizontally (at regional level in particular, for the purpose of this study).

Of note, such vertical institutional cooperation is a key action under COBSEA RAP MALI (KA 4.1.2), as well as the ASEAN FAMAD (Actions 1.C.1 and 2 on the incorporation of international law into regional platforms, and 1.C.3 on a regular dialogue with the Basel Convention Regional Centre). Both organisations also focus on horizontal coordination in a number of other actions (e.g. COBSEA RAP MALI KA 3 and 4; ASEAN FAMAD Actions 1.A.1, 2.C.1-2, 2.C.5, 3.C.1-2).

Whilst differences in organisation and mandate may be a challenge that cannot be resolved institutionally, other paths for coordination can be envisaged. For example, the model of the triple COP may be relevant in this context as it brings several intergovernmental meetings to take place in the same location and in back-to-back timings. This thereby provides a conduit for the improved flow of information, and an approach that limits the risk of different bodies engaging on different and especially inconsistent paths. Knowledge transfer and network development can also be tackled through virtual tools. These are further developed in the recommendations below.

# SECTION 7 – RECOMMENDATIONS

A dominating feature of this study is the multi-layered complexity of the issues raised by pollution from marine plastics globally as well as, in particular, in ASEAN+3. Characteristics of this complexity include:

- The number of intergovernmental institutions involved (50+) at international and regional levels;
- The number and diversity of stakeholders from governments, industry, civil society and academia;
- Unresolved scientific questions such as the impacts of marine plastics on human health and marine ecosystems, as well as emerging issues such as leakages of nurdles into the marine environment and the treatment of newly created materials;
- Disconnection between the legal and policy guidance and the reality of pollution pathways; and
- Need for better coordination and context-relevant technical discussions.

In this context, recommendations are divided around four axes of actions: (i) substantive issues in need of further research framed through a risk assessment approach; (ii) horizontal research coordination and stakeholder consultation; (iii) vertical research coordination; and (iv) context-specific outreach and education.

## 1. SUBSTANTIVE ISSUES IN NEED OF FURTHER RESEARCH

The research study pointed to six areas of research with specific sub-topics which would inform better policy making. Of note, most of these areas focus on downstream issues and processes. The scope of this study only extends to upstream processes to the extent that they are necessary to the consideration of pollution from marine plastics. This study is therefore limited to a selection of upstream issues which are relevant in this context.

### 1.1 Risk assessment approach: Characterising the magnitude of the risk

Risk management has progressively become a key management tool for governments as well as corporations. Under international law, a characterised risk of environmental harm also triggers an obligation to adopt a precautionary approach and measures to mitigate the risk. Lack of scientific certainty cannot be a justification for no measures being taken. In risk management, the key is to balance the response measures to the extent of the risk. In the context of pollution from marine plastic, the extent of this risk is still unclear. Understanding of exposure has greatly improved in the last five years (although not yet for micro and nano sizes through atmospheric processes), but not that of the magnitude and variations of this magnitude depending on polymers, associated contaminants, climate and ocean processes as well as local and socio-economic circumstances.

In order to inform a risk assessment approach as it is understood by governments and corporations, research on pollution from marine plastic must provide measures of potential impacts in units that are relevant to governments and relevant industries. This may include particular measures of exposure of different coastal populations to pollution from marine plastics, or exposure of marine resources of particular commercial value or ecological sensitivity.

### 1.2 Standardisation of definitions for plastic products and biodegradability

This study has relied on a very wide definition of plastic, embracing this variation across different authors and reports in order to provide a comprehensive review. This approach has highlighted uncertainties on the definition of plastic products and of biodegradability (including the conditions for biodegradability to occur in the marine environment). This would be useful in the monitoring of plastic debris and modelling of their impact (in order to distinguish plastic particles according to their toxicity and biodegradability), as well as for waste separation, recycling and waste management purposes in general. A task-force to propose a standardised definition would be desirable at a global or regional level for use by policy, industry and civil society. New plastic products, including those that are described as being plant-based, are for example an area for clarification.

### 1.3 Sources and pathways into the marine environment

Most model simulations incorporating baselines of plastic particles in the marine environment are still relying on proxies based on population density and general assessment of waste management standards. More granularity is necessary for the relevant adequate measures to be identified and adopted at national and local levels. These must take into account riverine inputs and coastal activities including coastal industries, landfills and maritime activities (e.g. offshore fisheries and aquaculture) from which plastic debris may originate. Waste management practices are also a key input. In this context, a risk approach would focus on identifying where areas of exposure are greatest (through accumulation or concentration of plastic particles) and vulnerability or sensitivity are also greatest (due to the presence of vulnerable communities, commercially or ecologically sensitives resources, species or habitats). Clean-up strategies of the most polluted areas may be directed through this approach.

### 1.4 Persistence, transformation, transport and fate in the marine environment

The lifetime and state of polymers vary depending on their type and condition in which they are introduced into the marine environments (e.g. exposure to light, oxygen, temperature, etc.). Plastic particles thus will evolve differently depending on where they end up in the oceans (e.g. water column versus seabed sediments). Their degradation and toxicity can vary also. In this context, a risk approach would focus on mapping the transport and fate of different polymers in different water bodies with priorities on areas of particular value or sensitivity. This should include a categorisation of fate in different parts of the marine environment (including accumulation in mangrove as sinks or other parts of the marine habitat, as well as different intake processes into marine organisms).

### 1.5 Measures of pollution: baseline and monitoring with standardised or comparable measures

The need for baselines and regular monitoring is not debated, and many surveys have already been undertaken, including on extensive areas of coastlines surveyed for marine plastic. However, the studies so far have focused on the distribution of plastic in one-off surveys that are mostly localised and/or done in non-comparable units. Future studies are needed to provide a more comprehensive survey and greater granularity of distribution and types of marine plastic debris in ASEAN+3 as a whole. A key gap is the establishment of baseline and monitoring of micro- and nano-plastics in ASEAN+3. Recent research suggests that plastic particles smaller than 100μm are more abundant than larger ones in the water column. This must include the distribution and concentration of microplastics in sediments, on the seabed and in the subsoil, in coastal and marine areas.

Measures to fill these gaps are of particular relevance to ASEAN+3, given the high quantity of marine plastics believed to be present in the seas of the region. Baselines of potential impact and toxicity from plastic particles are included below.

### 1.6 Impact on marine ecosystems and on human health

This last axis of focus is critical, yet only at an early stage of research. A risk assessment approach to impact on the marine environment would focus on first identifying types of impacts to assess their potential magnitude to different systems of particular importance. Several assessment models are developing with different plastic particle toxicity factors, including exposure time, particle size and shape, concentration, polymer type, particle condition, species and environmental condition. It would be useful for the region to also adopt some reference models for comparison between marine and coastal sub-areas. Equally important is research of marine plastic pollution on human health and food safety (e.g. fisheries products). Importantly, this topic extends, beyond impact from plastic found in the marine environment, to all plastic debris, including airborne plastic particles. It is therefore a very vast research area. However, research on exposure and magnitude of risk on different coastal communities of the region that would draw on findings from human health research, is recommended.

## 2. RESEARCH DEVELOPMENT AND COORDINATION

This axis of work focuses on the development of horizontal coordination across same and different stakeholder groups. Regional Seas bodies can play a critical role in such exchange, especially through the multi-stakeholder nodes of the GPML.

The following components would usefully support research that better responds to policy making needs for a science-based response to pollution from marine plastics:

- *Regional expert community to develop specialist epistemic communities*
  In order to have fluidity and to be open to new comers, this could involve informal expert groups connected through virtual communications (e.g. rotating webinars organised by regional institutions on a voluntary basis), thereby creating an opportunity for continuous exchange.

- *Knowledge-management*
  Data sharing platform (whether as a flexible open platform or series of platforms managed by a pool of regional universities or a centralised data repository with a clearing house mechanism or a combination of both approaches).

- *Stakeholder engagement and consultation*
  Several mechanisms and tools can be developed including networking events (such as the 2019 SEA of Solutions), stakeholder consultation processes before adoption of standards or guidelines (e.g. through an online process where a survey or a draft is opened for comments during a particular timeframe), topic-specific online dialogue platforms for stakeholders to ask questions or share useful content, etc.

## 3. COOPERATION BRIDGES BETWEEN RELEVANT GOVERNMENTAL AND INTERGOVERNMENTAL INSTITUTIONS

This axis of work focuses on the development of coordination structure between organisations such as international, regional and specialised intergovernmental bodies and working groups involved in different aspects of pollution from marine plastics. This would include integration between the relevant international, regional and national bodies as well as across regional bodies.

It is recommended that the three mechanisms of coordination among non-governmental stakeholders be also used by these intergovernmental groups to reach out and organise consultations on different issues they are working on. It is also recommended to take account of ASEAN's principle of centrality and ensure that intergovernmental processes of exchange include all ASEAN member states. This should support improved coordination in the work of the bodies concerned.

## 4. DEVELOPMENT OF CONTEXT-SPECIFIC OUTREACH AND EDUCATION

This last axis of work focuses on education and social behavioural sciences:

- To ensure *effective transfer of knowledge and capacity building* in local coastal communities as well as more generally, plastic producers and retailers; and
- To ensure that measures that are being devised are *realistic, feasible and can be implemented*.

It has been identified in this study as one of the lagging but critical areas of research for response measures to be effective in mitigating pollution from marine plastics.

# BIBLIOGRAPHY

## Countries' context and background on the management of plastic waste


General, for all

Greenpeace Southeast Asia (2018, November 27) The recycling myth: Malaysia and the broken global recycling system. Retrieved from: https://www.greenpeace.org/southeastasia/publication/549/the-recycling-myth/

Greenpeace Southeast Asia (2019, June 18) Southeast Asia's struggle against the plastic waste trade. A policy brief for ASEAN member states. Retrieved from: https://www.greenpeace.org/southeastasia/publication/2559/southeast-asias-struggle-against-the-plastic-waste-trade/.

Hoornweg, D. & B-T. Perinaz (2012) What a waste: A global review of solid waste management. Urban development series knowledge papers no. 15. World Bank, Washington, DC.

Jambeck, J.R., R. Geyer, C. Wilcox, T.R. Siegler, M. Perryman, A. Andrady, R. Narayan & K.L. Law (2015) Plastic waste inputs from land into the ocean. Science 347: 768–771.

Kaza, S., C. Lisa, P. Bhada-Tata & F. van Woerden (2018) What a waste 2.0: A global snapshot of solid waste management to 2050. World Bank Urban Development, Washington, DC, World Bank, Dec 2018.

Brunei Darussalam

Energy and Industry Department (2017) Brunei Darussalam's second national communication, under the United Nations Framework Convention on Climate Change. 49 pp.

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

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

United Nations Framework Convention on Climate Change (2017) Brunei Darussalam's second national communication. Energy and Industry Department, The Prime Minister's Office.

Yunos M.R., Z. Tarip & M.N. Salleh (2010) 3R (Reduce, Reuse, Recycle Concept) in Brunei Darussalam-Country presentation. The Second Meeting of Regional 3R Forum. Kuala Lumpur, Malaysia. 4–6 October 2010. Retrieved from: http://www.uncrd.or.jp/index.php?page=view&type=13&nr=38&menu=327.

Cambodia

Fondazione ACRA (2016, November 20) ACRA Social Report 2016. Retrieved from: https://issuu.com/fondazioneacra/docs/acra_socialreport2016.

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

Sethy, S., C. Sothun & R. Wildblood (2013) Municipal Solid Waste Management in Cambodia. In: Pariatamby, A. & M. Tanaka (eds), Municipal Solid Waste Management in Asia and the Pacific Islands. Environmental Science and Engineering, p. 77–94.

Singh, R.K., D.G.J. Premakumara, R. Yagasa & K. Onogawa (2018) State of Waste Management in Phnom Penh, Cambodia. United Nations for Environment Programme, Cambodia.

Indonesia

Aprilia, A., T. Tezuka & G. Spaargaren (2012) Household solid waste management in Jakarta, Indonesia: A socio-economic evaluation. In: Rebellon, L.F.M. (ed), Waste management – an integrated vision. IntechOpen, p. 71–100.

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

Damanhuri, E., W. Handoko & T. Padmi (2013) Municipal solid waste management in Indonesia. In: Pariatamby, A. & M. Tanaka (eds), Municipal solid waste management in Asia and the Pacific islands. Environmental Science and Engineering, p. 139–155.

Indonesian National Statistics Agency (2018) Statistik Indonesia, statistical yearbook of Indonesia 2015, Badan Pusat Statistik (BPS), Jakarta, Indonesia.

Lestari, P. & Y. Trihadiningrum (2019) The impact of improper solid waste management to plastic pollution in Indonesian coast and marine environment. Marine Pollution Bulletin 149: 110505.

Lebreton, L.C.M., J. van der Zwet, J-W. Damsteeg, B. Slat, A. Andrady & J. Reisser J (2017) River plastic emissions to the world's oceans. Nature Communications 8: 15611.

Ministry of Environment (2008) Indonesian domestic solid waste statistics year 2008, Jakarta, Ministry of Environment.
Shuker, I.G. & C.A. Cadman (2018) Indonesia – Marine debris hotspot rapid assessment: synthesis report (English). World Bank Group, Washington D.C.. Retrieved from: http://documents.worldbank.org/curated/en/983771527663689822/Indonesia-Marine-debris-hotspot-rapid-assessment-synthesis-report.

<u>Lao People's Democratic Republic</u>

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.
Global Green Growth Institute (GGGI) (2018) Solid Waste Management in Vientiane, Lao P.D.R. – Situation assessment and opportunities for waste-to-resource. Global Green Growth Institute, Seoul, RO Korea. 39 pp.
United Nations Environment (2017) Summary report: Waste management in ASEAN countries. Retrieved from: https://www.unenvironment.org/resources/report/waste-management-asean-countries-summary-report.

<u>Malaysia</u>

Aja, O.C. & H.H. Al-Kayiem (2014) Review of municipal solid waste management options in Malaysia, with an emphasis on sustainable waste-to-energy options. Journal of material cycles and waste management 16(4): 693–710.
Ministry of Energy, Science, Technology, Environment and Climate Change (2019, August 27) Malaysia's roadmap towards zero single-use plastics 2018–2030. Retrieved from: https://www.mestecc.gov.my/web/en/general/roadmap/.
Saeed, M.O., M.N. Hassan & M.A. Mujeebu (2009) Assessment of municipal solid waste generation and recyclable materials potential in Kuala Lumpur, Malaysia. Waste Management 29: 2209–2213.

<u>Myanmar</u>

Jeske, F. (2019) Survey on Plastic Waste in The Ayeyarwady, 2018-2019. FFI Myanmar Working Paper No. 09.
Premakumara, D.G.J., M. Hengesbaugh, K. Onogawa & O.M.T. Hlaing (2016) Quick study on waste management in Myanmar: Current situation and key challenges. In Proceedings of the 1st National/City Workshops for Developing National/City Waste Management Strategies in Myanmar, Nay Pyi Taw & Mandalay, Myanmar, p. 13–17.

<u>Philippines</u>

Global Alliance for Incinerator Alternatives (2019) Plastics exposed: How waste assessments and brand audits are helping Philippine cities fight plastic pollution. Philippines. 59 pp.

<u>Singapore</u>

Ministry of the Environment and Water Resources (2019) Key Environmental Statistics 2019. Retrieved from: https://www.mewr.gov.sg/docs/default-source/default-document-library/grab-our-research/-kes-2019.pdf.
Singapore Environment Council (2018) Consumer Plastic and Plastic Resource Ecosystem in Singapore. Singapore. 82 pp. Retrieved from: https://www.google.com/url?q=https://sec.org.sg/seaa/wp-content/uploads/2018/09/SEC-Plastic-Resource-Study-Paper_Final1.pdf&sa=D&ust=1583121925241000&usg=AFQjCNFmuwZmgEydOuXhxNl3bXBnL1W65A.
Zero Waste Masterplan Singapore (2019) Retrieved from: https://www.towardszerowaste.sg/images/zero-waste-masterplan.pdf.

<u>Vietnam</u>

Verma, R.L., G. Borongan & M. Memon (2016) Municipal solid waste management in Ho Chi Minh City, Vietnam, current practices and future recommendations. Procedia Environmental Sciences 35: 127-139.

<u>China</u>

Brooks, A.L., S. Wang & J.R. Jambeck (2018) The Chinese import ban and its impact on global plastic waste trade. Science advances 4(6): eaat0131.
Garcia, B., M.M. Fang & J. Lin (2019) Marine plastic pollution in Asia: All hands on deck!. Chinese Journal of Environmental Law 3(1): 11–46.
Wang, H.T. & Y.F. Nie (2001) Municipal solid waste characteristics and management in China. Journal of the Air & Waste Management Association 51:2, 250–263.

Velis, C.A. (2014) Global recycling markets – plastic waste: A story for one player – China. Report prepared by FUELogy and formatted by D-waste on behalf of International Solid Waste Association – Globalisation and Waste Management Task Force. ISWA, Vienna, September 2014.

RO Korea

Cho, D.O. (2005) Challenges to marine debris management in Korea. Coastal Management 33(4): 389–409.

Hong, S., J. Lee, D. Kang, H.W. Choi & S.H. Ko (2014) Quantities, composition, and sources of beach debris in Korea from the results of nationwide monitoring. Marine Pollution Bulletin 84: 27–34.

Hong, S., J. Lee & D. Kang (2015) Emergy evaluation of management measures for derelict fishing gears in Korea. Ocean Science Journal 50: 603–613.

Lee, J., S. Hong, Y.C. Jang, M.J. Lee, D. Kang & W.J. Shim (2015) Finding solutions for the styrofoam buoy debris problem through participatory workshops. Marine Policy 51: 182–189.

Morishige, C. (ed.) (2010) Marine debris prevention projects and activities in RO Korea and United States: A compilation of project summary reports. NOAA Technical Memorandum NOS-OR&R-36.

Japan

Harada, S. (2015) Current status and issues of river litter management as reducing marine litter. **水資源・環境研究** 28(1): 45–51 (available in Japanese).

Plastic Waste Management Institute (2019) Plastic products, plastic waste and resource recovery 2017. PWMI Newsletter 48: 2.

Sakai, S. (1996) Municipal solid waste management in Japan. Waste Management 16(5/6): 395–405.

Terazono, A. (2019) Recent management policy of plastic and packaging waste in Japan. Korea Society of Waste Management. ISEE 2019, Jeju, Korea. S2–06, pp. 253–261.

## Scientific publications included in the inventory database & other scientific articles mentioned in the discussion (as denoted by asterisk)


Brunei Darussalam

Qaisrani, Z.N., Shams, S., Guo, Z., Asadullah & Techato K. (2019) Physical assessment of marine debris along the coast of Brunei Darussalam. Journal of Applied and Emerging Sciences 9(2): 144–152.

Qaisrani, Z.N., Shams, S., Guo, Z., Reza, M.S. & Zainuddin, Q. (2018) Quantitative analysis of marine debris along the sea beaches of Brunei Darussalam. Conference Paper for 7th Brunei International Conference on Engineering and Technology 2018 (BICET 2018).

Cambodia

Fauna and Flora International (2019, June 18) Tackling plastic pollution for communities and coral reefs in coastal Cambodia. Retrieved from: https://www.fauna-flora.org/news/tackling-plastic-pollution-communities-coral-reefs-coastal-cambodia.

United Nations Development Programme (2019, July 12) What we're doing to combat plastic. Retrieved from: https://www.kh.undp.org/content/cambodia/en/home/projects/our-action-for-plastic-pollution-in-cambodia/what-we-re-doing-to-combat-plastic-0.html#bottomPar_columncontrol.

Reed, M., Duplain, D., Haissoune, A., Ferber, P. (2015) Strategic environmental assessment of the proposed marine protected area, Kep Archipelago, Cambodia. Retrieved from: https://www.marineconservationcambodia.org/kep-reports/file/4–kep-triangle-report-07-03–15–final-for-paul.

Indonesia

Afdal, M., S. Werorilangi, A. Faizal & A. Tahir (2019) Studies on microplastics morphology characteristics in the coastal water of Makassar City, South Sulawesi, Indonesia. International Journal of Environment Agriculture and Biotechnology 4(4): 1028–1033.

Akhir, K. (2018) A critical analysis of technological interventions towards the national action plan for marine litter management 2018–2025: Recommendations for addressing marine plastic litter in the 'New Balis' of Indonesia sustainably. World Maritime University Dissertations: 661.

Asadi, M.A., A.M.S. Hertika, F. Iranawari & A.Y. Yuwandita (2019) Microplastics in the sediment of intertidal areas of Lamongan, Indonesia. AACL Bioflux 12(4): 1065–1073.

Attamimi, A., N.P. Purba, S.R. Anggraini, S.A. Harahap & S. Husrin (2015) Investigation of marine debris in Kuta Beach, Bali. In: Suhartanto et al., (eds). Proceedings of Environmental Engineering and Water Technology, Integrated Water System and Governance (Malang, East Java, Indonesia), C1–7.

Ayuningtyas, W.C., D. Yona, S.H. Julinda & F. Iranawari (2019) Kelimpahan mikroplastik pada perairan di Banyuurip, Gresik, Jawa Timur. Journal of Fisheries and Marine Research 3(1): 41–45. (Available in Indonesian).

Balasubramaniam, M. & A.D. Phillott (2016) Preliminary observations of microplastics from beaches in the Indian Ocean. Indian Ocean Turtle Newsletter 23:13–16.

Bangun, A.P., H. Wahyuningsih & A. Muhtadi (2018) Impacts of macro- and microplastic on macrozoobenthos abundance in intertidal zone. IOP Conference Series: Earth and Environmental Science 122: 012102.

Cordova, M.R. & I.S. Nurhati (2019) Major sources and monthly variations in the release of land-derived marine debris from the Greater Jakarta area, Indonesia. Scientific Reports 9: 18730.

Cordova, M.R. & A.J. Wahyudi (2016) Microplastic in the deep-sea sediment of southwestern Sumatera waters. Marine Research in Indonesia 41(1): 27–35.

Cordova, M.R., T.A. Hadi & B. Prayudha (2018). Occurrence and abundance of microplastics in coral reef sediment: A case study in Sekotong, Lombok-Indonesia. AES Bioflux 10(1): 23–29.

Cordova, M.R., A.I.S. Purwiyanto & Y. Suteja (2019) Abundance and characteristics of microplastics in the northern coastal waters of Surabaya, Indonesia. Marine Pollution Bulletin 142: 183–188.

Cordova, M.R. & U.E. Hernawan (2018). Microplastics in Sumba waters, East Nusa Tenggara. In: IOP Conference Series: Earth and Environmental Science. IOP Conference Series: Earth and Environmental Science 162: 012023.

Dewi, I.S., A.A. Budiarsa & I.R. Ritonga (2015) Distribution of microplastic at sediment in the Muara Badak Subdistrict,Kutai Kartanegara Regency. Depik Jurnal Ilmu – Ilmu Perairan, Pesisir dan Perikanan 4(3): 121–131. (Available in Indonesian)

Falahudin, D., M.R. Cordova, X. Sun, D. Yogaswara, I. Wulandari, D. Hindarti & Z. Arifin (2020) The first occurrence, spatial distribution and characteristics of microplastic particles in sediments from Banten Bay, Indonesia. Science of the Total Environment 705: 135304.

Firdaus, M., P. Lestari & Y. Trihadiningrum (2019) Microplastic pollution in the sediment of Wonorejo estuary in Surabaya, Indonesia. In: Presented in the 2nd Conference in Fundamental and Applied Science for Advanced Technology (ConFAST), 21 January 2019, Yogyakarta, Indonesia.

Germanov, E.S., A.D. Marshall, I.G. Hendrawan, R. Admiraal, C.A. Rohner, J. Argeswara, R. Wulandari, M.R. Himawan & N.R. Loneragan (2019) Microplastics on the menu: Plastics pollute Indonesian manta ray and whale shark feeding grounds. Frontiers in Marine Science 6: 679.

Giesler, K. (2018) The plastic problem: Plastic pollution in Bali. Independent Study Project (ISP). Collection. 2937. Retrieved from: https://digitalcollections.sit.edu/isp_collection/2937/.

Handyman, D.I.W., N.P. Purba, W.S. Pranowo, S.A. Harahap, I.F. Dante & L.P.S. Yuliadi (2019) Microplastics patch based on hydrodynamic modeling in the North Indramayu, Java Sea. Polish Journal of Environmental Studies 28:135–142.

Hastuti, A.R., F. Yulianda & Y. Wardiatno (2014) Spatial distribution of marine debris in mangrove ecosystem of Pantai Indah Kapuk, Jakarta. Bonoworo Wetlands 4(2): 94–107. (Available in Indonesian).

Hastuti, A.R., D.T.F. Lumbanbatu & Y. Wardiatno (2019) The presence of microplastics in the digestive tract of commercial fishes off Pantai Indah Kapuk coast, Jakarta, Indonesia. Biodiversitas 20(5): 1233–1242.

Hiwari, H., N.P. Purba, Y.N. Ihsan, L.P.S. Yuliadi & P.G. Mulyani (2019) Condition of microplastic garbage in sea surface water at around Kupang and Rote, East Nusa Tenggara Province. In: Proceedings of the National Seminar on Indonesian Biodiversity Society 5(2): 165–171. (Available in Indonesian).

Hoeksema, B.W. & B. Hermanto (2018). Plastic nets as substrate for reef corals in Lembeh Strait, Indonesia. Coral Reefs 37(3): 631–631.

Husrin, S., U.J. Wisha, R. Prasetyo, A. Putra & A. Attamimi (2017) Characteristics of marine litters in the West Coast of Bali. Jurnal Segara 13(2): 129–140.

Ismail, M.R., M.W. Lewaru & D.J. Prihadi DJ (2018) Microplastics ingestion by fish in the Biawak Island. World Scientific News 106: 230–237.

Ismail, M.R., M.W. Lewaru & D.J. Prihadi (2019) Microplastics ingestion by fish in the Pangandaran Bay, Indonesia. World News of Natural Sciences 23: 173–181.

Isyrini, R., R. Tambaru, Y.A la Nafie, M. Ukkas & M.R. Cordova (2018) Beach debris on Labuange Beach, Barru District, South Sulawesi province, Malaysia. Jurnal Ilmu Kelautan SPERMONDE 4(2): 74–80.

Isyrini, R., Y.A. la Nafie, M. Ukkas, R. Rachim & M.R. Cordova (2019) Marine macro debris from Makassar Strait beaches with three different designations. IOP Conference Series Earth and Environmental Science 253(3): 012039.

Jasmin, H.H., N.P. Purba, S.A. Harahap, W.S. Pranowo, M.L. Syamsudin & I. Faizala (2019) The model of macro debris transport before reclamation and in existing condition in Jakarta Bay. Jurnal Ilmu dan Teknologi Kelautan Tropis 11(1): 131–140.

Khoironi, A., S. Anggoro & Sudarno (2018) The existence of microplastic in Asian green mussels. IOP Conference Series: Earth and Environmental Science 131: 012050.

Lestari, P., M. Firdaus & Y. Trihadiningrum (2019) The impact of improper solid waste management to plastic pollution in Indonesian coast and marine environment. Marine Pollution Bulletin 149: 110505.

Lestari, P., M. Firdaus & Y. Trihadiningrum (2018) Preliminary study of microplastics in a commercial bivalve (*Meretrix meretrix*) from Wonorejo Estuary, Indonesia. Presented at the 3rd International Seminar on Marine Technology (SENTA), 5–6 December 2018, Surabaya, Indonesia.

Lubis, I.E.N, W.R. Melani & A.D. Syakti (2019) Plastic debris contamination in grey-eel catfish (*Plotosus canius*) in Tanjungpinang water, Riau Islands-Indonesia. AIP Conference Proceedings 2094(1): 020035.

Maharani, A., N.P. Purba & I. Faizal (2018) Occurrence of beach debris in Tunda Island, Banten, Indonesia. E3S Web of Conferences 47: 04006.

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

Manullang, C.Y. (2018) Current status and future prospect of marine pollution research in the Banda Sea. In IOP Conference Series: Earth and Environmental Science. 184: 012007.

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

Oktaviana, M., J. Jompa & Amiruddin (2013) Constraints and strategies of solid waste management in Barrang Lompo Island. Fakultas Ilmu Kelautan dan Perikanan, Universitas Hasanuddin. (Available in Indonesian).

Pangetsu, I.F., N.P. Purba & M.L. Syamsyudin (2016) Kondisi microplastic di Perairan Indramayu, Jawa Barat. In: Proceedings of the National Seminar on Fisheries and Maritime Affairs: Technology, Law and Policy Synergy on Fisheries and Marine Sciences Toward Food Sovereignty in AEC (Bandung, Indonesia), 382. (Available in Indonesian).

Petrlik, J., Y. Ismawati, J. DiGangi, P. Arisandi, L. Bell & B. Beeler (2019) Plastic waste flooding Indonesia leads to toxic chemical contamination of the food chain. IPEN. Retrieved from: https://ipen.org/sites/default/files/documents/indonesia-egg-report-long-v1_2web-en.pdf.

Purba, N.P., M.L. Syamsuddin, R. Sandro, I.F. Pangestu & M.R. Prasetio (2017) Distribution of marine debris in Biawak Island, West Java, Indonesia. World Scientific News 66: 281–292.

Purba, N.P., Y.N. Ihsan, I. Faizal, D.I.W. Handyman, K.S. Widiastuti, P.G. Mulyani, M.F. Tefa & M. Hilmi (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, N.P., L.P. Dewanti, I.M. Apriliani, H. Herawati & I. Faizal (2018b) Distribution of macro debris at Pangandaran Beach, Indonesia. World Scientific News 103: 144–156.

Purba, N.P., D.I.W. Handyman, T.D. Pribadi, A.D. Syakti, W.S. Pranowo, A. Harvey & Y.N. Ihsan (2019a) Marine debris in Indonesia: A review of research and status. Marine Pollution Bulletin 146: 134–144.

Purba, N.P., W.S. Parnowo, S.M. Simanjuntak, I. Faizal, H.H. Jasmin, D.I.W. Handyman & P.G. Mulyani (2019b) Trajectory of microplastics at Savu Sea Marine National Park, East Nusa Tenggara. Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan 8(2): 125–134. (Available in Indonesian).

Rachmat, S.L.J., N.P. Purba, M.U.K. Agung & L.P.S. Yuliadi (2019) Characteristic of microplastic debris at estuary of DKI Jakarta. Jurnal Ilmu-Ilmu Perairan, Pesisir dan Perikanan 8(1): 9–17. (Available in Indonesian).

Rahmawati, N.H.F. & M.P. Patria (2019). Microplastics dissemination from fish *Mugil dussumieri* and mangrove water of Muara Teluknaga, Tangerang, Banten. IOP Journal of Physics: Conference Series 1282: 012104.

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

Rochman, C.M., A. Tahir, S.L. Williams, D.V. Baxa, R. Lam, J.T. Miller, F.C. Teh, S. Werorilangi, & S.J. Teh (2015) Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption. Scientific Reports 5: 14340.

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

Shuker, I.G. & C.A. Cadman (2018) Indonesia – Marine debris hotspot rapid assessment: synthesis report (English). World Bank Group, Washington D.C.. Retrieved from: http://documents.worldbank.org/curated/en/983771527663689822/Indonesia-Marine-debris-hotspot-rapid-assessment-synthesis-report.

Sur, C., J.M. Abbott, R. Ambo-Rappe, N. Asriani, S.O. Hameed, B.M. Jellison, H.A. Lestari, S.R. Limbong, M. Mandasari, G. Ng, E.V. Satterthwaite, S. Syahid, D. Trockel, W. Umar & S.L. Williams (2018) Marine debris on small islands: Insights from an educational outreach programme in the Spermonde Archipelago, Indonesia. Frontiers in Marine Science 5:35.

Syakti, A.D. (2017) Microplastics monitoring in marine environment. Omni-Akuatika 13(2): 1–6.

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

Syakti, A.D., N.V. Hidayati, Y.V. Jaya, S.H. Siregar, R. Yude, Suhendy, L. Asia, P. Wong-Wah-Chung & P. Doumenq (2018) Simultaneous grading of microplastic size sampling in the small islands of Bintan water, Indonesia. Marine Pollution Bulletin 137: 593–600.

Syakti, A.D., J.V. Jaya, A. Rahman, N.V. Hidayati, T.S. Raza'i, T. Idris, M. Trenggono, P. Doumenq & M.L. Chou (2019) Bleaching and necrosis of staghorn coral (*Acropora formosa*) in laboratory assays: Immediate impact of LDPE microplastics. Chemosphere 228: 528–535.

Tahir, A., S. Werorilangi, F.M. Isman, A. Zulkarnaen, A. Massinai & A. Faizal (2018) Short-term observation on marine debris at coastal areas of Takalar District and Makassar City, South Sulawesi-Indonesia. Jurnal Ilmu Kelautan SPERMONDE 4(2): 48–53.

Tahir, A., M.F. Samawi, K. Sari, R. Hidayat, R. Nimzet, E.A. Wicaksono, L. Asrul & S. Werorilangi (2019) Studies on microplastic contamination in seagrass beds at Spermonde Archipelago of Makassar Strait, Indonesia. IOP Science Journal of Physics: Conference Series 1341(2): 022008.

Tangdesu, T.R.C. (2018) Identifikasi sampah laut di muara Sungai Biringkasi dan wilayah pesisir sekitarnya di kabupaten. Ilmu Kelautan Fakultas Ilmu Kelautan dan Perikanan Universitas Hasanuddin. Skripsi: L11112256 [In Indonesian].
van Emmerik, T., M. Loozen, K. van Oeveren, F. Buschman & G. Prinsen (2019) Riverine plastic emission from Jakarta into the ocean. Environmental Research Letters 14(8): 084033.
Wahyuningsih, H., A.P. Bangun & A. Muhtadi (2018) The relation of sediment texture to macro- and microplastic abundance in intertidal zone. In IOP Conference Series: Earth and Environmental Science 122(1): 012101.
Yona, D., S.H.J. Sari, F. Iranawari, S. Bachri & W.C. Ayuningtyas (2019) Microplastics in the surface sediments from the eastern waters of Java Sea, Indonesia. F1000Research 8: 98.

Malaysia

Adnan, F.A.F., R. Kilip, D. Keniin & C. Payus (2015) Classification and quantification of marine debris at Teluk Likas, Sabah. Borneo Science 36(1).
Agamuthu, P., S.H. Fauziah & A.K. Khairunnisa (2012) Marine debris on selected Malaysian beaches: Impacts of human ignorance. Proceedings of the 10th Expert Meeting on Solid Waste Management in Asia and Pacific Islands.
Amin, R.M., E. S. Sohaimi, S.T. Anuar & Z. Bachok (2020) Microplastic ingestion by zooplankton in Terengganu coastal waters, southern South China Sea. Marine Pollution Bulletin 150: 110616.
Anuar, S.T., N.F.S.A. Wahab, A.A. Azmi, W.M.A.W.M. Halik, S. Lehta & Y.S. Ibrahim (2018) Investigation and spectroscopic characterisation of microplastic ingested by echinodermata (Holothuridae) of Malaysian waters. In: International Conference on Plastics in the Marine Environment 2018.
Aris, L.I.B. (2012) Analysis of plastic debris on Malaysia beaches. University of Malaya. Masters' thesis.
Auta, H.S., C.U. Emenike & S.H. Fauziah (2017) Screening for polypropylene degradation potential of bacteria isolated from mangrove ecosystems in Peninsular Malaysia. International Journal of Bioscience, Biochemistry and Bioinformatics 7(4): 245–251.
Auta, H.S., C.U. Emenike & S.H. Fauziah (2017a) Screening of Bacillus strains isolated from mangrove systems in Peninsular Malaysia for microplastic degradation. Environmental Pollution 231(2): 1552–1559.
Auta, H.S., C.U. Emenike & S.H. Fauziah (2017b). Distribution and importance of microplastics in the marine environment: A review of the sources, fate, effects, and potential solutions. Environment International 102: 165–176.
Barasarathi, J.,A. Periathamby, S.H. Fauziah & C.U. Emenike (2014) Microplastic abundance in selected mangrove forest in Malaysia. In: Proceedings of The ASEAN Conference on Science and Technology 2014, pp. 1–5.
Chee, S.Y., Y.J. Chai, D. Carey, Y. Yusup & J.B. Gallagher (2019) Anthropogenic marine debris and its dynamics across peri-urban and urban mangroves on Penang Island, Malaysia. bioRxiv 756106.
Chukwama, E.C., A.R.B.M. Shariff, C.M. Hasfalina, A.A. Mohamed, L.C. Abdullah (2019) GIS based analysis of plastic waste leakage in parts of Selangor state of Malaysia. 2019 American Society of Agricultural and Biological Engineers (ASABE) Annual International Meeting: 1900079.
Egbeocha, C.O., S. Malek, C.U. Emenike & P. Milow (2018) Feasting on microplastics: Ingestion by and effects on marine organisms. Aquatic Biology 27: 93–106.
Estim & Sudirman (2017) Types and abundance of macro- and micro-marine debris at Sebatik Island, Tawau, Sabah. Borneo Journal of Marine Science and Aquaculture 1: 57–64.
Fauziah, S.H., S.H. Siti, L. Japareng, H. Auwalu & P. Agamuthu (2019) Technical report: Abundance and distribution of marine debris on selected beaches of marine park islands. Department of Fisheries Malaysia.
Fauziah, S.H., I.A. Liyana & P. Agamuthu (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.
Fauziah, S.H., S.B. Mehran, A. Norkhairiyah, M. Priya & P. Agamuthu (2018) Worldwide distribution and abundance of microplastic: How dire is the situation? Waste Management and Research 36(10): 873–897.
Hocajo-Berná, A., García-Baciero, D. Yap, N. Izzati-Roslan (2019) Necropsy of a green turtle (*Chelonia mydas*) and the impacts of plastic pollution in Tioman Island, Malaysia. Marine Turtle Newsletter 158: 14–15.
Ibrahim, Y.S., A.A. Azmi, S.A. Shukor, S.T. Anuar & S.A. Abdullah (2016) Microplastics ingestion by *Scapharca cornea* at Setiu Wetland, Terengganu, Malaysia. Middle-East Journal of Scientific Research 24(6): 2129–2136.
Ibrahim, Y.S., R. Rathnam, S.T. Anuar & W.M.A.W.M. Khalik (2017) Isolation and characterisation of microplastic abundance in *Lates calcarifer* from Setiu Wetlands, Malaysia. Malaysian Journal of Analytical Sciences 21(5): 1054–1064.
Karami, A., A. Golieskardi, C.K. Choo, V. Larat, T.S. Galloway & B. Salamatinia (2017a) The presence of microplastics in commercial salts from different countries. Scientific Reports 7: 46173.
Karami, A., A. Golieskardi, Y.B. Ho, V. Larat & B. Salamatinia (2017b) Microplastics in eviscerated flesh and excised organs of dried fish. Scientific Reports 7: 5473.

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

Karami, A., A. Golieskardi, C.K. Choo, N. Romano, Y.B. Ho & B. Salamatinia (2016) A high-performance protocol for extraction of microplastics in fish. Science of The Total Environment 578: 485–494.

Karbalaei, S., A. Golieskardi, H.B. Hamzah, S. Abdulwahid, P. Hanachi, T.R. Walker & A. Karami (2019) Abundance and characteristics of microplastics in commercial marine fish from Malaysia. Marine Pollution Bulletin. 148: 5–15.

Khalik, W.M.A.W.M., Y.S. Ibrahim, S.T. Anuar, S. Govindasamy & N.F. Baharuddin (2018) Microplastics analysis in Malaysian marine waters: A field study of Kuala Nerus and Kuantan. Marine Pollution Bulletin 135: 451–457.

Khairunnisa, A.K., S.H. Fauziah & A. Agamuthu (2012) Marine debris composition and abundance: A case study of selected beaches in Port Dickson, Malaysia. Aquatic Ecosystem Health and Management 15(3): 279–286.

Matsuguma, Y., H. Kumata, H. Kanke, S. Sakurai, T. Suzuki, M. Itoh, Y. Okazaki, R. Boonyatumanond, M.P. Zakaria, S. Weerts & B. Newman (2017) Microplastics in sediment cores from Asia and Africa as indicators of temporal trends in plastic pollution. Archives of Environmental Contamination and Toxicology 73(2): 230-239.

Mobilik, JM, T.Y. Ling, M.L.B Husain & R. Hassan (2017) Type and quantity of marine debris at selected public beaches in Sabah (Tg. Aru and Kosuhoi) during different monsoon seasons. Borneo Science 38(1): 13–24.

Mobilik, J.M., T.Y. Ling, M.L.B. Husain & R. Hassan (2016) Type and quantity of shipborne garbage at selected tropical beaches. The Scientific World Journal Vol. 2016, Article ID 5126951

Mobilik, J.M., T.Y. Ling, M.L.B. Husain & R. Hassan (2015) Seasonal trends in abundance and composition of marine debris in selected public beaches in Peninsular Malaysia. AIP Conference Proceedings 1678, 020020.

Mobilik, J.M. & T.Y. Ling (2014). Type and abundance of marine debris at selected public beaches in Sarawak, East Malaysia, during the northeast Monsoon. Journal of Sustainability Science and Management 9(2): 43–51.

Mobilik, J.M. (2008) Marine debris on selected public beaches in Kuching, Bintulu and Miri, Sarawak. Universiti Malaysia Sarawak. Masters' thesis.

Noik, V.J. & P.M. Tuah (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.

Praveena, S.M., S.B.N. Shaifuddin & S. Akizuki (2018) Exploration of microplastics from personal care and cosmetic products and its estimated emissions to marine environment: An evidence from Malaysia. Marine Pollution Bulletin 136: 135–140.

Razlan, N.A. (2011) A study of marine debris on beach of Bidong Island, Terengganu. Universiti Malaysia Terengganu. Undergraduate's thesis, Bachelor of Science (Marine Science).

<u>Myanmar</u>

Balasubramaniamm, M. & A.D. Phillott (2016) Preliminary observations of microplastics from beaches in the Indian Ocean. Indian Ocean Turtle Newsletter 23:13–16.

Min, W.W. (2018) Current situation, challenge and future needs for marine debris management in coastal mangrove ecosystem, Myanmar. In: 2018 2nd International Conference on Environmental and Energy Engineering (IC3E 2018), At Xiamen University of Technology, China.

Jeske, F. (2019) Survey on plastic waste in the Ayeyarwady, 2018–2019. FFI Myanmar Working Paper No. 09

<u>Philippines</u>

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

Abreo, N.A.S., E.D. Macusi, G. Cuenca, C.T. Ranar, M. Andam, C.L. Carona & G.F.P. Arabejo (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, N.A.S., E.D. Macusi, D.D. Blatchley & G. Cuenca-Ocay (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, N.A.S., E.D. Macusi, D.D. Blatchley & G. Cuenca-Ocay (2016b) Ingestion of marine plastic debris by green turtle (*Chelonia mydas*) in Davao Gulf, Mindanao, Philippines. Philippine Journal of Science 145: 17–23.

Abreo, N.A.S., D.D. Blatchley & M.D.A. Superio (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, N.A.S., K.F. Thompson, G.F.P. Arabejo & M.D.A. Superio (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.

Abueg, L. (2019) A survey of the ocean's plastic waste problem, and some policy developments of the Philippines. Munich Personal RePEc Archive (MPRA) Paper No. 96263. 16 pp.

Argamino, C.R. & J.I.B. Janairo (2016) Qualitative assessment and management of microplastics in Asian Green Mussels (*Perna viridis*) cultured in Bacoor Bay, Cavite, Philippines. EnvironmentAsia 9(2): 48–54.
Bucol, L.A., E.F. Romano, S.M. Cabcaban, L.M.D. Siplon, G.C. Madrid, A.A. Bucol & B. Polidoro (2020) Microplastics in marine sediments and rabbitfish (*Siganus fuscescens*) from selected coastal areas of Negros Oriental, Philippines. Marine Pollution Bulletin 150: 110685.
Deocaris, C.C., J.O. Allosada, L.T. Ardiente, L.C.G. Bitang, C.L. Dulohan, J.K.I. Lapuz, L.M. Padilla, V.P. Ramos & J.B.P. Padolina (2019) Occurrence of microplastic fragments in the Pasig River. H2Open Journal 2(1): 92–100.
Espiritu, E.Q., S.A.S.N. Dayrit, A.S.O. Coronel, N.S.C. Paz, P.I.L. Ronquillo, V.C.G. Castillo & E.P. Enriquez (2019) Assessment of quantity and quality of microplastics in the sediments, waters, oysters, and selected fish species in key sites along the Bombong Estuary and the coastal waters of Ticalan in San Juan, Batangas. Philippine Journal of Science 148(4): 789–801.
Kalnasa, M.L., L.C. Boter, S.M. Lantaca, G. Flores & V.R.K. Galarpe (2018) Occurrence and characterization of surface sand microplastic and litter: First observation in Macajalar Bay, Philippines. Marine Pollution Bulletin 149: 110521.
Paler, K.O., C.T. Malenab, J.R. Maralit & H.M. Nacorda (2019) Plastic waste occurrence on a beach off southwestern Luzon, Philippines. Marine Pollution Bulletin 141: 416–419
Palermo, J.D.H. (2018) Trophic ecology of sardines: *Sardinella lemuru* feeding strategies and vulnerability to marine microplastic pollution in Northern Mindanao. PhD candidate, Institute of Environmental Science and Meteorology, University of the Philippines-Diliman.

<u>Singapore</u>

Bhargava, S., S.S.C Lee, L.S.M. Ying, M.L. Neo, S.L-M Teo & S. Valiyaveettil (2018) Fate of nanoplastics in marine larvae: A case study using barnacles, *Amphibalanus amphitrite*. ACS Sustainable Chemistry and Engineering 6: 6932–6940.
Chim, C.K., Y-L. Lee, S. Tong, T. Tay & R. Ong (2015) Blacktip reef sharks caught in trammel nets at Lazarus Island. Singapore Biodiversity Records 2015: 158–159.
Chim, C.K. & K.K.P Lim (2014) Coral cat-sharks at eastern Johor Straits. Singapore Biodiversity Records 2014: 54.
Chim, C.K. & K.K.P Lim (2014) Blackspot shark at eastern Johor Straits. Singapore Biodiversity Records 2014: 47.
Chua, M.A.H., D. Lane, S.K. Ooi, S. Tay & T. Kubodera (2019) Diet and mitochondrial DNA haplotype of a sperm whale (*Physeter macrocephalus*) found dead off Jurong Island, Singapore. PeerJ. 7. 10.7717/peerj.6705.
Curren, E. & S.C.Y. Leong (2019) Profiles of bacterial assemblages from microplastics of tropical coastal environments. Science of the Total Environment 655: 313–320.
Mohamed, N.N.H. & Obbard, J.P. (2014) Microplastics in Singapore's coastal mangrove ecosystems. Marine Pollution Bulletin 79: 278–283.
Ng, K.L. & J.P. Obbard (2006) Prevalence of microplastics in Singapore's coastal marine environment. Marine Pollution Bulletin 52: 761–767.
*Ocean Conservancy (2018) Building a Clean Swell. The International Coastal Cleanup 2018 Report. Washington, DC. 25 pp.
Ong, R., C.K. Chim, Lee, Y-l., S. Tong & T. Tay (2015) Blacktip reef sharks caught in trammel nets at Lazarus Island. Singapore Biodiversity Records 2015: 158–159.
Seng, N., S. Lai, J. Fong, M.F. Saleh, C. Cheng, Z.Y. Cheok & P.A. Todd (2020) Early evidence of macroplastics on seagrass and macroalgae. Marine and Freshwater Research (Online Early)
Yeo, R.K.H. (2014) Blacktip reef sharks at Semakau Landfill. Singapore Biodiversity Records 2014: 33–34.

<u>Thailand</u>

Azad, S.M.O., P. Towatana, S. Pradit, B.G. Patricia & H.T. Hue (2018) Ingestion of microplastics by some commercial fishes in the lower Gulf of Thailand: A preliminary approach to ocean conservation. International Journal of Agricultural Technology 14(7): 1017–1032.
Ballesteros, L.V., J.L. Matthews & B.W. Hoeksema (2018) Pollution and coral damage caused by derelict fishing gear on coral reefs around Koh Tao, Gulf of Thailand. Marine Pollution Bulletin 135: 1107–1116.
Kungskulniti , N., N. Charoenca, S.L. Hamann, S. Pitayarangsarit & J. Mock (2018) Cigarette waste in popular beaches in Thailand: High densities that demand environmental action. International Journal of Environmental Research and Public Health 15(4): 630.
Tharamon, P., S. Praisanklul & N. Leadprathom (2016) Contamination of microplastic in bivalve at Chaolao and Kungwiman beach Chanthaburi province. Khon Kaen Agricultural Journal 44(1): 738–744.

Thanida, H. M. Somchai, A. Nongnut & C. Nantarika (2009) A case report: Stomach foreign object in whaleshark (*Rhincodon typus*) stranded in Thailand. Proceedings of the 4th International Symposium on SEASTAR2000 and Asia Bio-logging Science (The 8th SEASTAR2000 workshop): 83–85.

Thushari, G.G.N., S. Chavanich & A. Yakupitiyage (2017) Coastal debris analysis in beaches of Chonburi Province, eastern of Thailand as implications for coastal conservation. Marine Pollution Bulletin 116(1–2): 121–129.

Thushari, G.G.N., J.D.M. Senevirathna, A. Yakupitiyage & S. Chavanich (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.

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

<u>Vietnam</u>

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

Le, D.Q., H. Takada, R. Yamashita, K. Mizukawa, J. Hosoda & D.A. Tuyet (2016) Temporal and spatial changes in persistent organic pollutants in Vietnamese coastal waters detected from plastic resin pellets. Marine Pollution Bulletin 109: 320-324.

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

Van Truong, N. & B.P. Chu (2019) Plastic marine debris: Sources, impacts and management. International Journal of Environmental Studies: 1–21.

<u>China</u>

Cai, M., H. He, M. Liu, S. Li, G. Tang, W. Wang, P. Huang, G. Wei, Y. Lin, B. Chen, J. Hui & Z. Cen (2018) Lost but can't be neglected: Huge quantities of small microplastics hide in the South China Sea. Science of the Total Environment 633: 1206–1216.

Chan, H.S., C. Dingle & C. Not (2019) Evidence for non-selective ingestion of microplastic in demersal fish. Marine Pollution Bulletin 149: 110523.

Cheang, C.C., Y. Ma & L. Fok (2018) Occurrence and composition of microplastics in the seabed sediments of the coral communities in proximity of a metropolitan area. International journal of environmental research and public health, 15(10): 2270.

Chen, M., M. Jin, P. Tao, Z. Wang, W. Xie, X. Yu & K. Wang (2018) Assessment of microplastics derived from mariculture in Xiangshan Bay, China. Environmental Pollution 242B: 1146–1156.

Cheung, P.K. & L. Fok (2016) Evidence of microbeads from personal care products contaminating the sea. Marine Pollution Bulletin 109: 582–585.

Cheung, P.K., L.T.O. Cheung & L. Fok (2016) Seasonal variation in the abundance of marine plastic debris in the estuary of a subtropical macro-scale drainage basin in South China. Science of the Total Environment 562: 658–665.

Cheung, L.T.O., C.Y. Lui & L. Fok (2018a) Microplastic contamination of wild and captive flathead grey mullet (*Mugil cephalus*). International Journal of Environmental Research and Public Health. 15(4): 597.

Cheung, P.K., L. Fok, P.L. Hung & L.T.O. Cheung (2018b) Spatio-temporal comparison of neustonic microplastic density in Hong Kong waters under the influence of the Pearl River Estuary. Science of The Total Environment 628–629: 731–739.

Ding, J., J. Li, C. Sun, F. Jiang, P. Ju, L. Qu, Y. Zheng & C. He (2019) Detection of microplastics in local marine organisms using a multi-technology system. Analytical Methods 11: 78–87.

Ding, J., F. Jiang, J. Li, Z. Wang, C. Sun, Z. Wang, L. Fu, N.X. Ding & C. He (2019) Microplastics in the coral reef systems from Xisha Islands of South China Sea. Environmental Science and Technology 53(14): 8036–8046.

Feng, Z., T. Zhang, Y. Li, X. He, R. Wang, J. Xu & G. Gao (2019) The accumulation of microplastics in fish from an important fish farm and mariculture area, Haizhou Bay, China. Science of the Total Environment 696: 133948.

Fok, L. & P.K. Cheung (2015) Hong Kong at the Pearl river estuary: A hotspot of microplastic pollution. Marine Pollution Bulletin 99: 112–118.

Fok, L., P.K. Cheung, G. Tang & W.C. Li (2017) Size distribution of stranded small plastic debris on the coast of Guangdong, South China. Environmental Pollution 220(A): 407–412.

Guo, X. & J. Wang (2019) Sorption of antibiotics onto aged microplastics in freshwater and seawater. Marine Pollution Bulletin 149: 110511.

Heo, N.W., S.H. Hong, G.M. Han, S. Hong, J. Lee, Y.K. Song, M. Jang & W.J. Shim. (2013) Distribution of small plastic debris in cross-section and high strandline on Heungnam beach, Korea. Ocean Science Journal 48(2): 225–233.

Huang, Y., M. Yan, K. Xu, H. Nie, H. Gong & J. Wang (2019) Distribution characteristics of microplastics in Zhubi Reef from South China Sea. Environmental Pollution 255: 113133.

Li, J., D. Yang, L. Li, K. Jabeen & H. Shi (2015) Microplastics in commercial bivalves from China. Environmental Pollution 207: 190-195.

Li, J., X. Qu, L. Su, W. Zhang, D. Yang, P. Kolandhasamy, D. Li & H. Shi (2016) Microplastics in mussels along the coastal waters of China. Environmental Pollution 214: 177–184.

Li, H.X., L.S. Ma, L. Lin, Z.X. Ni, X.R. Xu, H.H. Shi, Y. Yan, G.M. Zheng & D. Rittschof (2018a) Microplastics in oysters *Saccostrea cucullata* along the Pearl River Estuary, China. Environmental Pollution 236: 619–625.

Li, Y., E. Wolanski, Z. Dai, J. Lambrechts, C. Tang & H. Zhang (2018b) Trapping of plastics in semi-enclosed seas: Insights from the Bohai Sea, China. Marine Pollution Bulletin 137: 509–517.

Li, J., H. Zhang, K. Zhang, R. Yang, R. Li & Y. Li (2018c) Characterization, source, and retention of microplastic in sandy beaches and mangrove wetlands of the Qinzhou Bay, China. Marine Pollution Bulletin 136: 401–406.

Li, R., L. Zhang, B. Xue & Y. Wang (2019a) Abundance and characteristics of microplastics in the mangrove sediment of the semi-enclosed Maowei Sea of the South China sea: New implications for location, rhizosphere, and sediment compositions. Environmental Pollution 244: 685–692.

Li, R., L. Yu, M. Chai, H. Wu & X. Zhu (2020) The distribution, characteristics, and ecological risks of microplastics in the mangroves of Southern China. Science of the Total Environment 708: 135025.

Lo, H.S., X. Xu, C.Y. Wong & S.G. Cheung (2018) Comparisons of microplastic pollution between mudflats and sandy beaches in Hong Kong. Environmental Pollution 236: 208–217.

Lo, H.S., C.Y. Wong, N.F.Y. Tam & S.G. Cheung (2019) Spatial distribution and source identification of hydrophobic organic compounds (HOCs) on sedimentary microplastic in Hong Kong. Chemosphere 219: 418–426.

Luo, W., L. Su, N.J. Craig, F. Du, C. Wu & H. Shi (2019) Comparison of microplastic pollution in different water bodies from urban creeks to coastal waters. Environmental Pollution 246: 174–182.

Mai, L., L.J. Bao, L. Shi, L.Y. Liu & E.Y. Zeng (2018) Polycyclic aromatic hydrocarbons affiliated with microplastics in surface waters of Bohai and Huanghai Seas, China. Environmental Pollution 241: 834–840.

Mohsen, M., Q. Wang, L. Zhang, L. Sun, C. Lin & H. Yang (2019a) Heavy metals in sediment, microplastic and sea cucumber *Apostichopus japonicus* from farms in China. Marine Pollution Bulletin 143: 42–49.

Mohsen, M., Q. Wang, L. Zhang, L. Sun, C. Lin & H. Yang (2019b) Microplastic ingestion by the farmed sea cucumber *Apostichopus japonicus* in China. Environmental Pollution 245: 1071–1078.

Nie, H., J. Wang, K. Xu, Y. Huang, M. Yan. (2019) Microplastic pollution in water and fish samples around Nanxun Reef in Nansha Islands, South China Sea. Science of the Total Environment 696: 134022.

Pan, Z., H. Guo, H. Chen, S. Wang, X. Sun, Q. Zou, Y. Zhang, H. Lin, S. Cai & J. Huang (2019) Microplastics in the Northwestern Pacific: Abundance, distribution, and characteristics. Science of the Total Environment 650: 1913–1922.

Peng, G., B. Zhu, D. Yang, L. Su, H. Shi & D. Li (2017) Microplastics in sediments of the Changjiang Estuary, China. Environmental Pollution 225: 283–290.

Qiu, Q., J. Peng, X. Yu, F. Chen, J. Wang & F. Dong (2015) Occurrence of microplastics in the coastal marine environment: First observation on sediment of China. Marine Pollution Bulletin 98(1–2): 274–280.

Qu, X., L. Su, H. Li, M. Liang & H. Shi (2018) Assessing the relationship between the abundance and properties of microplastics in water and in mussels. Science of the Total Environment 621: 679–686.

So, W.K., K. Chan & C. Not (2018) Abundance of plastic microbeads in Hong Kong coastal water. Marine Pollution Bulletin 133: 500-505.

Su, L., H. Deng, B. Li, Q. Chen, V. Pettigrove, C. Wu & H. Shi (2019) The occurrence of microplastic in specific organs in commercially caught fishes from coast and estuary area of east China. Journal of Hazardous Materials 365: 716–724.

Sun, X., Q. Li, M. Zhu, J. Liang, S. Zheng & Y. Zhao (2017) Ingestion of microplastics by natural zooplankton groups in the northern South China Sea, Marine Pollution Bulletin 115.1–2: 217–224.

Sun, X., J. Liang, M. Zhu, Y. Zhao & B. Zhang (2018) Microplastics in seawater and zooplankton from the Yellow Sea. Environmental Pollution 242A: 585–595.

Sun, X., Q. Li, Y. Shi, Y. Zhao, S. Zheng, J. Liang, T. Liu & Z. Tian (2019) Characteristics and retention of microplastics in the digestive tracts of fish from the Yellow Sea. Environmental Pollution 249: 878–885.

Teng, J., Q. Wang, W. Ran, D. Wu, Y. Liu, S. Sun, H. Liu, R. Cao & J. Zhao (2019) Microplastic in cultured oysters from different coastal areas of China. Science of the Total Environment 653: 1282–1292.

Tsang, Y.Y., C.W. Mak, C. Liebich, S.W. Lam, E.T.P. Sze & K.M. Chan (2017) Microplastic pollution in the marine waters and sediments of Hong Kong. Marine Pollution Bulletin 115(1–2): 20-28.

Wang, J., Z. Tan, J. Peng, Q. Qiu & M. Li (2016) The behaviors of microplastics in the marine environment. Marine Environmental Research 113:7–17.

Wang, T., X. Zou, B. Li, Y. Yao, J. Li, H. Hui, W. Yu & C. Wang (2018) Microplastics in a wind farm area: A case study at the Rudong Offshore Wind Farm, Yellow Sea, China. Marine Pollution Bulletin 128: 466–474.

Wang, J., M. Wang, S. Ru & X. Liu (2019a) High levels of microplastic pollution in the sediments and benthic organisms of the South Yellow Sea, China. Science of the Total Environment 651(2): 1661–1669.

Wang, J., L. Lu, M. Wang, T. Jiang, X. Liu & S. Ru (2019b) Typhoons increase the abundance of microplastics in the marine environment and cultured organisms: A case study in Sanggou Bay, China. Science of the Total Environment 667: 1–8.

Wang, T., X. Zou, B. Li, Y. Yao, Z. Zang, Y. Li, W. Yu & W. Wang (2019c) Preliminary study of the source apportionment and diversity of microplastics: Taking floating microplastics in the South China Sea as an example. Environmental Pollution 245: 965–874.

Xiong, X., X. Chen, K. Zhang, Z. Mei, Y. Hao, J. Zheng, C. Wu, K. Wang, Y. Ruan, P.K.S. Lam & D. Wang (2018) Microplastics in the intestinal tracts of East Asian finless porpoises (*Neophocaena asiaeorientalis sunameri*) from Yellow Sea and Bohai Sea of China. Marine Pollution Bulletin 136: 55–60.

Xu, P., G. Peng, L. Su, Y. Gao, L. Gao & D. Li (2018) Microplastic risk assessment in surface waters: A case study in the Changjiang Estuary, China. Marine Pollution Bulletin 133: 647–654.

Yang, D., H. Shi, L. Li, J. Li, K. Jabeen & P. Kolandhsamy (2015) Microplastic Pollution in Table Salts from China. Environmental Science and Technology 49(22): 13622–13627.

Yao, W., D. Di, Z. Wang, Z. Liao, H. Huang, K. Mei, R.A. Dahlgren, M. Zhang & X. Shang (2019) Micro- and macroplastic accumulation in a newly formed *Spartina alterniflora* colonized estuarine saltmarsh in southeast China. Marine Pollution Bulletin 149: 110636.

Yu, X., J. Peng, J. Wang, K. Wang & S. Bao (2016) Occurrence of microplastics in the beach sand of the Chinese inner sea: the Bohai Sea. Environmental Pollution 214: 722–730.

Zhang, W., X. Ma, Z. Zhang, Y. Wang, J. Wang, J. Wang & D. Ma (2015) Persistent organic pollutants carried on plastic resin pellets from two beaches in China. Marine Pollution Bulletin 99: 28–34.

Zhang, H. (2017) Transport of microplastics in coastal seas. Estuarine, Coastal, and Shelf Science 199: 74–86.

Zhang, W., S. Zhang, J. Wang, Y. Wang, J. Mu, P. Wang, X. Lin & D. Ma (2017) Microplastic pollution in the surface waters of the Bohai Sea, China. Environmental Pollution 231: 541–548.

Zhang, F., X. Wang, J. Xu, L. Zhu, G. Peng, P. Xu & D. Li (2019a) Food-web transfer of microplastics between wild caught fish and crustaceans in East China Sea. Marine Pollution Bulletin 146: 173–182.

Zhang, C., H. Zhou, Y. Cui, C. Wang, Y. Li & D. Zhang (2019b) Microplastics in offshore sediment in the Yellow Sea and East China Sea, China. Environmental Pollution 244: 827–833.

Zhao, S., L. Zhu & D. Li (2015) Characterization of small plastic debris on tourism beaches around the South China Sea. Regional Studies in Marine Science 1: 55–62.

Zhao, J., W. Ran, J. Teng, Y. Liu, H. Liu, X. Yin, R. Cao & Q. Wang (2018) Microplastic pollution in sediments from the Bohai Sea and the Yellow Sea, China. Science of the Total Environment 640-641: 637–645.

Zheng, Y., J. Li, W. Cao, X. Liu, F. Jiang, J. Ding, X. Yin & C. Sun (2019) Distribution characteristics of microplastics in the seawater and sediment: A case study in Jiaozhou Bay, China. Science of the Total Environment 674: 27–35.

Zhou, C., X. Liu, Z. Wang, T. Yang, L. Shi, L. Wang, S. You, M. Li & C. Zhang (2016) Assessment of marine debris in beaches or seawaters around China Seas and coastal provinces. Waste Management 48: 652–660.

Zhou, Q., H. Zhang, C. Fu, Y. Zhou, Z. Dai, Y. Li, C. Tu & Y. Luo (2018) The distribution and morphology of microplastics in coastal soils adjacent to the Bohai Sea and the Yellow Sea. Geoderma 322: 201–208.

Zhu, L., H. Bai, B. Chen, X. Sun, K. Qu & B. Xia (2018) Microplastic pollution in North Yellow Sea, China: Observations on occurrence, distribution, and identification. Science of the Total Environment 636: 20-29.

Zhu, L., H. Wang, B. Chen, X. Sun, K. Qu & B. Xia (2019a) Microplastic ingestion in deep-sea fish from the South China Sea. Science of the Total Environment 677: 493–501.

Zhu, J., Q. Zhang, Y. Li, S. Tan, Z. Kang, X. Yu, W. Lan, L. Cai, J. Wang & H. Shi (2019b) Microplastic pollution in the Maowei Sea, a typical mariculture bay of China. Science of the Total Environment 658: 62–68.

Zhu, J., X. Yu, Q. Zhang, Y. Li, S. Tan, D. Li, Z. Yang & J. Wang (2019c) Cetaceans and microplastics: First report of microplastic ingestion by a coastal delphinid, *Sousa chinensis*. Science of the Total Environment. 659: 649–654.

Zhu, C., D. Li, Y. Sun, X. Zheng, X. Peng, K. Zheng, B. Hu, X. Luo & B. Mai (2019d) Plastic debris in marine birds from an island located in the South China Sea. Marine Pollution Bulletin 149: 110566.

<u>RO Korea</u>

Al-Odaini, N.A., W.J. Shim, G.M. Han, M. Jang & S.H. Hong (2015) Enrichment of hexabromocycloddodecanes in coastal sediments near aquaculture areas and a wastewater treatment plant in a semi-enclosed bay in South Korea. Science of the Total Environment 505: 290-298.

*Browne, M.A., T.S. Galloway & R.C. Thompson (2010) Spatial patterns of plastic debris along estuarine shorelines. Environmental Science & Technology 44: 3404–3409.

Chae, Y., S.H. Hong & Y.J. An (2020) Photosynthesis enhancement in four marine microalgal species exposed to expanded polystyrene leachate. Ecotoxoicology and Environmental Safety 189: 109936.

Chae, Y., D. Kim & Y.J. An (2019) Effects of micro-sized polyethylene spheres on the marine microalga *Dunaliella salina*: Focusing on the algal cell to plastic particle size ratio. Aquatic Toxicology 219: 105296.

Cho, D.O. (2005) Challenges to marine debris management in Korea. Coastal Management 33(4): 389–409.

Cho, D.O. (2009) The incentive programme for fishermen to collect marine debris in Korea. Marine Pollution Bulletin 58(3): 415–417.

Cho, Y., W.J. Shim, M. Jang, G.M. Han & S.H. Hong (2019) Abundance and characteristics of microplastics in market bivalves from South Korea. Environmental Pollution 245: 1107–1116.

Choi, E.C. & J.S. Lee (2018) The willingness to pay for removing the microplastics in the ocean – The case of Seoul metropolitan area, South Korea. Marine Policy 93: 93–100.

Eo, S., S.H. Hong, Y.K. Song, J. Lee, J. Lee & W.J. Shim (2018) Abundance, composition, and distribution of microplastics larger than 20μm in sand beaches of South Korea. Environmental Pollution 238: 894–902.

Heo, N.W., S.H. Hong, G.M. Han, S. Hong, J. Lee, Y.K. Song, M. Jang & W.J. Shim (2013) Distribution of small plastic debris in cross-section and high strandline on Heungnam beach, South Korea. Ocean Science Journal 48(2): 225–233.

*Hidalgo-Ruz, V., L. Gutow, R.C. Thompson & M. Thiel (2012) Microplastics in the marine environment: a review of the methods used for identification and quantification. Environmental Science & Technology 46(6): 3060-3075.

Hong, S., J. Lee, Y.C. Jang, Y.J. Kim, H.J. Kim, D. Han, S.H. Hong, D. Kang & W.J. Shim (2013) Impacts of marine debris on wild animals in the coastal area of Korea. Marine Pollution Bulletin 66(1–2): 117–124.

Hong, S., J. Le, D. Kang, H.W. Choi & S.H. Ko (2014a) Quantities, composition, and sources of beach debris in Korea from the results of nationwide monitoring. Marine Pollution Bulletin 84: 27–34.

Hong, S.Y., C.W. Lee, S. Hong, J. Lee, & Y.C. Jang (2014b) Evaluation of beach pollution by aquaculture styrofoam buoys in Tongyeong, Korea. Journal of the Korean Society for Marine Environment and Energy 17(2): 104–115.

Hong, S.W., J. Lee & D. Kang (2015) Emergy evaluation of management measures for derelict fishing gears in Korea. Ocean Science Journal 50: 603–613.

Hong, S., J. Lee, C. Lee, S.J. Yoon, S. Jeon, B.O. Kwon, J.H. Lee, J.P. Giesy & J.S. Khim (2016) Are styrene oligomers in coastal sediments of an industrial area aryl hydrocarbon-receptor agonists? Environmental Pollution 213: 913–921.

Hong, S.H., W.J. Shim & L. Hong (2017a) Methods of analysing chemicals associated with microplastics: A review. Analytical Methods 9: 1361–1368.

Hong, S., J. Lee & S. Lim (2017b) Navigational threats by derelict fishing gear to navy ships in the Korean seas. Marine Pollution Bulletin 119(2): 100-105.

Jang, C.J., J. Lee, S. Hong, J.Y. Mok, K.S. Kim, Y.J. Lee, H.W. Choi, H. Kang & S. Lee (2014a) Estimation of the annual flow and stock of marine debris in South Korea for management purposes. Marine Pollution Bulletin 86: 505–511.

Jang, Y.C., J. Lee, S. Hong, J.S. Lee, W.J. Shim & Y.K. Song (2014b) Sources of plastic marine debris on beaches of Korea: More from the ocean than the land. Ocean Science Journal 49: 151–162.

Jang, S.W., D.H. Kim, K.T. Seong, Y.H. Chung & H.J. Yoon (2014c) Analysis of floating debris behaviour in the Nakdong River basin of the southern Korean peninsula using satellite location tracking buoys. Marine Pollution Bulletin 88: 275–283.

Jang, Y.C., S. Hong, J. Lee, M.J. Lee & W.J. Shim (2014d) Estimation of lost tourism revenue in Geoje Island from the 2011 marine debris pollution event in South Korea. Marine Pollution Bulletin 81: 49–54.

Jang, S.W., S.K. Lee, D.H. Kim, Y.H. Chung & H.J. Yoon (2015) Application of remote monitoring to overcome the temporal and spatial limitations of beach litter survey. Advanced Science and Technology Letters 95: 67–72.

Jang, M., W.J. Shim, G.M. Han, M. Rani, Y.K. Song & S.H. Hong (2016) Styrofoam debris as a source of hazardous additives for marine organisms. Environmental Science and Technology 50(10): 4951–4960.

Jang, M., W.J. Shim, G.M. Han, Y.K. Song & S.H. Hong (2018) Formation of microplastics by polycaetes (*Marphysa sanguinea*) inhabiting expanded polystyrene marine debris. Marine Pollution Bulletin 131: 365–369.

Jeong, C.B., E.J. Won, H.M. Kang, M.C. Lee, D.S. Hwang, U.K. Hwang, B. Zhou, S. Souissi, S.J. Lee & J.S. Lee (2016) Microplastic size-dependent toxicity, oxidative stress induction, and p-JNK and p-p38 activation in the monogonont rotifer (*Brachionus koreanus*). Environmental Science and Technology 50(16): 8849–8857.

Jeong, C.B. H.M. Kang, M.C. Lee, D.H. Kim, J. Han, D.S. Hwang, S. Souissi, S.J. Lee, K.H. Shin, H.G. Park & J.S. Lee. (2017) Adverse effects of microplastics and oxidative stress-induced MAPK/Nrf2 pathway-mediated defense mechanisms in the marine copepod *Paracyclopina nana*. Scientific Reports 7: 41323.

Jeong, C.B., H.M. Kang, Y.H. Lee, M.S. Kim, J.S. Lee, J.S. Seo, M. Wang & J.S. Lee (2018) Nanoplastic ingestion enhances toxicity of persistent organic pollutants (POPs) in the monogonont rotifer *Brachionus koreanus* via multixenobiotic resistance (MXR) disruption. Environmental Science and Technology 52(19): 11411–11418.

Jo, H.J., O.B. Kwon & S.B. Jeong (2005) A study on the distribution and composition of marine debris in the middle part of East Sea, Korea. Journal of the Korean Society of Fisheries and Ocean Technology 41(4): 306–315.

Jung, R.T., H.G. Sung, T.B. Chun & S.I. Keel (2010) Practical engineering approaches and infrastructure to address the problem of marine debris in Korea. Marine Pollution Bulletin 60(9): 1523–1532.

Kang, J.H., O.Y. Kwon & W.J. Shim (2015a) Potential threat of microplastics to zooplanktivores in the surface waters of the Southern Sea of Korea. Archives of Environmental Contamination and Toxicology 69: 340-351.

Kang, J.H., O.Y. Kwon, K.W. Lee, Y.K. Song & W.J. Shim (2015b) Marine neustonic microplastics around the southeastern coast of Korea. Marine Pollution Bulletin 96(1–2): 304–312.

*Karami, A., A. Golieskardi, C.K. Choo, N. Romano, Y.B. Ho & B. Salamantinia (2017) A high-performance protocol for extraction of microplastics in fish. Science of the Total Environment 578: 485–494.

Khim, J.S., S. Hong, S.J. Yoon, J. Nam, J. Ryu & S.G. Kang (2018) A comparative review and analysis of tentative ecological quality objectives for protection of marine environments in Korea and China. Environmental Pollution 242: 2027–2039.

Kim, J.H., M.S. Kim & Y.B Kim (2005) Distribution and composition of floating debris in the East Sea during the summer season. Journal of Fisheries and Marine Sciences Education 17(1): 58–66.

Kim, M., S. Hyun & J.H. Kwon (2015a) Estimation of the environmental load of High- and Low-Density Polyethylene from South Korea using a mass balance approach. Archives of Environmental Contamination and Toxicology 69(3): 367–373.

Kim, I.S., D.H. Chae, S.K. Kim, S.B. Choi & S.B. Woo (2015b) Factors influencing the spatial variation of microplastics on high-tidal coastal beaches in Korea. Archives of Environmental Contamination and Toxicology 69: 299–309.

Kim, S.W. & Y.J. An (2019) A simple and efficient method for separation of low-density polyethylene films into different micro-sized groups for laboratory investigation. Science of the Total Environment 668: 84–89.

Kwon, B.G., K. Koizumi, S.Y. Chung, Y. Kodera, J.O. Kim & K. Saido (2015) Global styrene oligomers monitoring as new chemical contamination from polystyrene plastic marine pollution. Journal of Hazardous Materials 300: 359–367.

Lee, D.I., H.S. Cho & S.B. Jeong (2006) Distribution characteristics of marine litter on the sea bed of the East China Sea and the South Sea of Korea. Estuarine, Coastal and Shelf Science 70: 187–194.

Lee, K.W., W.J. Shim, O.Y. Kwon & J.H. Kang (2013a) Size-dependent effects of micro polystyrene particles in the marine copepod *Tigriopus japonicus*. Environmental Science and Technology 47(19): 11278–11283.

Lee, J., S. Hong, Y.K. Song, S.H. Hong, Y.C. Jang, M. Jang, N.W. Heo, G.M. Han, M.J. Lee, D. Kang & W.J. Shim (2013b) Relationships among the abundances of plastic debris in different size classes on beaches in South Korea. Marine Pollution Bulletin 77: 349–354.

Lee, J., J.S. Lee, Y.C. Jang, S.Y. Hong, W.J. Shim, Y.K. Song, S.H. Hong, M. Jang, G.M. Han, D. Kang & S. Hong (2015) Distribution and size relationships of plastic marine debris on beaches in South Korea. Archives of Environmental Contamination and Toxicology 69: 288–298.

Lee, H.S. & Y.J Kim (2017) Estimation of microplastics emission potential in South Korea – for primary source. Journal of the Korean Society of Oceanography 22(3): 135–149.

Lee, J., S. Hong & J. Lee (2019) Rapid assessment of marine debris in coastal areas using a visual scoring indicator. Marine Pollution Bulletin 149: 110552.

Rani, M., W.J. Shim, G.M. Han, M. Jang, Y.K. Song & S.H. Hong (2014) Hexabromocyclododecane in polystyrene based consumer products: An evidence of unregulated use. Chemosphere 110: 111–119.

Rani, M., W.J. Shim, M. Jang, G.M. Han & S.H. Hong (2017) Releasing of hexabromocyclododecanes from expanded polystyrenes in seawater – field and laboratory experiments. Chemosphere 185: 798–805.

Saido, K., K. Koizumi, H. Sato, N. Ogawa, B.G. Kwon, S.Y. Chung. T. Kusui, M. Nishimura & Y. Kodera (2014) New analytical method for the determination of styrene oligomers formed from polystyrene decomposition and its application at the coastlines of the North-West Pacific Ocean. Science of the Total Environment 473–474: 490-495.

Shim, W.J., Y.K. Song, S.H. Hong & M. Jang (2016) Identification and quantification of microplastics using Nile Red staining. Marine Pollution Bulletin 113: 469–476.

Song, Y.K., S.H. Hong, M. Jang, J.H. Kang, O.Y. Kwon, G.M. Han & W.J. Shim (2014) Large accumulation of micro-sized synthetic polymer particles in the sea surface microlayer. Environmental Science and Technology 48(16): 9014–9021.

Song, Y.K., S.H. Hong, M. Jang, G.M. Han, M. Rani, J. Lee & W.J. Shim (2015) A comparison of microscopic and spectroscopic identification methods for analysis of microplastics in environmental samples. Marine Pollution Bulletin 93: 202–209.

Song, Y.K., S.H. Hong, M. Jang, G.M. Han, S.W. Jung & W.J. Shim (2017) Combined effects of UV exposure duration and mechanical abrasion on microplastic fragmentation by polymer type. Environmental Science and Technology 51(8): 4368–4376.

Song, Y.K., S.H. Hong, S. Eo, M. Jang, G.M. Han, A. Isobe & W.J. Shim (2018) Horizontal and vertical distribution of microplastics in Korean coastal waters. Environmental Science and Technology 52(21): 12188–12197.

Japan

Amamiya, K., K. Saido, S.Y. Chung, T. Hiaki, D.S. Lee & B.G. Kwon (2019) Evidence of transport of styrene oligomers originated from polystyrene plastic to oceans by runoff. Science of the Total Environment 667: 57–63.

Chiba, S., H. Saito, R. Fletcher, T. Yogi, M. Kayo, S. Miyagi, M. Ogido & K. Fujikura (2018) Human footprint in the abyss: 30 year records of deep-sea plastic debris. Marine Policy 96: 204–212.

Endo, S., R. Takizawa, K. Okuda, H. Takada, K. Chiba, H. Kanehiro, H. Ogi, R. Yamashita & T. Date (2005) Concentration of polychlorinated biphenyls (PCBs) in beached resin pellets: Variability among individual particles and regional differences. Marine Pollution Bulletin 50: 1103–1114.

Goto, T. & H. Shibata (2015) Changes in abundance and composition of anthropogenic marine debris on the continental slope off the Pacific coast of northern Japan, after the March 2011 Tohoku earthquake. Marine Pollution Bulletin 95: 234–241.

Hirai, H., H. Takada, Y. Ogata, R. Yamashita, K. Mizukawa, M. Saha, C. Kwan, C. Moore, H. Gray, D. Laursen, E.R. Zettler, J.W. Farrington, C.M. Reddy, E.E. Peacock & M.W. Ward (2011) Organic micropollutants in marine plastics debris from the open ocean and remote and urban beaches. Marine Pollution Bulletin 62: 1683–1692.

Isobe, A., K. Kubo, Y. Tamura, S. Kako, E. Nakashima & N. Fujii (2014) Selective transport of microplastics and mesoplastics by drifting in coastal waters. Marine Pollution Bulletin 89: 324–330.

Isobe, A., K. Uchida, T. Tokai & S. Iwasaki (2015) East Asian seas: A hot spot of pelagic microplastics. Marine Pollution Bulletin 101(2): 618–623.

Isobe, A. (2016) Percentage of microbeads in pelagic microplastics within Japanese coastal waters. Marine Pollution Bulletin 110(1): 432–437.

Isobe, A., S. Iwasaki, K. Uchida & T. Tokai (2019) Abundance of non-conservative microplastics in the upper ocean from 1957 to 2066. Nature Communications 10: 417.

Iwasaki, S., A. Isobe, S. Kako, K. Uchida & T. Tokai (2017) Fate of microplastics and mesoplastics carried by surface currents and wind waves: A numerical model approach in the Sea of Japan. Marine Pollution Bulletin 121(1–2): 85–96.

Jamieson, A.J., L.S.R. Brooks, W.D.K. Reid, S.B. Piertney, B.E. Narayanaswamy & T.D. Linley (2019) Microplastics and synthetic particles ingested by deep-sea amphipods in six of the deepest marine ecosystems on Earth. Royal Society Open Science 6: 180667.

Kako, S., A. Isobe, S. Magome, H. Hinata, S. Seino & A. Kojima (2011) Establishment of numerical beach-litter hindcast/forecast models: An application to Goto Islands, Japan. Marine Pollution Bulletin 62(2): 293–302.

Kataoka, T., H. Hinata & S. Kako (2012) A new technique for detecting colored macro plastic debris on beaches using webcam images and CIELUV. Marine Pollution Bulletin 64: 1829–1836.

Kataoka, T., H. Hinata & S. Kato (2013). Analysis of a beach as a time-invariant linear input/output system of marine litter. Marine Pollution Bulletin 77(1–2): 266–273.

Kataoka, T., H. Hinata & S. Kato (2015) Backwash process of marine macroplastics from a beach by nearshore currents around a submerged breakwater. Marine Pollution Bulletin 101(2): 539–548.

Kataoka, T. & H. Hinata (2015) Evaluation of beach cleanup effects using linear system analysis. Marine Pollution Bulletin 91(1): 73–81.

Kinjo, A. K. Mizukawa, H. Takada & K. Inoue (2019) Size-dependent elimination of ingested microplastics in the Mediterranean mussel *Mytilus galloprovincialis*. Marine Pollution Bulletin 149: 110512.

Kusui, T. & M. Noda (2003) International survey on the distribution of stranded and buried litter on beaches along the Sea of Japan. Marine Pollution Bulletin 47(1–6): 175–179.
Mato, Y., T. Isobe, H. Takada, H. Kanehiro, C. Ohtake & T. Kaminuma (2001) Plastic resin pellets as a transport medium for toxic chemicals in the marine environment. Environmental Science and Technology 35(2): 318–324.
Matsuguma, Y., H. Takada, H. Kumata, H Kanke, S. Sakurai, T. Suzuki, M. Itoh, Y. Okazaki, R. Boonyatumanond, M.P. Zakaria, S. Weerts & B. Newman (2017) Microplastics in sediment cores from Asia and Africa as indicators of temporal trends in plastic pollution. Archives of Environmental Contamination and Toxicology 73(2): 230-239.
Maximenko, N., J. Hafner, M. Kamachi & A. MacFadyen (2018) Numerical simulations of debris drift from the Great Japan Tsunami of 2011 and their verification with observational reports. Marine Pollution Bulletin 132: 5–25.
Nakashima, E., A. Isobe, S. Kako, T. Itai & S. Takahashi (2012) Quantification of toxic metals derived from macroplastic litter on Ookushi Beach, Japan. Environmental Science and Technology 46(18): 10099–10105.
Nakashima, E., A. Isobe, S. Kako, T. Itai, S. Takahashi & X. Guo (2016) The potential of oceanic transport and onshore leaching of additive-derived lead by marine macro-plastic debris. Marine Pollution Bulletin 107: 333–339.
Sagawa, N., K. Kawaai & H. Hinata (2018) Abundance and size of microplastics in a coastal sea: Comparison among bottom sediment, beach sediment, and surface water. Marine Pollution Bulletin 133: 532–542.
Tanaka, K., H. Takada, R. Yamashita, K. Mizukawa, M. Fukuwaka & Y. Watanuki (2013) Accumulation of plastic-derived chemicals in tissues of seabirds ingesting marine plastics. Marine Pollution Bulletin 69: 219–222.
Tanaka, K., H. Takada, R. Yamashita, K. Mizukawa, M. Fukuwaka & Y. Watanuki (2015) Facilitated leaching of additive-derived PBDEs from plastic by seabirds' stomach oil and accumulation in tissues. Environmental Science and Technology 49: 11799–11807.
Tanaka, K. & H.Takada (2016) Microplastic fragments and microbeads in digestive tracts of planktivorous fish from urban coastal waters. Scientific Reports 6: 34351.
Tanaka, K., J.A. van Franeker, T. Deguchi & H. Takada (2019) Piece-by-piece analysis of additives and manufacturing byproducts in plastics ingested by seabirds: Implication for risk of exposure to seabirds. Marine Pollution Bulletin 145: 36–41.
Terazono, A. (2019) Recent management policy of plastic and packaging waste in Japan. Korea Society of Waste Management. ISEE 2019, Jeju, Korea. S2–06, pp. 253–261.
Yamashita, R., H. Takada, M. Fukuwaka & Y. Watanuki (2011) Physical and chemical effects of ingested plastic debris on short-tailed shearwaters, *Puffinus tenuirostris*, in the North Pacific Ocean. Marine Pollution Bulletin 62: 2845–2849.

## Documents and reports from intergovernmental institutions

ASEAN Secretariat (2019) ASEAN Framework of Action on Marine Debris. Retrieved from: https://asean.org/asean-framework-action-marine-debris/.
ASEAN Secretariat (2019) Bangkok Declaration on Combating Marine Debris in ASEAN Region. Retrieved from: https://asean.org/bangkok-declaration-combating-marine-debris-asean-region/.
COBSEA (2019) COBSEA Regional Action Plan on Marine Litter (RAP MALI). Retrieved from: http://wedocs.unep.org/handle/20.500.11822/30162.
GESAMP (2015) Sources, fate and effects of microplastics in the marine environment: A global assessment (Kershaw, P. J., ed), (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection). Rep. Stud. GESAMP No. 90: 96.
GESAMP (2016) Sources, fate and effects of microplastics in the marine environment: Part two of a global assessment (Kershaw, P.J., & Rochman, C.M., eds), (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) Rep. Stud. GESAMP No. 93: 220.
GESAMP (2019) Guidelines for the monitoring and assessment of plastic litter and microplastics in the ocean (Kershaw P.J., Turra A. & Galgani F. eds), (IMO/FAO/UNESCO-IOC/UNIDO/WMO/IAEA/UN/UNEP/UNDP/ISA Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection) Rep. Stud. GESAMP No. 99: 130.
UNEP (2011) The Honolulu Strategy - A global framework for prevention and management of marine debris.
UNEP (2013) Manila Declaration. 15th Global Meeting of the Regional Seas Conventions and Action Plans, 30 September - 1 October 2013 in Montego Bay, Jamaica.
UNEP (2016) Marine Litter Legislation: A Toolkit for Policymakers. Retrieved from: http://wedocs.unep.org/bitstream/handle/20.500.11822/8630/Marine_litter_legislation_A_policy_toolkit_for_policymakers-2016marine_litter_legislation.pdf.pdf?sequence=2&isAllowed=y.

UNEP (2018). Global Partnership on Marine Litter (GPML) Framework Document. 4th Intergovernmental Review Meeting on the Implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities 31 October - 1 November 2018 in Bali, Indonesia.

UNEP (2018). Legal Limits on Single-Use Plastics and Microplastics: A Global Review of National Laws and Regulations. Retrieved from: http://wedocs.unep.org/handle/20.500.11822/27113.

UNEP (2018). Single-Use Plastics - A Roadmap for Sustainability. Retrieved from: https://wedocs.unep.org/bitstream/handle/20.500.11822/25496/singleUsePlastic_sustainability.pdf?sequence=1&isAllowed=y.

UNEP (2019). The Role of Packaging Regulations and Standards in Driving the Circular Economy. Retrieved from: http://sos2019.sea-circular.org/wp-content/uploads/2019/11/FINAL_THE-ROLE-OF-PACKAGING-REGULATIONS-AND-STANDARDS-IN-DRIVING-THE-CIRCULAR-ECONOMY.pdf.

# APPENDIX I – LIST OF VISIBLE PLAYERS IN THE MARINE PLASTIC RESEARCH ACROSS ASEAN+3

Table 1. List of all visible institutions and/or authors with clear interest in research on pollution from marine plastics in ASEAN+3, an expansion of Table 1.2.14.16 in the report. Note: some researchers may have several research affiliations and may not just be affiliated to one single one as reflected here.

| | (Research) Institution | Researchers | Visible Research Interests |
|---|---|---|---|
| BRN | Department of Environment, Parks and Recreation (JASTRe) | - | Plastic pollution statistics |
| | Prince of Songkla University (PSU) | - | Marine debris (on coastal beaches) |
| | Universiti Brunei Darussalam (UBD) | Md Sumon Reza | Marine debris (on coastal beaches) |
| | Universiti Teknologi Brunei (UTB) | Zahid Naeem Qaisrani | Marine debris (on coastal beaches) |
| KHM | *Fauna and Flora International (FFI): Project in Cambodia 'Tackling plastic pollution for communities and coral reefs in coastal Cambodia' | - | Plastic pollution |
| | Marine Conservation Cambodia | - | Marine research and marine conservation, clean-up initiatives on Kep Mainland beaches |
| | Royal University of Phnom Penh | - | Has growing research capacity |
| | *United Nations Development Programme (UNDP): Project in Cambodia: 'Combating Plastic Pollution in Cambodia' | | |
| IDN | Bandung Institute of Technology | Susanna Nurdjaman<br>Ivonne Radjawane | Oceanographic modelling |
| | Bogor Agricultural University | Ayu Ramadhini Hastuti | Marine debris (monitoring and characterisation), microplastics (ingestion) |
| | | Sigid Hariyadi | Marine litter, macroplastics and microplastics (monitoring and characterization) |
| | Brawijaya University | Aisyah Yuninda Yuwandita | Microplastics (monitoring and characterization) |
| | | Defri Yona | Microplastics (monitoring and characterization) |
| | | Feni Iranawati | Microplastics (monitoring and characterization) |
| | | Muhammad Arif Asadi | Microplastics (monitoring and characterization) |
| | Diponegoro University | Adian Khoironi | Microplastics (ingestion) |

| | | | |
|---|---|---|---|
| | Hasanuddin University/Universitas Hasanuddin | Ahmad Faizal | Marine debris (on coastal beaches), microplastics (monitoring and characterization) |
| | | Akbar Tahir | Marine debris (on coastal beaches), microplastics (monitoring, characterization and ingestion) |
| | | Shinta Werorilangi | Marine debris (on coastal beaches), microplastics (monitoring, characterization and ingestion) |
| | Indonesian Ministry of Marine Affairs & Fisheries | Widodo Setiyo Pranowo | Marine debris (review of research), macroplastics and microplastics (movement, hydrodynamic modelling) |
| | Indonesian Institute of Sciences/Lembaga Ilmu Pengetahuan Indonesia (LIPI) | Muhammad Reza Cordova | Marine macrodebris (on coastal beaches), microplastics (monitoring, characterization and spatial distribution), plastic contaminants (heavy metals) |
| | Jenderal Soedirman University/Universitas Jenderal Soedirman | Nuning Via Hidayati | Microplastics (monitoring, characterisation and spatial distribution) |
| | Mularwaman University/Universitats Mulawarman | Intan Sari Dewi | Microplastics (monitoring and characterisation) |
| | Padjadjaran University | Adinda Maharani | Marine debris (on coastal beaches) |
| | | Agung Ramos | Macroplastics (movement and hydrodynamic modelling) |
| | | Dannisa Ixora Wanadwiva Handyman | Marine debris (review of research), macroplastics (monitoring and characterization), microplastics (movement and hydrodynamic modelling) |
| | | Haifa H. Jasmin | Macroplastics and microplastics (movement, hydrodynamic modelling) |
| | | Ibnu Faizal Dante | Macroplastics (monitoring, characterization, movement and hydrodynamic modelling) and microplastics (movement and hydrodynamic modelling) |
| | | Lintang Permata Sari Yuliadi | Microplastics (monitoring, characterization, movement and hydrodynamic modelling) |
| | | Mega L. Syamsudin | Macroplastics (monitoring, characterization, movement and hydrodynamic modelling), microplastics (movement and hydrodynamic modelling) |
| | | Noir Primadona Purba | Marine debris (review of research), macroplastics (monitoring, characterisation, movement and hydrodynamic modelling), microplastics (monitoring, characterization, movement and hydrodynamic modelling) |
| | | Putri G. Mulyani | Macroplastics (monitoring and characterization), microplastics (monitoring, characterization, movement and hydrodynamic modelling) |
| | | Syawaludin Alisyahbana Harahap | Macroplastics and microplastics (movement, hydrodynamic modelling) |

| | | | |
|---|---|---|---|
| | | Yudi N. Ihsan | Marine debris (review of research), macroplastics and microplastics (monitoring and characterization) |
| | Sepuluh Nopember Institute of Technology/Institut Teknologi Sepulu Nopember (ITS) | Prieskarinda Lestari | Upstream solid waste management to plastic pollution, microplastics (monitoring and characterization) |
| | | Yulinah Trihadiningrum | Upstream solid waste management to plastic pollution, microplastics (monitoring and characterization) |
| | Sriwijaya University | Anna Ida Sunaryo Purwiyanto | Macrodebris, microplastics (monitoring and characterization) |
| | Udayana University | Yulianto Suteja | Microplastics (monitoring and characterization) |
| | University of Raja Ali Haji Maritime | Agung Dharmar Syakti | Marine debris (review of research), macroplastics (monitoring and characterization), mesoplastics (ingestion), microplastics (monitoring, characterization and ingestion) |
| | University of Singaperbangsa Kawarang/Universitas Singaperbangsa Karawang | Suma Anggoro | Microplastics (monitoring, characterization, degradation and interaction with marine biota) |
| MYS | University of Malaya | Shahul Hamid Fauziah | Largely working together on marine debris, microplastics, marine pollution, leachate, environmental bioremediation, waste treatment and management |
| | | Agamuthu Periathamby | |
| | | Chijioke Emenike | |
| | University of Sarawak | Julyus Melvin Mobilik | Marine debris, marine pollution |
| | Universiti Malaysia Terengganu (Microplastic Research Interest Group) | Wan Mohd Afiq Wan Mohd Khalik | Largely marine debris, microplastics, monitoring, marine pollution, environmental analysis, microplastic ingestion |
| | | Yusof Shuaib Ibrahim | |
| | | Sabiqah Tuan Anuar | |
| | Universiti Malaysia Terengganu (Ocean Pollution and Ecotoxicology, OPEC) | - | Different expertise of marine biology, chemistry, biopolymer |
| MYN | University of Yangon* | - | Attended a seminar planning for capacity building in addressing marine pollution and water quality monitoring issues in Myanmar. |
| PHL | Davao Oriental State College of Science and Technology | Neil Angelo Abreo | Marine plastic, monitoring, marine pollution, microplastic ingestion |

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|---|---|---|---|
| | Plastics Research Network Philippines (PlaReNet) | Deo Florence Llacuna Onda (and several others) | Aim: consolidate efforts and facilitate the creation of a national scientific research framework to complement the national plan of action being prepared by the Department of Environment and Natural Resources (DENR), focusing on plastic pollution, marine plastic debris and microbes |
| | University of Basel | Mila Yong | Microplastics (monitoring, characterization and ingestion) in whale sharks and surface water in Oslob, Cebu, Philippines |
| | University of the Philippines Los Baños | Maria Kristina Oquinena Paler | Microplastics (monitoring, characterization and ingestion) in Cebu, Philippines |
| SGP | National University of Singapore | Obbard J | Marine pollution, ALDFG, microplastics, sorption to biota surface, plastic toxicity impacts, microbial assemblages |
| | | | |
| | Nanyang Technological University (NTU) - Singapore Centre for Environmental Life Sciences Engineering (SCELSE) | - | Marine plastic, microplastics, microbial assemblages, novel plastic degradation methodologies |
| | Agency for Science, Technology and Research (A*STAR) | - | Plastic polymer, chemical synthesis of green alternatives to plastic |
| | National Parks Board Singapore (NParks) | - | Microplastics monitoring, public education |
| THA | Chulalongkorn University | - | Marine plastic debris, marine plastic ingestion |
| | Burapha University Chanthaburi Campus | - | Microplastic ingestion |
| | Prince of Songkla University | - | Marine plastic debris, marine plastic ingestion |
| | Mahidol University | - | Marine plastic pollution |
| | Ministry of Natural Resources and Environment - Department of Marine and Coastal Resources (DCMR) | - | Marine plastic ingestion |
| VNM | Ho Chi Minh City University of Technology | - | Marine plastic debris in riverine systems |
| | Can Tho University | - | Transport of plastic debris in riverine systems, microplastic, toxicology |
| | VASI | - | Law and policy on combatting pollution from marine debris |

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

# APPENDIX II – SCIENTIFIC PUBLICATIONS EXAMINED IN ASEAN+3 (FOR COUNTRIES WITH >30 PUBLICATIONS)

As part of Part 1, Section 2 – "Marine Plastic Research in ASEAN+3 Member States".

Table 1. List of published work identified and examined in this study for Indonesia, where total literature examined is 64.

| Published Peer Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Kusumawati et al. (2020a)<br><br>Teuku Umar University; Raja Ali Haji Maritime University; Bogor Agricultural Institute | Examinining millennial perception towards marine litter and the influence of environmental education towards youth perceptions in West Aceh, Indonesia | January-June 2019 |
| Kusumawati et al. (2020b)<br><br>Teuku Umar University; Raja Ali Haji Maritime University; Bogor Agricultural Institute | Examining the people's perception towards marine litter responsibility in Aceh Jaya Regency, Indonesia | January-July 2019 |
| Purba and Faizal (2019)<br><br>Padjadjaran University | Asssessing the efficiency of novel surface drifters (Float Artificial Debris, FAD) in measuring the spread of marine debris, using Lagrangian instrument and trajectory analysis | N.A. |
| Petrlik et al. (2019)<br><br>International Pollutants Elimination Network (international); Arnika Association (Czech); Nexus3 Foundation; Ecological Observation and Wetlands Conservation | Analysing pollution status and toxicity of plastic waste at dumping sites, in relation to food chain contamination and human health impact | April 2019, June to September 2019 |
| Cordova and Nurhati (2019)<br><br>Indonesian Institute of Sciences | Quantifying, identifying and characterising macroplastics monthly emissions from 9 estuarine rivers into Jakarta Bay, Indonesia | June 2017 to June 2018 |
| Afdal et al. (2019)<br><br>Hasanuddin Uni | Quantifying, identifying and characterising microplastics in coastal waters of Makassar City, South Sulawesi, Indonesia | N.A. |
| Asadi et al. (2019)<br><br>Uni of Brawijaya | Quantifying, identifying and characterising microplastics in intertidal sediments at Lamongan, Indonesia | June 2018 |
| Ayuningtyas et al. (2019)<br><br>Brawijaya Uni; State Uni of Malang | Quantifying, identifying and characterising microplastics in eastern Java Sea at Banyuurip, Central Java, Indonesia | March 2018 |
| Cordova et al. (2019)<br><br>Indonesian Institute of Sciences; Sriwijaya Uni; Udayana Uni | Quantifying, identifying and characterising microplastics in coastal regions in northern Surabaya, East Java, Indonesia | March 2017 |
| Falahudin et al. (2019) | Quantifying, identifying and characterising microplastics in sediment in waters of Banten Bay, Indonesia | April 2016 |

| Published Peer Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Indonesian Institute of Sciences; Chinese Academy of Sciences (China) | | |
| Firdaus et al. (2019)<br><br>Sepuluh Nopember Institute of Technology | Quantifying, identifying and characterising microplastics in sediment of Wonorejo estuary in Surabaya, Indonesia | N.A. |
| Germanov et al. (2019)<br><br>Murdoch Uni (Australia); Marine Megafauna Foundation (UK); Udayana Uni; Victoria Uni of Wellington (New Zealand); Mataram Uni; Bogor Agricultural Uni | Quantifying, identifying and characterising surface microplastics in coastal feedings grounds for manta rays and whale sharks in Indonesia | 2016 to 2018 |
| Handyman et al. (2019)<br><br>Padjadjaran Uni; Ministry of Maritime Affairs and Fisheries; Sekolah Tinggi Teknologi Angkatan Laut | Hydrodynamic and particle tracking modelling of microplastic movement at Java Sea; Examining probability of microplastic patch | November 2015 to May 2016 |
| Hastuti et al. (2019)<br><br>Bogor Agricultural Uni | Quantifying, identifying and characterising microplastics in commercial bivalves in the Wonorejo estuary, downstream of Surabaya river, Indonesia | March to July 2015 |
| Hiwari et al. (2019)<br><br>Padjadjaran Uni | Quantifying, identifying and characterising surface microplastics in Savu Sea, East Nusa Tenggara Province | June 2018 |
| Ismail et al. (2019)<br><br>Padjadjaran Uni | Quantifying, identifying and characterising microplastics in locally caught fish in Pangandaran Bay, Indonesia | April 2018 |
| Isyrini et al. (2019)<br><br>Hasanuddin Uni; Indonesian Institute of Sciences | Quantifying, identifying and characterising macroplastics among coastal debris on Labuange, Lumpue and Bojo beach of Indonesia<br>(a follow-up to Isyrini et al. 2018 study) | March to May 2018 |
| Jasmin et al. (2019)<br><br>Padjadjaran Uni; Ministry of Maritime Affairs and Fisheries | Hydrodynamic and particle tracking modelling of macrodebris movement at estuaries leading to Jakarta Bay, before and after its reclamation; Examining probability of microplastic patch | 2012 to 2018 |
| Lestari and Trihadiningrum (2019)<br><br>Sepuluh Nopember Institute of Technology | Review country's solid waste management infrastructure and services, and its impact to plastic pollution in Indonesia | N.A. |
| Lubis et al. (2019)<br><br>Raja Ali Haji Maritime Uni; Jenderal Soedirman Uni | Quantifying, identifying and characterising micro- and meso-plastics in fish in waters near human settlement | May 2018 to January 2019 |
| Purba et al. (2019a)<br><br>Padjadjaran Uni; Raja Ali Haji Maritime Uni; Ministry of Maritime Affairs and Fisheries; MantaWatch (UK) | Literature review of marine debris research and status in Indonesia | 2012 to 2018 |
| Purba et al. (2019b) | Hydrodynamic and particle tracking modelling of microplastic movement at the Savu Sea National Marine Park, East Nusa Tenggara | 2017 |

| Published Peer Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Padjadjaran Uni; Pusat Riset Kelautan; Sekolah Tinggi Teknologi Angkatan Laut | | |
| **Rachmat et al. (2019)**<br>Padjadjaran Uni | Quantifying, identifying and characterising microplastics in waters at river mouth and coastal waters off the Jakarta Bay, Indonesia, at different tidal conditions and water depth | July 2017 |
| **Rahmawati and Patria (2019)**<br>Uni of Indonesia | Quantifying, identifying and characterising microplastics in waters and in fish at mangrove ecosystem of the Muara Teluknaga, Tangerang regency of Indonesia | N.A. |
| **Syakti et al. (2019)**<br>Jenderal Soedirman Uni; Raja Ali Haji Maritime Uni; Riau Islands Province Dompak; Aix Marseille Uni (France); National Uni of Singapore (Singapore) | Investigating impacts of LDPE on *Acropora formosa* coral health (bleaching and necrosis) | August 2018 |
| **Tahir et al. (2019)**<br>Hasanuddin Uni | Quantifying, identifying and characterising microplastics in sediment and benthic animal of a seagrass ecosystem at Spermonde archipelago | July and September 2017 |
| **van Emmerik et al. (2019)**<br>The Ocean Cleanup (The Netherlands) | Assessment of riverine macroplastic transport into the ocean (Java Sea) | May 2018 |
| **Yona et al. (2019)**<br>Brawijaya Uni; State Uni of Malang | Quantifying, identifying and characterising microplastics in eastern Java Sea | March 2018 |
| **Akhir (2018)**<br>World Maritime Uni (Sweden) | Literature review of the effectiveness of the national marine plastic plan by the Indonesian Government and providing recommendations | N.A. |
| **Bangun et al. (2018)**<br>Uni of North Sumatra | Quantifying, identifying and characterising microplastics in sediments in assessing relation to macrozoobenthos density in Jaring Halus Village | February to April 2017 |
| **Cordova and Hernawan (2018)**<br>Indonesian Institute of Sciences | Quantifying, identifying and characterising microplastics in Sumba pristine outlet of Surabaya river | August 2016 |
| **Cordova et al. (2018)**<br>Indonesian Institute of Sciences | Quantifying, identifying and characterising of microplastics in coral reef sediment in Sekotong, Lombok Island | December 2015 |
| **Giesler (2018)**<br>SIT Study Abroad (USA) | Literature review of marine plastic problem in Bali, Indonesia | N.A. |
| **Hoeksema and Hermanto (2018)**<br>Naturalis Biodiversity Center; Indonesian Institute of Sciences | Examining presence of ALDFG (plastic net) and as a substrate for coral reef | N.A. |
| **Ismail et al. (2018)**<br>Padjadjaran Uni | Quantifying, identifying and characterising microplastics in locally caught fish in Biawak Island, Indonesia | May to July 2017 |

| Published Peer Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Isyrini et al. (2018)<br><br>Hasanuddin Uni; Indonesian Institute of Sciences | Quantifying, identifying and characterising coastal debris into different types, including plastic, in Labuange beach, South Sulawesi, Indonesia | June to August 2018 |
| Khoironi et al. (2018)<br><br>Diponegoro Uni | Quantifying, identifying and characterising microplastics in wild Asian green mussels of 3 different salinities in Java Sea | September 2017 |
| Lestari et al. (2018)<br><br>Sepuluh Nopember Institute of Technology | Quantifying, identifying and characterising microplastics in commercial M. Meretrix bivalves in the Wonorejo estuary, downstream of Surabaya river, Indonesia | N.A. |
| Maharani et al. (2018)<br><br>Uni of North Sumatra | Quantifying, identifying and characterising coastal debris into different types, including plastic, in Tunda Island | N.A. |
| Manullang et al. (2018)<br><br>Indonesian Institute of Sciences | Literature review of current marine pollution research status and future prospect (of plastic pollution) in the Banda Sea | N.A. |
| Nordén and Karlsson (2018)<br><br>KTH Royal Institute of Technology (Sweden) | Examining the effectiveness of a mathematical model in determining the optimal placement of a clean-up system following particle tracking, a case study at Jakarta Bay, Indonesia | February 2011 |
| Purba et al. (2018a)<br><br>Padjadjaran Uni; Divers Clean Action; National Marine Protected Area Agency | Quantifying, identifying and characterising coastal debris into different types, including plastic, in Savu Sea Marine National Park | June 2018 |
| Purba et al. (2018b)<br><br>Padjadjaran Uni | Quantifying, identifying and characterising coastal debris into different types, including plastic, in Pangandaran Beach | May, August, October 2017 |
| Ramos et al. (2018)<br><br>Padjadjaran Uni | Hydrodynamic and particle tracking modelling of microplastic movement from western Pacific Ocean to the northern waters of Indonesia; Examining probability of microplastic patch | 2016 |
| Richardson et al. (2018)<br><br>Uni of Tasmania CSIRO (Australia); Ghostnets Australia (Australia) | Examining possible causes of ALDFG from Australian and Indonesian fisherman | N.A. |
| Shuker and Cadman (2018)<br><br>World Bank | Informed and analysing land-based leakage of solid waste, particularly plastics, to the marine environment | N.A. |
| Sur et al. (2018)<br><br>Uni of California, Davis (USA); Hasanuddin Uni | Examining the effectiveness of an educational outreach programme in raising awareness of the impacts and scale of marine debris to children in Barrang Lompo, Makassar City, South Sulawesi, Indonesia | 2013 to 2016 |
| Syakti et al. (2018)<br><br>Jenderal Soedirman Uni; Raja Ali Haji Maritime Uni; Riau Uni | Quantifying, identifying and characterising surface microplastics in high human-impact stations around Bintan regency, Riau Islands, Indonesia | N.A. |
| Tahir et al. (2018)<br><br>Hasanuddin Uni | Quantifying, identifying and characterising coastal debris into different types, including plastic, at coastal areas of Takalar District and Makassar City | August to October 2016 |

| Published Peer Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Tangdesu et al. (2018)<br><br>Hasanuddin Uni | Quantifying, identifying and characterising coastal debris into different types, including plastic, in Biringkassi River, Takalar Regency, South Sulawesi, Indonesia | August 2017 |
| Wahyuningsih et al. (2018)<br><br>Uni of North Sumatra | Quantifying, identifying and characterising micro- and macro-plastics in sediments in assessing sediment texture to plastic density in Jaring Halus Village | February to April 2017 |
| Husrin et al. (2017)<br><br>Ministry of Maritime Affairs and Fisheries; Uni Dhyana Pura Bali | Quantifying, identifying, characterising and comparing coastline, seabed and floating macroplastic on Kuta Beach, Bali, during different seasons; Examining possible sources of macroplastic; Assessing local's awareness and perspective of marine pollution responsibility | March, April, December 2015, and February 2016 |
| Manalu et al. (2017)<br><br>Bogor Agricultural Uni | Quantifying, identifying and characterising of microplastics in riverbed sediment in Jakarta Bay, Indonesia | December 2015, January 2016 |
| Purba et al. (2017)<br><br>Padjadjaran Uni | Quantifying, identifying and characterising coastal debris into different types, including plastic, in Biawak Island, Indramayu, Indonesia | 2013 and 2014 |
| Syakti (2017)<br><br>Jenderal Soedirman Uni; Raja Ali Haji Maritime Uni | Discussing standardized microplastic monitoring methodologies in various marine environments | N.A. |
| Syakti et al. (2017)<br><br>Jenderal Soedirman Uni; Raja Ali Haji Maritime Uni; Aix Marseille Uni (France) | Quantifying, identifying and characterising coastal debris into different types, including plastic, on Cilacap coast, Indonesia | 2013 to 2015 |
| Balasubramaniam and Phillott (2016)<br><br>Asian Uni for Women | Quantifying, identifying and characterising of microplastics on sea turtle nesting beaches around the Indian Ocean, in relation to further examining the potential of microplastic threat to sea turtle | N.A. |
| Cordova and Wahyudi (2016)<br><br>Indonesian Institute of Sciences | Quantifying, identifying and characterising of microplastics in deep-sea sediment in Southwestern Sumatera waters | May 2015 |
| Pangetsu et al. (2016)<br><br>Padjadjaran Uni | Hydrodynamic and particle tracking modelling of microplastic movement at Indramayu | N.A. |
| Attamimi et al. (2015)<br><br>Padjadjaran Uni; Ministry of Maritime Affairs and Fisheries | Quantifying, identifying and characterising coastal debris into different types, including plastic, in Kuta beach, Bali | N.A. |
| Dewi et al. (2015)<br><br>Mulawarman Uni | Quantifying, identifying and characterising of microplastics in various sediments in Muara Badak, Kutai Kartanegara regency, Indonesia | April 2015 |
| Rochman et al. (2015)<br><br>Uni of California, Davis (USA); Hasanuddin Uni | Quantifying, identifying and characterising microplastics in fish sold in fish market in Indonesia | August to November 2014 |
| Hastuti et al. (2014)<br><br>Bogor Agricultural Uni | Quantifying, identifying and characterising macroplastics and microplastics in mangrove ecosystem of Pantai Indah Kapuk, Jakarta | March to August 2014 |

| Published Peer Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Oktaviana et al. (2014)<br>Hasanuddin Uni | Quantifying, identifying and characterising land and marine debris into different types, including marine plastic, in Barrang Lompo Island | N.A. |

Table 2. List of published work identified and examined in this study for Malaysia, where total literature examined is 36.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Amin et al. (2019)<br>Uni Malaysia Terengganu | Quantifying, identifying, characterising and comparing microplastic in zooplankton and seawater in Terangganu coast, Malaysia | August 2017 |
| Chee et al. (2019)<br>Uni Sains Malaysia; Natural Resources Wales (UK); Uni of Tasmania (Australia) | Quantifying, identifying and characterising mangrove debris into different types, including plastic, in 4 mangroves of Malaysia | October, November 2018 |
| Chukwuma et al. (2019)<br>Nnamdi Azikiwe Uni (Nigeria); Uni Putra Malaysia | Developing and application of a Plastic Waste Leakage Model using GIS geospatial technology for land-based plastic leakage to the ocean | N.A. |
| Fauziah et al. (2019)<br>Uni of Malaya; Uni Teknologi MARA; Uni Science Malaysia; Department of Fisheries Malaysia | Quantifying, identifying and characterising coastal debris into different types, including plastic, in 2 beaches of Malaysia; Examining occurrences of marine debris in relation to dry and rainy seasons | April to December 2018 |
| Hocajo-Berná et al. (2019)<br>Juara Turtle Project | Quantifying, identifying and characterising ingested debris, including plastic, in dead sea turtle (Chelonia mydas green turtle) of Tioman Island, Malaysia | June 2017 |
| Karbalaei et al. (2019)<br>Alzahra Uni (Iran); Kian Fara Pars Pharmaceutical Co. (Iran); Uni Putra Malaysia; Dalhousie Uni (Canada); Griffith Uni (Australia) | Quantifying, identifying and characterising microplastics in commercial fish from the fish market in Malaysia | N.A. |
| Anuar et al. (2018)<br>Uni Malaysia Terengganu | Quantifying, identifying, characterising and comparing ingested microplastics in wild and farmed sea cucumbers (*Holothuria scabra*) in Malaysian waters | N.A. |
| Egbeocha et al. (2018)<br>Uni of Malaya; Hezekiah Uni (Nigeria) | Reviewing effects of ingested microplastic in marine organisms on a global scale | N.A. |
| Hamid et al. (2018)<br>Uni of Malaya | Reviewing global abundance and distribution of microplastics in marine and freshwater ecosystems | N.A. |
| Karami et al. (2018)<br>Uni Putra Malaysia; Monash Uni Malaysia; HORIBA Jobin Yvon S.A.S. (France) | Quantifying, identifying and characterising microplastics and mesoplastics in canned sardines and sprats manufactured for direct human consumption | N.A. |
| Khalik et al. (2018) | Quantifying, identifying and characterising microplastics found in Malaysian marine waters near Kuala Nerus and Kuantan port. | September to October 2015 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Uni Malaysia Terengganu (Microplastic Research Interest Group) | | |
| Praveena et al. (2018)<br><br>Uni Putra Malaysia; Uni Teknologi MARA; SOKA Uni (Japan) | Estimating microplastic emission from personal care and cosmetics products into the marine environment in Malaysia | N.A. |
| Auta et al. (2017a)<br><br>Uni of Malaya; Federal Uni of Tech. (Nigeria) | Examining potential of bacterial isolates of mangrove sediment in degrading UV-treated PE, PET, PP, PS polymer types microplastics | N.A. |
| Auta et al. (2017)<br><br>Uni of Malaya; Federal Uni of Tech. (Nigeria) | Examining polypropylene-degrading microorganisms in mangrove sediments obtained from Peninsular Malaysia | N.A. |
| Auta et al. (2017b)<br><br>Uni of Malaya; Federal Uni of Tech. (Nigeria) | Global outlook at the concentration, biological impact, distribution sources and fate of microplastics | N.A. |
| Estim and Sudirman (2017)<br><br>Uni Malaysia Sabah | Quantifying, identifying and characterising coastal debris into different types, including macroplastics & microplastics in coastline sediment; floating macroplastic, in Sebatik Island, Tawau, Sabah, Malaysia | December 2015 to May 2016 |
| Ibrahim et al. (2017)<br><br>Uni Malaysia Terengganu | Quantifying, identifying and characterising microplastics in wild and farmed Asian sea bass (*Lates calcarifer*) in Setiu Wetlands, Malaysia | October 2016 |
| Karami et al. (2017a)<br><br>Uni Putra Malaysia; Monash Uni Malaysia; HORIBA Jobin Yvon S.A.S. (France); Uni of Exeter (UK) | Quantifying, identifying and characterising microplastics in edible commercial salts across countries including Malaysia, in relation to human health | N.A. |
| Karami et al. (2017b)<br><br>Uni Putra Malaysia; Monash Uni Malaysia; HORIBA Jobin Yvon S.A.S. (France) | Quantifying, identifying and characterising microplastics in edible fish tissues | N.A. |
| Matsuguma et al. (2017)<br><br>Tokyo Uni of Agriculture and Tech.; Tokyo Uni of Pharmacy and Life Sciences; Environmental Research and Training Center (Thailand); Uni of Malaya, Malaysia; Council for Science and Industrial Research (South Africa) | Quantifying, identifying and characterising microplastics in various sediment cores in Asia and Africa, including Malaysia coastal area | September 2006 (for Malaysia) |
| Mobilik et al. (2017)<br><br>Uni Malaysia Sarawak; Uni Malaysia Terengganu | Quantifying, identifying and characterising coastal debris into different types, including plastic, in Sabah, Malaysia during different seasons; Examining possible sources of macroplastic | December 2012, May, July 2013 |
| Ibrahim et al. (2016)<br><br>Uni Malaysia Terengganu | Quantifying, identifying and characterising microplastics in wild bivalve (*Scapharca cornea*) from Setiu Wetlands, Malaysia. | October 2014 |
| Karami et al. (2016) | Developing a standardised methodology for best microplastic extraction from fish, using African catfish (*Clarias gariepinus*) as a fish model | N.A. |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Uni Putra Malaysia; Monash Uni Malaysia | | |
| Mobilik et al. (2016)<br>Uni Malaysia Sarawak; Uni Malaysia Terengganu | Quantifying, identifying and characterising coastal debris into different types, including plastic, at 5 beaches of Malaysia, in relation to establish shipping activities as a source of stranded marine litter in the Malaysian Territorial water | October 2012 to October 2014 |
| Adnan et al. (2015)<br>Uni Malaysia Sabah | Quantifying, identifying and characterising coastal debris into different types, including plastic, at Likas Bay beach, Sabah of Malaysia | November, December 2011 |
| Fauziah et al. (2015)<br>Uni of Malaya | Quantifying, identifying and characterising coastal plastic debris buried in sand at selected beaches in Malaysia | N.A. |
| Mobilik et al. (2015)<br>Uni Malaysia Sarawak; Uni Malaysia Terengganu | Quantifying, identifying and characterising g coastal debris into different types, including plastic, at 2 beaches of Malaysia during different seasons; Examining possible sources of macroplastic | December 2012, May, July 2013 |
| Noik and Tuah (2015)<br>Uni Malaysia Sabah | Quantifying, identifying and characterising microplastics on two sandy beaches in Kuching, Sarawak | November 2013, August 2014 |
| Noik et al. (2015)<br>Uni Malaysia Sabah | Quantifying, identifying and characterising microplastics on two beaches in Kuching, Sarawak, in relation to leaching of heavy metals | N.A. |
| Barasarathi et al. (2014)<br>Uni of Malaya | Quantifying, identifying and characterising microplastics in mangrove sediment at Semanta Mangrove of Malaysia, with emphasis on remote area isolated from anthropogenic activities. | April 2014 |
| Mobilik et al. (2014)<br>Malaysia Marine Department (Sarawak); Uni Malaysia Sarawak; Uni Malaysia Terengganu | Quantifying, identifying and characterising coastal debris into different types, including plastic, at 4 beaches of Malaysia during the NE monsoon; Examining possible sources of macroplastic | October 2012 |
| Agamuthu et al. (2012)<br>Uni of Malaya | Quantifying, identifying and characterising coastal debris into different types, including plastic, on 4 beaches of Malaysia; Assessing local's awareness and perspective of marine pollution responsibility | N.A. |
| Aris (2012)<br>Uni of Malaya | Quantifying, identifying and characterising buried microplastics on beaches in Malaysia | January to March 2010 |
| Khairunnisa et al. (2012)<br>Uni of Malaya | Quantifying, identifying and characterising coastal debris into different types, including plastic, on two beaches in Port Dickson | January to March 2010 |
| Razlan (2011)<br>Uni Malaysia Terengganu | Quantifying, identifying and characterising coastline macroplastics on beaches of Bidong Island, Malaysia | March, August 2010 |
| Mobilik (2008)<br>Uni Malaysia Sarawak | Quantifying, identifying and characterising coastline macroplastics on beaches in Sarawak, Malaysia; Assessing local's awareness and perspective of marine pollution responsibility | N.A. |

Table 3. List of published work identified and examined in this study for China, where total literature examined is 129. Note abbreviations: First Institute of Oceanography, Ministry of Natural Resources (FIO-MNR); Qingdao Pilot National Laboratory for Marine Sci. and Tech. (QNLM); Chinese Academy of Sciences (CAS); Chinese Academy of Fishery Sciences (CAFS); Chinese Academy of Geological Sciences (CAGS).

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Fu et al. (2020)<br>Hainan University; Chia Nan University of Pharmacy and Science; Beijing Institute of Technology | Reviewing occurrences and distribution of microplastics in China, as well as research status and policies | 2009-2019 |
| Peng et al. (2020)<br>Guangdong Uni of Tech.; Clemson Uni (USA) | Reviewing microplastics in marine environments, in relation to its sources, occurrence and effects | N.A. |
| Chan et al. (2019)<br>Uni of Hong Kong | Quantifying microplastics in benthic fish from Hong Kong coastal waters and finding factors affecting microplastic consumption | Summer 2015, December 2016, July 2017 |
| Cong et al. (2019)<br>National Marine Environmental Monitoring Center (Dalian); Minjiang Uni; Dalian Ocean Uni; East China Normal Uni | Impacts of polystyrene microspheres on mortality and reproduction of marine medaka (*Oryzias melastigma*) | N.A. |
| Ding et al. (2019)<br>FIO-MNR; QNLM | Describing methodologies of detecting and characterising microplastics in marine biota | December 2017 |
| Ding et al. (2019)<br>FIO-MNR; QNLM; State Key Laboratory of Marine Resource Utilization in South China Sea; Sansha Trackline Institute of Coral Reef Environment Protection; Menaul School (Qingdao) | Quantifying, identifying and characterizing microplastics in seawater, fish, and corals in the Paracel (Xisha) Islands | June 2017 |
| Feng et al. (2019)<br>Jiangsu Ocean Uni; Xiamen Uni; Lianyungang Environmental Monitoring Center of Jiangsu Province | Quantifying microplastics in tissues of wild fish from a mariculture area in Haizhou Bay | April 2018 |
| Fok et al. (2019)<br>Education Uni of Hong Kong; CAS Guangzhou | Meta-analysis of methodologies used by microplastic studies conducted in China | 2014-2019 |
| Gao et al. (2019)<br>FIO-MNR; QNLM; Qingdao Uni of Sci. and Tech. | Investigating sorption mechanism of heavy metals on microplastics, in simulated and field seawater systems | January 2016 |
| Guo & Wang (2019a)<br>Tsinghua Uni | Investigating properties of aged microplastics and the sorption mechanism of antibiotics (Sulfamethoxazole, sulfamethazine, cephalosporin) on it, in fresh and simulated seawater systems | N.A. |
| Guo & Wang (2019b)<br>Tsinghua Uni | Investigating properties of primary microplastics and the sorption mechanism of Strontium ion ($Sr^{2+}$) on it | N.A. |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Guo & Wang (2019c)<br><br>Tsinghua Uni | Reviewing microplastics (types, properties, distribution, degradation mechanism and resultant changes to properties), pollutants and their interactions, in marine and coastal environments | N.A. |
| Guo et al. (2019a)<br><br>Tsinghua Uni; Sichuan Normal Uni | Investigating sorption mechanism of common pollutant (antibiotic Sulfamethazine) on microplastics, in various conditions (pH and salinity) | N.A. |
| Guo et al. (2019b)<br><br>Tsinghua Uni | Investigating sorption mechanism of common pollutant (antibiotic Sulfamethoxazole) on microplastics, in various conditions (pH and salinity) | N.A. |
| Ho & Not (2019)<br><br>Uni of Hong Kong | Quantifying, identifying and characterising microplastic and macroplastic debris on a beach in Hong Kong and describe their distribution a nearshore environment | July to October 2016 |
| Ho & Leung (2019)<br><br>Hong Kong Baptist Uni; Shenzhen Virtual Uni Park | Investigating sorption mechanism of 2 organic UV filter on LDPE & PS polymer type microplastics, in single and multi-solute systems | N.A. |
| Huang et al. (2019)<br><br>South China Agricultural Uni | Quantifying abundance of microplastics in surface waters in the Spratly (Nansha) Islands | May 2018 |
| Ke et al. (2019)<br><br>Zhejiang Mariculture Research Institute; Wenzhou Fisheries Technology Extension Service; CSG Power Generation Co. Ltd.; CAS Guangzhou | Investigating toxicity of leachates from single-use PE bags on embryo and larvae development in wild clam (*Meretrix meretrix*) | N.A. |
| Li et al. (2019)<br><br>Guangxi Uni; Xiamen Uni | Quantifying, identifying and characterising microplastics in mangrove sediments in the Maowei Sea, and comparing between those near river estuaries and those near entrances of the sea, or those in the rhizosphere/non-rhizosphere sections of the mangrove sediments | ? |
| Li et al. (2019)<br><br>Tsinghua Uni | Investigating sorption of Triclosan on microplastics, in relation to particle size and solution chemistry | N.A. |
| Li et al. (2019)<br><br>Peking Uni Shenzhen Graduate School; Tsinghua Uni | Quantifying, identifying, and characterising microplastics in mangroves in Southern China | August 2017 |
| Liu et al. (2019a)<br><br>East China Normal Uni | Assessing existing and revealing novel methodology in accurate quantification of microplastics in the pelagic environment | April 2019 |
| Liu et al. (2019b)<br><br>Shandong Uni | Investigating sorption of 2 phthalate esters on 3 polymer types of microplastics, in relation to microplastics characteristics and solution chemistry | N.A. |
| Liu et al. (2019c)<br><br>East China Normal Uni; Georgia Institute of Tech. (USA) | Investigating sorption mechanism of hydrophobic organic compound (17β-Estradiol, E2) on 8 polymer types of microplastics (PA, HD/LLD-PE, PP, LD/MD-PE, PS, PC, PMMA, PVC) | N.A. |
| Liu et al. (2019d) | Investigating sorption mechanism of hydrophilic organic chemical (ciprofloxacin, CIP) on 2 polymer types of aged and virgin microplastics, in freshwater and seawater systems | N.A. |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Shanghai Ocean Uni; Shandong Uni; State Key Laboratory of Pollution Control and Resource Reuse, College of Environmental Science and Engineering; Shanghai Institute of Pollution Control and Ecological Security | | |
| Liu et al. (2019e)<br><br>Qingdao Uni; FIO-MNR; National Food Quality Supervision and Inspection Center (Beijing) | Investigating sorption mechanism of brominated flame retardants (tris-(2,3-dibromopropyl) isocyanurate, TBC, & hexabromocyclododecanes, HBCD) on microplastics, in seawater systems | N.A. |
| Lo et al. (2019)<br><br>City Uni of Hong Kong | Investigating spatial distribution, composition and source of hydrophobic organic compounds on sedimentary microplastics in Hong Kong | March to May 2017 |
| Luo et al. (2019)<br><br>East China Normal Uni; CAS Wuhan Institute of Hydrobiology | Quantifying and comparing microplastic pollution in freshwater bodies, rivers, and coastal waters in and around Shanghai | April to September 2017 |
| Mohsen et al. (2019)<br><br>CAS Qingdao Institute of Oceanology; QNLM; CAS Yantai Institute of Coastal Zone Research; Uni of CAS; CAS Qingdao Center for Ocean Mega-Science; Al-Azhar Uni (Egypt) | Quantifying microplastics in the intestines and coelomic fluid of farmed sea cucumbers (*Apostichopus japonicus*) in the Bohai Sea and Yellow Sea and adjacent sediments | November 2017, March to May 2018 |
| Mohsen et al. (2019)<br><br>CAS Qingdao Institute of Oceanology; QNLM; CAS Yantai Institute of Coastal Zone Research; Uni of CAS; CAS Qingdao; Al-Azhar Uni (Egypt) | Assessing the concentrations of heavy metals in the sediments and microplastics in the field; investigating correlations between concentrations of heavy metals in body wall of sea cucumbers, sediment and microplastics | 2017 to 2018 |
| Nie et al. (2019)<br><br>South China Agricultural Uni | Quantifying microplastics from surface waters and fish in the Spratly (Nansha) Islands | May 2018 |
| Pan et al. (2019)<br><br>Third Institute of Oceanography, State Oceanic Administration (Xiamen); Heriot-Watt Uni (UK) | Quantifying, identifying and characterising microplastics in surface seawaters in the northwestern Pacific, from around Taiwan, to the north of the Philippine Sea, to off the east coast of Japan | August to September 2017 |
| Ruan et al. (2019)<br><br>City Uni of Hong Kong; CAS Wuhan Institute of Hydrobiology | Quantifying microplastics and HBCD levels in 2 wastewater treatment plants of Hong Kong | July 2017 |
| Su et al. (2019)<br><br>East China Normal Uni; Uni of Melbourne (Australia); Royal Melbourne Institute of Technology Uni (Australia); CAS | Quantifying, identifying and characterising microplastics in various organs of commercial fish caught near the Yangtze Estuary, East China | October to November 2017 |
| Sun et al. (2019)<br><br>CAS Qingdao Institute of Oceanology;<br>Uni of CAS; CFAS Yellow Sea Fisheries Research Institute;<br>CAS Qingdao Center for Ocean Mega-Science; | Quantifying, identifying and characterising microplastics in the digestive tracts of benthic fish in the Yellow Sea | June 2016 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Sun et al. (2019)<br><br>Tianjin Uni; Ningbo Uni; Tianjin Agricultural Uni | Investigating toxicity of HDPE microplastics, with and without associated heavy metals (Cu, Cd, Pb), on growth in yellow seahorse (*Hippocampus kudas*) | N.A. |
| Teng et al. (2019)<br><br>CAS Yantai Institute of Coastal Zone Research; Uni of CAS; Shandong Marine Resource and Environment Research Institute | Quantifying, identifying and characterising microplastics in cultured oysters from along the coasts of China | March to May 2016 |
| Wan et al. (2019)<br><br>Xi'an Uni of Tech.; North China Electric Power Uni; Shaoxing Uni; Georgia Institute of Tech. (USA) | Investigating sorption mechanism of antibiotic (tetracycline) on microplastic polystyrene polymer type | N.A. |
| Wang et al. (2019)<br><br>Nanjing Uni; Nanjing Uni of Information Sci. and Tech | Estimating the total emissions of primary microplastics from China | 2015 |
| Wang et al. (2019)<br><br>Ocean Uni of China | Quantifying, identifying and characterising microplastics in sediments and benthic organisms from the South Yellow Sea | August to September 2017 |
| Wang et al. (2019)<br><br>Nanjing Uni; QNLM; Huaiyin Normal Uni; Marine Fisheries Research Institute of Jiangsu Province | Establishing a classification system for the quantitative analysis of microplastic sources, with a case study in the South China Sea | August 2017 |
| Wang et al. (2019)<br><br>Beijing Normal Uni; Dongguang Uni of Tech.; CAGS Institute of Mineral Resources; Michigan State Uni (USA) | Investigating size-effect on sorption of harmful organic compounds (phenanthrene, nitrobenzene) on PS polymer type microplastics | N.A. |
| Wang et al. (2019)<br><br>Beijing Normal Uni; Dongguan Uni of Tech.; CAGS Institute of Mineral Resources | Investigating sorption mechanism of harmful organic compounds (phenanthrene, nitrobenzene, naphthalene) on 5 polymer types of microplastics and mesoplastics | N.A. |
| Wang et al. (2019)<br><br>Ocean Uni of China; CAS Yellow Sea Fisheries Research Institute | Quantifying, identifying, characterising and comparing microplastics in sea water, sediments, cultured oysters (*Crassostrea gigas*) in Sanggou Bay, China, before and after a typhoon event | July, August 2017 |
| Wu et al. (2019)<br><br>Southern Uni of Sci. and Tech.; Hong Kong Baptist Uni; Zhejiang Uni of Tech. | Investigating sorption mechanism of 5 bisphenol analogues on PVC polymer type microplastics | N.A. |
| Yan et al. (2019)<br><br>South China Agricultural Uni | Quantifying, identifying and characterising microplastics along the downstream section of the Pearl River, comparing between the urban section in Guangzhou with the estuary section | December 2017 |
| Yao et al. (2019)<br><br>Wenzhou Medical Uni; Uni of California, Davis (USA) | Quantifying plastic debris in estuarine sediments and understanding vegetation as a sink for trapping plastic debris | December 2016 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Zhang (2017)<br><br>Key Laboratory of Coastal Zone Environmental Processes and Ecological Remediation; CAS Yantai Institute of Coastal Zone Research | Reviewing the physical processes involved in determining the fate and transport of microplastics in coastal areas | - |
| Zhang et al. (2019)<br><br>Xihua Uni; CAS Yantai Institute of Coastal Zone Research; Yantai Oil Spill Response Technical Center of Yantai Maritime Safety Administration; Shandong Marine Resource and Environment Research Institute | Quantifying, identifying and characterising microplastics in sediments in Sishili Bay, Yantai, Shandong | June 2017 |
| Zhang et al. (2019)<br><br>East China Normal Uni | Quantifying, identifying and characterising microplastics in wild fish and crustacean species obtained off the East China Sea, in relation to determining food-web transfer b | September 2017 |
| Zhang et al. (2019)<br><br>Zhejiang Uni; Guilin Uni of Tech.; Second Institute of Oceanography, State Oceanic Administration | Quantifying, identifying and characterising microplastics in sediments of the southern Yellow Sea and East China Sea | March 2017 |
| Zhang et al. (2019)<br><br>Shanghai Polytechnic Uni; Chinese Research Academy of Environmental Sciences | Quantifying, identifying and characterising in the surface waters of small estuaries in Shanghai | September, October 2018 |
| Zhang et al. (2019)<br><br>FIO-MNR; Qingdao Uni | Investigating sorption mechanism of 2 Polyhalogenated carbazoles (3,6-Dibromocarbazole(3,6-BCZ) and 1,3,6,8-Tetrabromocarbazole (1,3,6,8-BCZ)) on PP polymer type microplastics, in simulated seawater systems | N.A. |
| Zheng et al. (2019)<br><br>FIO-MNR; QNLM | Quantifying, identifying and characterising microplastics in Jiaozhou Bay, China | November 2017 |
| Zhu et al. (2019)<br><br>Beibu Gulf Uni; Guilin Uni of Tech.; Guangxi Uni | Quantifying microplastics ingested in 3 stranded individual Indo-Pacific humpback dolphins (*Sousa chinensis*) | 2015 |
| Zhu et al. (2019)<br><br>Shandong Uni | Investigate the effect of microplastic exposure on mortality, growth, and oxidative stress in a marine microalga (*Skeletonema costatum*), and its interaction effects with the antibacterial agent triclosan | - |
| Zhu et al. (2019)<br><br>CAFS; QNLM; Shanghai Ocean Uni | Quantifying, identifying and characterising microplastics in deep sea fishes from the northern continental slope of the South China Sea | March 2017 |
| Zhu et al. (2019)<br><br>Beibu Gulf Uni; Marine Environmental Monitoring Center of Guangxi; Shanghai Sci, and Tech. Museum; East China Normal Uni | Quantifying, identifying and characterising microplastics in surface water of the Maowei Sea, its upstream rivers and the cultured fish and oysters of Maowei Sea | October 2017 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Zhu et al. (2019)<br><br>CAS Guangzhou Institute of Geochemistry, CAS Guangzhou South China Sea Institute of Oceanology; South China Agricultural Uni; Uni of CAS | Quantifying, identifying and characterising plastic debris in marine birds from Yongxing Island, South China Sea | 2017 |
| Zuo et al. (2019)<br><br>CAS Guangzhou South China Sea Institute of Oceanology; Ministry of Environmental Protection South China Institute of Environmental Sciences; Uni of CAS | Investigating sorption mechanism of common PAH (phenanthrene) on biodegradable plastic bag-derived microplastics (poly(butylene adipate co-terephthalate), PBAT) | N.A. |
| Brook et al. (2018)<br><br>Uni of Georgia (USA) | Quantifying the effects of the Chinese import ban on plastic waste in terms of the likely volume of waste displaced, and also describe current global patterns of the plastic scrap and waste trade | 1988 to 2016 |
| Cai et al. (2018)<br><br>Xiamen Uni | Quantifying microplastics from surface waters in the South China Sea | April 2017 |
| Cheang et al. (2018)<br><br>Education Uni of Hong Kong | Quantifying, identifying and characterising microplastics in seabed sediments adjacent to coral communities in Hong Kong | March to April 2017 |
| Chen et al. (2018)<br><br>Ningbo Uni; CAS Ningbo Institute of Materials Technology and Engineering | Quantifying microplastics in the surface waters, intertidal sediments, and benthic sediments of Xiangshan Bay, Zhejiang, with a focus on potential mariculture origins | October 2017 |
| Cheung et al. (2018)<br><br>Education Uni of Hong Kong | Quantifying, identifying and characterising microplastics in wild and farmed flathead grey mullets obtained from local markets, originating from off the coast of Hong Kong | February to March 2017 |
| Cheung et al. (2018)<br><br>Uni of Hong Kong; Education Uni of Hong Kong | Quantifying, identifying and characterising plastics in surface waters of Hong Kong under the influence of the Pearl River Estuary, in relation to its seasonal distribution | February, July 2015 |
| Guo et al. (2018)<br><br>Northwest Agricultural and Forestry Uni; Anhui Uni of Sci. and Tech.; Ministry of Agriculture (Shaanxi) | Investigating desorption mechanism of common pollutant (Tylosin) on microplastics | N.A. |
| Leung et al. (2018)<br><br>Hong Kong Uni of Sci. and Tech. | Investigating impact of PS polymer type microplastics on the regeneration rate of polychaete, in simulated seawater systems | N.A. |
| Li (2015)<br><br>Education Uni of Hong Kong | Assessing the known distribution, sources, fates, and effects of microplastics in marine environments | - |
| Li et al. (2018)<br><br>East China Normal Uni; Shanghai Natural History Museum; Columbia Uni (USA); East China Uni of Sci. and Tech. | Developing density gradient solutions to measure the densities of unknown microplastics | - |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Li et al. (2018)<br><br>CAS Yantai Institute of Coastal Zone Research; Uni of CAS; Yantai Uni | Investigating properties of 5 microplastics and the sorption mechanism of 5 antibiotics (sulfadiazine, amoxicillin, tetracycline, ciprofloxacin, trimethoprim) on it, in freshwater and seawater systems | N.A. |
| Li et al. (2018)<br><br>Yangzhou Uni; CAS Yantai Institute of Coastal Zone Research; Yantai Uni | Quantifying the abundance of microplastics in coastal sediments of Qinzhou Bay, Guangxi | December 2016 |
| Li et al. (2018)<br><br>CAS Guangdong South China Sea Institute of Oceanology; CFAS Pearl River Fisheries Research Institute; Uni of CAS; South China Sea Branch of the State Oceanic Administration; East China Normal Uni; Duke Uni (USA) | Quantifying, identifying and characterising microplastics in wild oysters (*Saccostrea cucullata*) along the Pearl River Estuary in South China | July 2016 |
| Li et al. (2018)<br><br>CAS Yantai Institute of Coastal Zone Research; James Cook Uni (Australia); Catholic Uni of Louvain (Belgium) | Hydrodynamic modelling of microplastic distribution in the Bohai Sea, based on field samples | August to September 2016 |
| Lo et al. (2018)<br><br>City Uni of Hong Kong | Quantifying and comparing microplastic pollution on mudflats and sandy beaches in Hong Kong | June to September 2016 |
| Lo et al. (2018)<br><br>Hong Kong Uni of Sci. and Tech. | Investigating the effects of microplastic exposure in the larval and juvenile stages of slipper limpet (*Crepidula onyx*) | - |
| Luan et al. (2019)<br><br>Ocean Uni of China | Investigating toxicity of leachates from PS microplastics on larvae developments in cultured clam (*Meretrix meretrix*) | N.A. |
| Mai et al. (2018)<br><br>Jinan Uni | Quantifying, identifying and characterising microplastics in surface waters of Bohai and Huanghai Seas, China, and its affiliation with PAH | May, June 2017 |
| Qu et al. (2018)<br><br>East China Normal Uni; CAS Guangzhou South China Sea Institute of Oceanology; Qinzhou Uni | Quantifying, identifying, characterising and comparing microplastics in waters and in wild mussels along coastal waters of China and in laboratory-exposed mussels | March 2016 to June 2017 |
| Razanajatovo et al. (2018)<br><br>Jiangnan Uni; Jiangsu Collaborative Innovation Center of Technology and Material of Water Treatment, Suzhou | Investigating sorption mechanism of 3 pharmaceuticals (sulfamethoxazole (SMX), propranolol (PRP) and sertraline (SER)) on PE polymer type microplastics | N.A. |
| So et al. (2018)<br><br>Uni of Hong Kong | Quantifying, identifying and characterising microplastics (microbeads) in southern coastal waters of Hong Kong | February 2016 to April 2017 |
| Sun et al. (2018)<br><br>CAS Shenyang Qingdao Institute of Oceanology; QNLM; Uni of CAS; CAS Qingdao Institute of Oceanology | Quantifying microplastics in seawater and ingested in zooplankton from the Yellow Sea | August to September 2015 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Tang et al. (2018)<br><br>Xiamen Uni; CAS Yantai Institute of Coastal Zone Research; CAS Guangzhou South China Sea Institute of Oceanology; Zhejiang Agricultural and Forestry Uni | Quantifying, identifying and characterising microplastics in surface waters and sediments of Xiamen coastal areas, and its affiliation with PAH | March, April 2017 |
| Wang et al. (2018)<br><br>Nanjing Uni; Marine Fisheries Research Institute of Jiangsu Province | Quantifying, identifying and characterising microplastics in surface waters and sediments in an offshore wind farm in the Yellow Sea, north of the Yangtze River delta | September 2017 |
| Wang et al. (2018)<br><br>Jinan Uni | Discuss the chemicals detected in microplastics and known interaction mechanisms, as well as the potential uptake of chemicals from microplastics into marine organisms | - |
| Wang et al. (2018)<br><br>CAS Wuhan Botanical Garden; Sino-Africa Joint Research Center; Uni of CAS | Investigating sorption mechanism of a common PAH (pyrene) on PE, PES, PVC polymer types microplastics | N.A. |
| Wang et al. (2018)<br><br>Ningbo Uni | Investigating sorption mechanism of common PAH (phenanthrene) on microplastics obtained from mariculture farm in Xiangshan Bay, southeastern China | N.A. |
| Xiong et al. (2018)<br><br>CAS Wuhan; City Uni of Hong Kong, Uni of CAS | Quantifying, identifying and characterising microplastics in intestinal tracts of East Asian finless porpoises (*Neophocaena asiaeorientalis sunameri*) from Yellow Sea and Bohai Sea of China | Autumn 2015 |
| Xu et al. (2018)<br><br>East China Normal Uni | Establishing a risk assessment model for microplastics pollution in surface waters for revealing areas of high risk and hotspots, with a case study in the Changjiang Estuary and the adjacent East China Sea | August 2017 |
| Xu et al. (2018)<br><br>Zhejiang Uni | Investigating sorption of antibiotic (tetracycline) on microplastics in the presence of dissolved organic matter, | N.A. |
| Xu et al. (2018)<br><br>Zhejiang Uni | Investigating sorption mechanism of antibiotic (sulfamethoxazole) on PE polymer type microplastics | N.A. |
| Zeng et al. (2018)<br><br>Jinan Uni | Discussing the abundances and characteristics of microplastics in wastewater treatment plants, discharged into both rivers and marine environments | - |
| Zhang et al. (2018)<br><br>Zhejiang Agriculture and Forestry Uni; CAS Nanjing Institute of Soil Science; CAS Yantai Institute of Coastal Zone Research | Investigating sorption mechanism of antibiotic (oxytetracycline) on PS polymer type, beached and virgin microplastics | N.A. |
| Zhang et al. (2018)<br><br>Zhejiang Agriculture and Forestry Uni; CAS Yantai Institute of Coastal Zone Research; Helmholz-Zentrum Geesthacht, | Measuring levels of plastic additives (organophosphorus esters and phthalates) on microplastics on beaches in the Bohai and Yellow Seas | June to July 2015 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Institute of Coastal Research (Germany); Uni of CAS; MINJIE Analytical Laboratory (Germany) | | |
| Zhang et al. (2018)<br><br>Qingdao Uni; FIO-MNR | Investigating sorption mechanism of 3 synthetic musks on PP polymer type microplastics, in simulated seawater systems | N.A. |
| Zhao et al. (2018)<br><br>East China Normal Uni | Summarising and comparing existing methods for quantifying microplastics in marine environments | - |
| Zhao et al. (2018)<br><br>CAS Yantai Institute of Coastal Zone Research; Yantai Oil Spill Response Technical Center of Yantai Maritime Safety Administration | Quantifying, identifying and characterising microplastics in benthic sea sediments in the Bohai Sea and Yellow Sea | June to July 2016 |
| Zhou et al. (2018)<br><br>CAS Yantai Institute of Coastal Zone Research; Zhejiang Agriculture and Forestry Uni | Quantifying, identifying and characterising microplastics in beach soils along Shandong Province, facing the Bohai and Yellow Seas | April, May 2015 |
| Zhu et al. (2018)<br><br>CAFS Yellow Sea Fisheries Research Institute; QNLM | Quantifying, identifying and characterising microplastics in the waters and sediments of the North Yellow Sea | October 2016 |
| Cheung & Fok (2017)<br><br>Uni of Hong Kong; Education Uni of Hong Kong | Characterising and quantifying the amount of microbeads in facial scrubs, and estimating the emissions of microbeads from facial scrubs in China based on consumer usage data | - |
| Fok et al. (2017)<br><br>Education Uni of Hong Kong; South China Agricultural Uni | Quantifying sizes of small plastic pieces on beaches in Guangdong | July 2015 |
| Hu et al. (2017)<br><br>Air Force Logistics College, Jiangsu; Huangshan Uni | Investigating sorption mechanism of lubrication oil on PS and PE polymer types microplastics | N.A. |
| Jabeen et al. (2017)<br><br>East China Normal Uni; National Environmental Monitoring Center (Dalian) | Quantifying, identifying and characterising microplastic and mesoplastic in marine and freshwater fishes obtained from fishery markets | May to December 2015 |
| Peng et al. (2016)<br><br>Guangdong Uni of Tech. | An overview of the occurrence, fate, and risks of microplastics to the environment | - |
| Peng et al. (2017)<br><br>East China Normal Uni; Shanghai Jiao Tong Uni | Quantifying, identifying and characterising microplastics in sediments along the Changjiang Estuarine system | September 2015 |
| Sun et al. (2017)<br><br>CAS Institute of Oceanology; Uni of CAS; QNLM | Quantifying, identifying and characterising microplastics ingested by natural zooplankton groups in the northern South China Sea | June 2015 |
| Tsang et al. (2017)<br><br>The Chinese Uni of Hong Kong; The Open Uni of Hong Kong | Quantifying, identifying and characterising microplastics in surface waters and sediments in various coastal regions of Hong Kong | June, July, November, March 2015 to 2016 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Xu et al. (2017)<br>City Uni of Hong Kong | Investigating the effects of microplastic exposure on clearance rate (prey ingestion), absorption efficiency, and respiration rate in the marine clam (*Atactodea striata*), and examining the reduction of microplastics accumulation following depuration | - |
| Zhang et al. (2017)<br>National Marine Environmental Monitoring Center, Dalian; Ocean Uni of China; FIO-MNR | Quantifying, identifying and characterising microplastics in the surface waters of the Bohai Sea, China | August 2016 |
| Zhang et al. (2017)<br>Ocean Uni of China | Investigate the effect of microplastic exposure on growth and photosynthesis rate of marine microalgae (*Skeletonema costatum*), controlling for the effect of shading | - |
| Zhu et al. (2017)<br>Nankai Uni | Quantifying HBCD levels in soil, plants, and marine organisms found near an EPS manufacturing plant | September 2014, March 2015 |
| Cheung & Fok (2016)<br>Education Uni of Hong Kong | Test the hypothesis that microbeads found on the sea surface Hong Kong could have originated from personal care products | February, July 2015 |
| Cheung et al. (2016)<br>Hong Kong Institute of Education | Quantifying the abundance of microplastics on beaches in Hong Kong | July to September 2014, January to March 2015 |
| Li et al. (2016)<br>East China Normal Uni; National Marine Environmental Monitoring Center | Quantifying, identifying and characterising microplastics in wild and farmed mussels (*Mytilus edulis*) along coast of China | July to October 2015 |
| Li et al. (2016)<br>Hong Kong Institute of Education | Reviewing plastic waste in marine environments, in relation to its sources, occurrence and effects | N.A. |
| Li et al. (2016c)<br>CAS (Guangzhou); Duke Uni | Investigating toxicity of leachates from 7 types of plastics on *Amphibalanus amphitrite* barnacle larvae survival and settlement | N.A. |
| Qiu. Et al. (2016)<br>Guangdong Uni of Tech.; Dongguang Environmental Monitoring Central Station | Reviewing techniques used in extracting, quantifying, and identifying microplastics from sediments, seawater, and organisms, and discussing the relative advantages and challenges. | - |
| Wang et al. (2016)<br>Guangdong Uni of Technology; Dongguang Environmental Monitoring Central Station | Reviewing physical, chemical, and biological behaviors of microplastics in the marine environment, and identify key areas for future research | - |
| Yu et al. (2016)<br>Ningbo Uni; Guangdong Uni of Tech.; Coastal Carolina Uni | Quantifying, identifying and characterising microplastics in the beach sand of the north Bohai Sea | July 2015 |
| Zhan et al. (2016)<br>South China Agricultural Uni; Guangdong Uni of Tech. | Investigating sorption mechanism of a common PCB (3,3′,4,4′-tetrachlorobiphenyl) on PP polymer types microplastics, in simulated seawater systems | N.A. |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Zhou et al. (2016)<br><br>Qufu Normal Uni; National Marine Environmental Forecasting Center, Beijing | Quantifying, identifying and characterising macrodebris, including plastics, on beaches, coastal surface waters, and seafloor on the coast of China | 2007 to 2014 |
| Fok & Cheung (2015)<br><br>Hong Kong Institute of Education | Quantifying the abundance of microplastics on beaches in Hong Kong | July to September 2014 |
| Li et al. (2015)<br><br>East China Normal Uni; Donghua Uni | Quantifying, identifying and characterising microplastics in 9 species of commercial bivalves from local fishery market in Shanghai, China | N.A. |
| Qiu et al. (2015)<br><br>Guangdong Uni of Tech.; Clemson Uni | Quantifying, identifying and characterising microplastics in sediments on 5 beaches in China | May to June 2014 |
| Wang et al. (2015)<br><br>Uni of Hong Kong | Investigating sorption mechanism of 2 perfluorochemicals (perfluorooctanesulfonate (PFOS) and perfluorooctanesulfonamide (FOSA)) on microplastics of polymer types PE, PS, PVC | N.A. |
| Yang et al. (2015)<br><br>East China Normal Uni; Donghua Uni | Quantifying, identifying and characterising microplastics in commercial table salt from China | October, November 2014 |
| Zhang et al. (2015)<br><br>Ocean Uni of China; National Marine Environmental Monitoring Center (Dalian); China Protection Association of Environment and Industry; FIO-MNR | Quantifying POPs on plastic resin pellets on sandy beaches in the Bohai Sea | July 2012 |
| Zhao et al. (2015)<br><br>East China Normal Uni | Quantifying, identifying and characterising small plastics on 6 tourism beaches around the South China Sea | April to May 2014 |
| Zhao et al. (2015)<br><br>East China Normal Uni | Quantifying, identifying and characterising microplastics in 3 urban estuaries leading to the East China Sea | July 2013 |

Table 4. List of published work identified and examined in this study for RO Korea, where total literature examined is 67.
Note abbreviations: Korea Institute of Ocean Science and Technology (KIOST); Korea Uni of Science and Technology, Korea (UST); Our Sea of East Asia Network (OSEAN)

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Chae et al. (2019)<br><br>Konkuk Uni | Examining the effect of relative size of polyethylene microspheres to a marine algae *Dunaliella salina* on its growth, photosynthetic activity, and cell morphology | N.A. |
| Chae et al. (2019)<br><br>Konkuk Uni; KIOST Oil and POPs Research Group; UST | Examining the effect of EPS leachate on photosynthetic activity of four marine algae species | N.A. |
| Cho et al. (2019)<br><br>KIOST Oil and POPs Research Group; UST | Quantifying microplastics in bivalves destined for human consumption bought in South Korean markets | February, March 2017 |
| Kim and An (2019)<br><br>Konkuk Uni | Designing a vacuum-based method of separating low-density PE films by size | N.A. |
| Lee et al. (2019)<br><br>Korea Uni ; Incheon National Uni | Measuring rate of transfer of HOCs from a polyethylene film onto simulated fish intestinal fluid | N.A. |
| Lee et al. (2019)<br><br>OSEAN Korea Marine Litter Institute | Conducted rapid assessment of marine debris on the coasts of RO Korea using a visual scoring indicator | April, June, August, October 2017 |
| Yoon et al. (2019)<br><br>Mokpo National Uni ; Daegu Uni | Design and identify an effective suction mode for separating marine plastic debris from floatsam of other materials in a mobile floating debris collection system, for recycling into solid fuel | N.A. |
| Choi and Lee (2018)<br><br>Korea Uni; Korea Maritime and Ocean Uni | Estimate willingness to pay for removing microplastics from the ocean based on public perceptions in Seoul | N.A. |
| Hong et al. (2018)<br><br>KIOST ; UST | Provide an overview of the chemicals found to be associated with marine debris and microplastics, as a chapter in a book. | N.A. |
| Jang et al. (2018)<br><br>KIOST Oil and POPs Research Group; UST | Observing ingestion and fragmentation of EPS debris (styrofoam fishing buoy-derived) in marine polychaetes, in the field and in laboratory conditions | August to December 2014 |
| Jeong et al. (2018)<br><br>Sungkyunkwan Uni; National Institute of Fisheries Science; Xiamen Uni (China) | Investigate effects of micro- and nano-plastic ingestion on oxidative stress and multixenobiotic resistance in the monogont rotifer *Brachionus koreanus* | N.A. |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Khim et al. (2018)<br><br>Seoul National Uni; Chungnam National Uni; Anyang Uni; Northwest Pacific Action Plan Marine Environmental Emergency Preparedness and Response; Korea Research Institute of Ships and Ocean Engineering | Examined several measures of ecosystem health in coastal environments, including marine litter | 1970 to 2017 |
| Lee et al. (2018)<br><br>Korea Uni ; Ajou Uni | Model desorption of HOCs from PE and PP films and measure HOC diffusion coefficients in plastic | N.A. |
| Lee et al. (2018)<br><br>Korea Uni ; Ajou Uni | Measure and model desorption rates of HOCs from PE and PP microplastic fragments of irregular sizes | N.A. |
| Shim et al. (2018)<br><br>KIOST | Provide an overview of the abundance, spatial, and temporal distributions of microplastics in the marine environment (as an introductory chapter in a book) | N.A. |
| Song et al. (2018)<br><br>KIOST Oil and POPs Research Group; UST; Kyushu Uni | Characterising the vertical distribution of microplastics in near-coastal waters of RO Korea | July to August 2016 and 2017 |
| Eo et al. (2018)<br><br>KIOST Oil and POPs Research Group; UST; OSEAN Korea Marine Litter Institute | Quantifying abundance of microplastics on sandy beaches in RO Korea | March, May 2016 |
| Hong et al. (2017)<br><br>KIOST Oil and POPs Research Group; Korea Uni of Sci. and Tech. | Review methods used to analyse chemicals associated with microplastic debris | Up to July 2016 |
| Hong et al. (2017)<br><br>OSEAN Korea Marine Litter Institute; Korea Naval Academy | Quantifying entanglement records of ALDFG on ships of RO Korea's navy | 2010 to 2015 |
| Jang et al. (2017)<br><br>KIOST Oil and POPs Research Group; UST | Measuring HBCD levels in expanded polystyrene debris on Asia-Pacific coasts | 2013 to 2015 |
| Jeong et al. (2017)<br><br>Sungkyunkwan Uni ; Hanyang Uni ; Université de Lille (France) ; French National Centre for Scientific Research (France) ; Université Littoral Cote d'Opale (France) | Measure ingestion and egestion rates of PS microbeads in a copepod *Paracylcopina nana,* examine impacts on development time, fecundity, and reactive oxygen species levels, and propose a molecular pathway for toxic impacts of PS involving an oxidative stress response pathway | N.A. |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Kwon et al. (2017)<br>Korea Uni; KIOST Oil and POPs Research Group | Review and commentary on microplastics as vectors for hydrophobic organic additives | N.A. |
| Lee and Kim (2017)<br>Mokpo National Maritime Uni | Estimating the amount of microplastics discharged into the environment per year in RO Korea | N.A. |
| Lee et al. (2017)<br>OSEAN Korea Marine Litter Institute; Pukyong National Uni; KIOST Oil and POPs Research Group; UST | Quantifying meosplastic on beaches of RO Korea | N.A. |
| Raini et al. (2017)<br>KIOST Oil and POPs Research Group; UST | Quantifying absorption and desorption of HBCDs by EPS in the field and in laboratory experiments | N.A. |
| Rani et al. (2017)<br>KIOST Oil and POPs Research Group; UST | Quantifying levels of ultraviolet stabilizers and antioxidants in beached plastic marine debris, compared to new products | March 2014 |
| Song et al. (2017)<br>KIOST Oil and POPs Research Group; UST | Measuring the rate of fragmentation of LDPE, PP, and EPS by UV and physical abrasion, and characterising the size distribution of the resulting particles over time, through a laboratory simulation experiment | N.A. |
| Hong et al. (2016)<br>Seoul National Uni; Institute of Environmental Protection and Safety, NeoEnBiz Co. (RO Korea); Uni of Saskatchewan (Canada); Michigan State Uni (USA); Uni of Hong Kong (China); Nanjing Uni (China) | Quantifying styrene oligomers in coastal sediments of Lake Shihwa, RO Korea, and assess aryl hydrocarbon receptor binding affinity of styrene oligomers | April, 2015 |
| Jang et al. (2016)<br>KIOST Oil and POPs Research Group; UST | Measuring HBCD levels in mussels adhering to polystyrene buoys | September, October 2013 |
| Jeong et al. (2016)<br>Sungkyunkwan Uni; Hanyang Uni; KIOST Marine Chemistry and Geochemistry Research Center; National Fisheries Research and Development Institute; Chinese Academy of Sciences Institute of Hydrobiology (China); Université de Lille (France); French National Centre for Scientific Research (France); Université Littoral Cote d'Opale (France); | Measure ingestion and egestion rates of PS microbeads in a rotifer *Brachionus koreanus*, examine impacts on development time, fecundity, survival, and levels of molecules involved in an oxidative stress response pathway, and propose a molecular pathway for toxic impacts of PS | N.A. |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Shim et al. (2016)<br><br>KIOST Oil and POPs Research Group; UST | Developing a method for staining and identifying microplastics using Nile Red and fluorescence microscopy | N.A. |
| Al-Odaini et al. (2015)<br><br>KIOST Oil and POPs Research Group; UST | Identifying the spatial distribution and source of HBCDs in Jinhae and Masan Bay | March, 2010 and May 2012 |
| Chae et al. (2015)<br><br>Incheon National Uni; KIOST Oil and POPs Research Group; UST | Quantifying microplastics in near-shore surface seawaters of Incheon/Kyeonggi region | August 2013 |
| Hong et al. (2015)<br><br>OSEAN Korea Marine Litter Institute; Pukyong National Uni | Evaluate the cost-effectiveness of three derelict fishing gear programmes (cleanup with ships, buy back, floating reception barge) in RO Korea using an energy accounting method | N.A. |
| Jang et al. (2015)<br><br>Pukyong National Uni; APEC Climate Center; OCEANTECH CO. | Present an unmanned and automated technique to remotely monitor beach debris through camera and drone surveillance and image identification software | January to December 2013 |
| Kang et al. (2015)<br><br>KIOST South Sea Research Institute; KIOST Pacific Ocean Research Center; KIOST Oil and POPs Research Group; UST | Sampling and quantifying floating microplastics in Geoje Bay, near mouth of Nakdong River | May and July 2012 |
| Kang et al. (2015)<br><br>KOIST South Sea Research Institute; KIOST Oil and POPs Research Group; UST | Quantify and compare the amount of microplastics with the amount of zooplankton in Geoje and Jinhae Bays, RO Korea, to assess potential microplastic ingestion risk to zooplanktivores | May, June, July 2013 |
| Kim et al. (2015)<br><br>Korea Uni | Estimating the volume of HDPE and LDPE released by RO Korea into the marine environment | 1995 to 2012 |
| Kim et al., (2015)<br><br>Incheon National Uni ; Inha Uni | Examining the effect of location on the spatial distribution of microplastics on sandy beaches in RO Korea | July 2013 |
| Kwon et al. (2015)<br><br>Chosun College of Science and Tech.; Nihon Uni (Japan); Chonnam National Uni; National Institute of Advanced Industrial Sci. and Tech.; Hanyang Uni | Quantifying the concentrations and determining the spatial distributions of artificial styrene oligomers derived from PS in a long-term global monitoring study, and observing leaching of styrene oligomers from weathered PS virgin pellets | 2003 to 2013 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
| --- | --- | --- |
| Lee et al. (2015)<br><br>OSEAN Korea Marine Litter Institute; KIOST Oil and POPs Research Group; UST; Pukyong National Uni | Quantifying and characterising the spatial distribution of marine debris on RO Korean beaches, across the country and on individual beaches | April and May, 2013 and 2014 |
| Lee et al. (2015)<br><br>OSEAN Korea Marine Litter Institute; Pukyong National Uni; KIOST Oil and POPs Research Group; UST | Developing policy ideas for managing styrofoam buoy debris in participatory workshops | 2011, 2012 |
| Rani et al. (2015)<br><br>KIOST Oil and POPs Research Group; UST | Quantifying levels of additives in plastic marine debris, compared to new products | March 2014 |
| Song et al. (2015)<br><br>KIOST Oil and POPs Research Group; UST; OSEAN Korea Marine Litter Institute | Comparing the accuracy of microplastic identification solely with microscopes vs with spectroscopy | May, July 2012 |
| Song et al. (2015)<br><br>KIOST Oil and POPs Research Group; UST | Quantifying microplastic debris on the sea surface microlayer of Jinhae Bay | June 2013 |
| Hong et al. (2014)<br><br>OSEAN Korea Marine Litter Institute; Kyungnam Uni | Quantifying marine debris on 13 beaches in Tongyeong City | Autumn 2013 |
| Hong et al. (2014)<br><br>OSEAN Korea Marine Litter Institute; Pukyong National Uni; KIOST Oceanographic Data and Information Center; Gyeongsang National Uni | Quantifying marine debris on beaches throughout RO Korea | March 2008 to November 2009 |
| Jang et al. (2014)<br><br>Pukyong National Uni; OCEANTECH CO.; Tongmyong Uni | Modelling behaviour of floating debris in the Nakdong River basin through tracking buoys, estimating output of marine debris from the river to the ocean, and identifying hotspots of accumulation within the river | July to August 2012 and July to August 2013 |
| Jang et al. (2014)<br><br>OSEAN Korea Marine Litter Institute; KIOST Oil and POPs Research Group; UST | Estimate lost tourism revenue due to a marine debris pollution event in Geoje Island | July 2011 |
| Jang et al. (2014) | Estimate the amount of marine debris in RO Korean waters, extrapolating from field surveys (both local and from other countries) | 2012 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| OSEAN Korea Marine Litter Institute; Korea Maritime Institute; KIOST Oceanographic Data and Information Center; Korea Marine Environment Management Corporation | | |
| Jang et al. (2014)<br><br>OSEAN Korea Marine Litter Institute; KIOST Oil and POPs Research Group; UST | Identifying the main source (land-based or sea-based) of marine plastic debris on beaches in RO Korea, through assigning probabilistic scores to individual debris items | Spring 2013 |
| Lee et al. (2014)<br><br>Korea Uni; KIOST Oil and POPs Research Group | Evaluating sorption capacity of 3 types of microplastics for hydrophobic organic chemicals in seawater | N.A. |
| Rani et al. (2014)<br><br>KIOST Oil and POPs Research Group; UST | Quantifying levels of HBCDs in a variety of polystyrene products | N.A. |
| Saido et al. (2014)<br><br>National Institute of Advanced Industrial Sci. and Tech.; Nihon Uni (Japan); Shizuoka Uni (Japan); Korea Institute of Toxicology; Chonnam National Uni; Toyama Prefecture Uni (Japan); Uni of Tokyo (Japan) | Quantifying and characterising the distribution of styrene oligomers on sandy beaches of Japan and RO Korea | 2010 to 2012 |
| Song et al. (2014)<br><br>KIOST ; UST | Quantifying microplastics on the sea surface microlayer around Geoje Island and Nakdong river mouth | May, July 2012 |
| Heo et al. (2013)<br><br>KIOST Oil and POPs Research Group; UST; OSEAN Korea Marine Litter Institute | Quantifying mesoplastic on Heungnam beach, Geoje Island, and comparing differences in result when measuring along the cross-sectional line or the high strandline | February 2011 |
| Hong et al. (2013)<br><br>OSEAN; Chungnam Wild Animal Rescue Center; Migratory Birds Center of National Park Research Institute; PGA Wetland Ecology Institute; KIOST Oil and POPs Research Group; Pukyong National Uni | Recording instances of plastic marine debris entanglement and ingestion on marine animals in RO Korea | 2003 to 2012 |
| Hong et al. (2013)<br><br>KIOST; Ramkhamhaeng Uni (Thailand); Uni of the Philippines (Philippines); East China Normal Uni (China) | Quantifying PCB levels in bottom sediments of coral reefs in Thailand and observing the leaching of PCBs from various plastics in seawater in laboratory conditions | June 2010 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Jang & Song (2013)<br><br>Information unavailable | Assessing the rationality/potential efficiency of RO Korea's current marine debris policies, which focus largely on cleanup | 2009 |
| Lee et al. (2013)<br><br>OSEAN; KIOST Oil and POPs Research Group; UST; Pukyong National Uni | Quantifying micro-, meso-, and macroplastic debris found on beaches in Geoje Bay, and correlating the abundance of debris in the three size classes | May and September 2012 |
| Lee et al. (2013)<br><br>KISOT South Sea Environment Research Department; KIOST Oil and POPs Research Group | Investigating effects of 3 sizes of polystyrene microbeads on the survival, development, and fecundity of a copepod (*Tigriiopus japaonicus*) across two generations | N.A. |
| Jung et al. (2010)<br><br>Uni of Ulsan; KIOST Maritime and Ocean Engineering Research Institute; Korea Institute of Machinery and Materials | Presenting technological interventions developed in RO Korea to prevent, capture, and recycle marine debris, through floating capture bongs and trawling | 1999 to 2010 |
| Cho (2009)<br><br>Korea Maritime Institute | Review and discuss the potential effectiveness of the RO Korean government's incentive programme for fishermen to collect marine debris | 2003 to 2006 |
| Lee et al. (2006)<br><br>Chonnam National Uni | Sampling marine litter on the sea bed of the East China Sea and South Sea of RO Korea | 1996 to 1997, 2002 to 2005 |
| Cho (2005)<br><br>Korea Maritime Institute | Review the impact of marine debris in RO Korea and the practices, policies, and challenges for managing marine debris, with a focus on ALDFG | up to around 2003 |
| Jo et al. (2005)<br><br>Gangwon Provincial Uni; Yosu National Uni | Sampling floating marine debris in the near-shore waters of Gangwon | May, August 2004 |
| Kim et al. (2005)<br><br>Pukyong National Uni; Korea Institute of Marine and Fisheries Tech. | Sampling floating marine debris in the East Sea of RO Korea (Sea of Japan) | July 2003 |

Table 5. List of published work identified and examined in this study for Japan, where total literature examined is 30.

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Amamiya et al. (2019)<br><br>Nihon Uni; Chonnam National Uni (Korea); Seoul National Uni (Korea); Chosun College of Sci. and Tech. (Korea) | Assess the possible transport routes of polystyrene plastic from land to the ocean along the coastline of Tokyo Bay | Aperiodic sampling from August 2008 to May 2011 |
| Isobe et al. (2019)<br><br>Kyushu Uni; Civil Engineering Research Institute for Cold Region; Tokyo Uni of Marine Sci. and Tech. | Quantify the microplastic abundance in the present and future ocean environment, by mapping out the abundance of pelagic microplastics through a transoceanic survey across a meridional transect from the Southern Ocean to Japan; Predicting future abundance of pelagic microplastics over the Pacific Ocean using a numerical model | 2016 |
| Jamieson et al. (2019)<br><br>Newcastle Uni (UK); Uni of Aberdeen (UK); Scottish Marine Institute (UK) | Examine the extent of microplastic and microfibre pollution across some of the deepest points of the ocean, specifically investigated the presence of ingested microplastic fibres and fragments in the hindgut of lysianassoid amphipods across multiple hadal trenches around the Pacific Rim | 2008 to 2017 |
| Kinjo et al. (2019)<br><br>Uni of Tokyo; Tokyo Uni of Agriculture and Tech. | Investigate the length of time where ingested microplastics (of 3 different sized polystyrene microspheres) are retained in their digestive tracts of Mediterranean mussels | N.A. |
| Tanaka et al. (2019)<br><br>Tokyo Uni of Agriculture and Tech.; Wageningen Marine Research (The Netherlands); Yamashina Institute for Ornithology | Understand the impacts of marine organisms ingesting plastics exposed to hazardous chemicals, by identifying the compounds found on plastics fragments to which seabirds potentially have substantial exposure | Sampling in 2010 and 2015 |
| Chiba et al. (2018)<br><br>Japan Agency for Marine-Earth Science and Tech.; UNEP World Conservation Monitoring Center (UK); Marine Works Japan, Ltd. | Develop database to capture deep-sea debris information; Examine archives of photographs from dives by deep-sea submersibles and remotely operated vehicles; Assess the quantity, debris types, and impacts on deep-sea ecosystem | 1983 to present-day |
| Maximenko et al. (2018)<br><br>Uni of Hawaii, Manoa (USA); Japan Agency for Marine-Earth Science and Tech.; US National Oceanic and Atmospheric Administration (USA) | Simulate the movement of floating debris generated by the Great Japan Tsunami of 2011 using a suite of five ocean models | 2011 |
| Iwasaki et al. (2017)<br><br>Kyushu Uni; Kagoshima Uni; Tokyo Uni of Marine Sci. and Tech. | Establish a model to visualise the transport process of small plastic fragments in the Sea of Japan | N.A. |
| Matsuguma et al. (2017)<br><br>Tokyo Uni of Agriculture and Tech.; Tokyo Uni of Pharmacy and Life Sciences; Environmental Research and Training Center (Thailand); Uni of Malaya (Malaysia); Natural Resources and the Environment, Council for Science and Industrial Research (South Africa) | Assess the microplastic polymer types in sediment cores collected in the marine environment in parts of Asia and Africa; Provide a quantitative evaluation of the role of sediment as a sink for microplastics in marine ecosystems in these areas; Demonstrate the utility of sediment cores for understanding history of and trends in microplastic pollution | Sampling took place between 2004 and 2012 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Sagawa et al. (2018)<br><br>Ehime Uni | Conduct comparative surveys of microplastics in three zones of coastal seas of Japan; Examine the abundance and size of microplastics, as well as their polymer types in a coastal sea; Compare across the bottom sediment, beach sediment, and surface water; Deduce sinking and fragmentation process of foamed polystyrene (FPS) plastics | August to September 2016, January, April 2017 |
| Isobe (2016)<br><br>Kyushu Uni | Compare and provide a conservative estimate of the quantity of microbeads with the quantity of pelagic microplastics potentially degraded in the coastal waters of Japan | September to October 2015 |
| Nakashima et al. (2016)<br><br>Ehime Uni | Investigate the potential of long-distance oceanic transport and leaching of additive-derived Pb from the PVC fishing floats on beaches | N.A. |
| Tanaka and Takeda (2016)<br><br>Tokyo Uni of Agriculture & Tech. | Survey of microplastics abundance, distribution and types found in planktivorous fish from urban coastal waters of Japan | August 2015 |
| Goto and Shibata (2015)<br><br>Iwate Fisheries Tech. Center; Kitasato Uni | Assess the abundance and composition of anthropogenic marine debris on the basis of six bottom trawl surveys on the continental slope off Iwate Prefecture between pre- and post-earthquake period | April to June, November 2003, May, November 2004, June, November 2011 |
| Isobe et al. (2015)<br><br>Kyushu Uni; Tokyo Uni of Marine Sci. and Tech. | Assess the concentrations and properties of pelagic micro- and meso-plastics in the East Asian seas around Japan | July to September 2014 |
| Kataoka and Hinata (2015)<br><br>National Institute for Land and Infrastructure Management; Ehime Uni | Understand how beach cleanup effects may influence the properties of marine plastics (i.e. leaching of toxic metals or fragmentation), by establishing a method for evaluating beach cleanup effects based on a linear system analysis | N.A. |
| Kataoka et al. (2015)<br><br>National Institute for Land and Infrastructure Management; Ehime Uni; Toyohashi Uni of Tech. | Understand the behaviour of backwashed floats in high wave events, by assessing the backwash process based on analysis of 2-year mark-recapture experiments, as well as nearshore current structures revealed by sequential images taken by webcam | 2011 |
| Tanaka et al. (2015)<br><br>Tokyo Uni of Agriculture and Tech.; Hokkaido National Fisheries Research Institute; Hokkaido Uni | Investigate the transfer and leaching rates of polybrominated diphenyl ethers (PBDEs) from plastics to digestive fluids of seabirds off northern North Pacific Ocean | June to July, 2008 to 2010 and May to July, 2010, 2011 |
| Isobe et al. (2014)<br><br>Kyushu Uni; Ehime Uni; Kagoshima Uni; Kochi Uni; Saga Uni | Assess the occurrence (distribution and abundance) of small plastic fragments in the Seto Inland Sea, Japan using field surveys and a numerical particle-tracking model | 2010 to 2012 |
| Kataoka et al. (2013)<br><br>National Institute for Land and Infrastructure Management; Toyohashi Uni of Tech. | Understand the beach response to the time-variant/invariant inputs, by considering the Wadahama Beach as a linear black box and calculate the unit response impulse (UIR) of target litter items based on MR experiments to acquire an overall understanding of the beach response to marine litter input regardless of seasonality and positions of individual items. | 2011 |
| Tanaka et al. (2013) | Investigate the accumulation of plastic-derived chemicals in tissues of seabirds ingesting marine plastics; Examine the polybrominated diphenyl ethers (PBDEs) in abdominal adipose | June to July 2015 |

| Published Peer-Reviewed Work/Research Team | Aim of Research | Period of Study |
|---|---|---|
| Tokyo Uni of Agriculture and Tech.; Hokkaido National Fisheries Research Institute; Hokkaido Uni | tissues of oceanic seabirds collected in the northern North Pacific Ocean; Compare levels with ingested plastic debris found in stomachs of seabirds | |
| Kataoka et al. (2012)<br><br>National Institute for Land and Infrastructure Management; Ehime Uni | Assess a method for detecting plastic pixels of any colour and computing the beach area covered with plastic debris using photographs taken by a webcam | November 2010 to May 2011 |
| Nakashima et al. (2012)<br><br>Ehime Uni | Estimate potential risk of toxic metals that could leach into a beach environment from plastic litter washed ashore on Ookushi Beach, Goto Islands, Japan using balloon aerial photography, in situ beach surveys, and leaching experiments | October 2009 |
| Hirai et al. (2011)<br><br>Tokyo Uni of Agriculture & Tech.; Uni of the Philippines (Philippines); Algalita Marine Research Foundation (USA); Woods Hole Oceanographic Institution (USA); Sea Turtles Forever (USA) | Understand the spatial variation in concentrations and compositions of organic micropollutants in marine plastic debris and their sources | Sampling took place between 2005 and 2009 |
| Kako et al. (2011)<br><br>Ehime Uni; Sanyo Techno Marine, Inc., National Institute for Land and Infrastructure Management; Kyushu Uni; Japan Environment Action Network | Establish a system for hindcasting/forecasting the quantity of litter reaching a beach using ocean circulation model, a two-way particle tracking model (PTM) to find litter sources, and an inverse method to compute litter outflows at each source | September 2007 to September 2009 |
| Yamashita et al. (2011)<br><br>Tokyo Uni of Agriculture and Tech.; Hokkaido National Fisheries Research Institute; Hokkaido Uni | Assess the presence/absence of plastics in stomach, types of plastics, as well as the physical and chemical effects (i.e. PCBs) of ingested plastics on short-tailed shearwater seabirds | June to July 2003, June to July 2005 |
| Endo et al. (2005)<br><br>Tokyo Uni of Agriculture & Tech.; Tokyo Uni of Marine Science and Tech.; Hokkaido Uni; Tokuyama Corporation | Assess the concentrations of polychlorinated biphenyls (PCBs) in beached resin pellets to reveal variability between individual particles and differences among beaches | 2001 and 2002 |
| Kusui and Noda (2003)<br><br>Toyama Prefectural Uni; Northwest Pacific Region Environmental Cooperation Center | Investigate the distribution and abundance of marine litter on 26 beaches along the Sea of Japan | September to November 2000 |
| Mato et al. (2001)<br><br>Tokyo Uni of Agriculture & Tech.; Tokyo Uni of Fisheries; National Institute of Health Sciences | Quantify the presence of toxic chemicals on resin pellets collected from four Japanese coasts, and conduct field adsorption experiments using PP virgin pellets | 1997 and 1998 |

# APPENDIX III – DETAILED ANALYSIS OF RESEARCH FOCI IN ASEAN+3

Table 1. Marine plastics research foci within the ASEAN+3 member states, where a total of 10 clusters of research foci have been identified. Legend: Red = 0 articles; Yellow = 1-9 articles; Light-green = 10-20 articles; Dark-green = >20 articles.

| Clustered Research Focus | BRN | KHM | IDN | MYS | MMR | PHL | SGP | THA | VNM | CHN | ROK | JPN | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Methodology for marine plastic clean-up + Methodology for monitoring + Survey and monitoring | 1 | 2 | 48 | 29 | 3 | 8 | 7 | 7 | 3 | 79 | 32 | 20 | 239 |
| Ecological and environmental impact | 1 | 0 | 12 | 9 | 1 | 12 | 9 | 7 | 3 | 38 | 11 | 14 | 117 |
| Contaminants associated with marine plastics | 0 | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 40 | 17 | 12 | 72 |
| Movement of plastics in water bodies + Accumulation zones and hotspots + Contribution from rivers + Source differentiation | 1 | 0 | 14 | 5 | 1 | 2 | 0 | 1 | 3 | 11 | 5 | 17 | 60 |
| Socio-economic impact | 1 | 0 | 8 | 6 | 0 | 9 | 0 | 3 | 2 | 14 | 5 | 1 | 49 |
| Research framework, coordination + Laws, administrative measures + Guidelines and standards | 0 | 1 | 6 | 2 | 1 | 4 | 0 | 3 | 1 | 1 | 6 | 1 | 27 |
| Upstream research/waste management | 0 | 0 | 2 | 2 | 0 | 2 | 0 | 0 | 0 | 5 | 4 | 1 | 16 |
| Contribution from ALDFG + Discharge from offshore structures (incl. aquaculture) | 0 | 0 | 2 | 1 | 0 | 0 | 0 | 1 | 0 | 1 | 8 | 3 | 16 |
| Social perception + Public outreach/beach clean-up | 0 | 0 | 8 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 3 | 17 |
| Fragmentation and degradation | 0 | 0 | 1 | 0 | 0 | 2 | 0 | 0 | 1 | 3 | 6 | 2 | 15 |
| Number of clustered research foci per country | 4 | 2 | 9 | 9 | 4 | 8 | 3 | 6 | 7 | 9 | 10 | 10 | 10 |

Table 2. A further examination of Table 1 above in presenting the percentages (rounded to the nearest 3.s.f) of articles in each clustered research out of total papers published in the country. Highlighting of numbers done for countries with more than 10 papers including Indonesia, Malaysia, Philippines, China, RO Korea and Japan. Legend: Light-green = research foci constitutes for <50% of all research done in the country; Dark-green = research foci constitutes for >50% of all research done in the country.

| Clustered Research Focus | BRN | KHM | IDN | MYS | MMR | PHL | SGP | THA | VNM | CHN | ROK | JPN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Methodology for marine plastic clean-up + Methodology for monitoring + Survey and monitoring | 100 | 66.7 | 78.7 | 80.6 | 60.0 | 57.1 | 77.8 | 87.5 | 75.0 | 60.9 | 47.8 | 66.7 |
| Ecological and environmental impact | 100 | 0.00 | 19.7 | 25.0 | 20.0 | 85.7 | 100 | 87.5 | 75.0 | 29.7 | 16.4 | 46.7 |
| Contaminants associated with marine plastics | 0.00 | 0.00 | 0.00 | 2.78 | 0.00 | 0.00 | 11.1 | 0.00 | 25.0 | 31.3 | 25.4 | 40.0 |
| Movement of plastics in water bodies + Accumulation zones and hotspots + Contribution from rivers + Source differentiation | 100 | 0.00 | 21.3 | 13.9 | 20.0 | 14.3 | 0.00 | 12.5 | 75.0 | 8.59 | 7.46 | 56.7 |
| Socio-economic impact | 100 | 0.00 | 13.1 | 16.7 | 0.00 | 64.3 | 0.00 | 37.5 | 50.0 | 10.9 | 7.46 | 3.33 |
| Research framework, coordination + Laws, administrative measures + Guidelines and standards | 0.00 | 33.3 | 9.84 | 5.56 | 20.0 | 21.4 | 0.00 | 25.0 | 25.0 | 0.78 | 8.96 | 3.33 |
| Upstream research/waste management | 0.00 | 0.00 | 3.28 | 5.56 | 0.00 | 14.3 | 0.00 | 0.00 | 0.00 | 3.91 | 5.97 | 3.33 |
| Contribution from fisheries/ALDFG + Discharge from offshore infrastructures (incl. aquaculture) | 0.00 | 0.00 | 3.28 | 2.78 | 0.00 | 0.00 | 0.00 | 12.5 | 0.00 | 0.78 | 11.9 | 10.0 |
| Social perception + Public outreach/beach clean-up | 0.00 | 0.00 | 9.84 | 5.56 | 0.00 | 14.3 | 0.00 | 0.00 | 0.00 | 0.00 | 2.99 | 10.0 |
| Fragmentation and degradation | 0.00 | 0.00 | 1.64 | 0.00 | 0.00 | 14.3 | 0.00 | 0.00 | 25.0 | 2.34 | 8.96 | 6.67 |
| *Excluded from analysis* | | | | | | | | | | | | |
| Port reception facilities | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Fibreglass-reinforced plastic vessels | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 1.49 | 0.00 |
| Hull scraping and marine coating | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Language and cultural barriers/data accessibility | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

# APPENDIX IV – PLASTIC CONTAMINANTS (POLYMER TYPES, ASSOCIATED AND SORBED CONTAMINANTS)

Table 1. Complete table of all organic contaminants identified as the most commonly researched polymer types and corresponding number of publications in ASEAN+3 and regulation status under international law. An expansion of Table 1.2.14.8 in the report. Legend: Red = not regulated under any of the three conventions (London Convention/London Protocol, Basel Convention and the Stockholm Convention); Green = under the regulation of at least 1 of the mentioned conventions.

| Organic contaminants (plastic polymer types) | | | | |
|---|---|---|---|---|
| Regulated | No. of papers | | Unregulated | No. of papers |
| Polyethylene (PE) | 125 | | Polyvinyl chloride (PVC) | 56 |
| Polypropylene (PP) | 107 | | Expanded polystyrene (EPS) | 31 |
| Polystyrene (PS) | 95 | | Styrene-acrylonitrile (SAN) | 23 |
| Polyethylene terephthalate (PET or PETE or or PETP or PET-P) | 64 | | Low-density polyethylene (LDPE) | 19 |
| Polyamides (PA) | 39 | | Nylon | 19 |
| Polyurethane (PU or PUR) | 12 | | Cellophane (CP) | 15 |
| Acrylic polymers | 11 | | Polyester | 15 |
| Polycarbonate (PC) | 10 | | Rayon/viscose | 11 |
| Alkyd | 7 | | High-density polyethylene (HDPE) | 10 |
| Polyvinyl alcohol (PVA) | 5 | | Ethylene-vinyl acetate (EVA) or Polyethylene-vinyl acetate (PEVA) | 7 |
| Polymethyl methacrylate (PMMA) | 4 | | Polyethylene-polypropylene copolymer (PEP or PE/PP) | 7 |
| Acrylonitrile butadiene styrene (ABS) | 3 | | Polyethersulfone (PES) | 6 |
| Polybutylene terephthalate (PBT) | 3 | | Polyethyl acrylate | 6 |
| Styrene | 3 | | Polytetrafluoroethylene (PTFE)/teflon | 6 |
| Synthetic cellulose | 2 | | Resin | 6 |
| Acrylonitrile (AN) | 1 | | Polycaprolactone (PCL) | 3 |
| Epoxy resins | 1 | | Polyoxymethylene (POM) | 3 |
| Polycarbonate/acrylonitrile butadiene styrene (PC/ABS) | 1 | | Vinyl | 3 |
| Polyphenylene sulphides (PPS) | 1 | | Polyacrylate/styrene | 2 |
| Polysiloxanes/silicones | 1 | | Polyethylene propylene diene (PEPD) | 2 |

| | | | | |
|---|---|---|---|---|
| Polyvinyl acetate (PVAC) | 1 | | Polypropylene/ethylene-propylene rubber (PP/EPR) | 2 |
| Urethane alkyd | 1 | | Styrene-acrylate | 2 |
| Melamine formaldehyde resins | 0 | | Wax | 2 |
| Phenol formaldehyde resins | 0 | | Acrylonitrile styrene acrylate (ASA) | 1 |
| Polyacetals | 0 | | Cellulose (CL) | 1 |
| Polyvinyl butyral | 0 | | Dipar | 1 |
| Urea formaldehyde resins | 0 | | Epoxy | 1 |
| Alkanes C10-C13 | Too generic? | | Ethylene propylene diene monomer (EDPM) | 1 |
| Butadiene | Too generic? | | Extruded polyester (XPS) | 1 |
| Ethers | Too generic? | | Foamed polystyrene (FPS) | 1 |
| Ethylene | Too generic? | | General purpose polystyrene (GPPS) | 1 |
| Mixed PE, PP and PET | Too generic? | | Linear low-density polyethylene (LLDPE) | 1 |
| Polyether | Too generic? | | Medium-density polyethylene (MDPE) | 1 |
| | | | Paraffin | 1 |
| | | | Phenoxy resin | 1 |
| | | | Poly(1-butene) (PB) | 1 |
| | | | Poly(1-octene) | 1 |
| | | | Polyacrylonitrile (PAN) | 1 |
| | | | Polyarylamide (PAA/PARA) | 1 |
| | | | Polyarylether (PAE) | 1 |
| | | | Polybutadiene (PBD) | 1 |
| | | | Polybutyl methacrylate (PBMA) | 1 |
| | | | Polybutylene adipate terephthalate (PBAT) | 1 |
| | | | Polychlorinated biphenyl (PCB) | 1 |
| | | | Polyester alkyd (PAK) | 1 |
| | | | Polyethyl acrylate styrene | 1 |

| | | | |
|---|---|---|---|
| | | Polyethylene/ethylacrylate copolymer | 1 |
| | | Polyisoprene/polystyrene | 1 |
| | | Polyphenylene | 1 |
| | | Polypropylene/ethylene-propylene-diene terpolymer (PP/EPDM) | 1 |
| | | Polystyrene–(ethylene–butylene)–styrene | 1 |
| | | Polysulfone (PSUL) | 1 |
| | | Polyvinyl sulfate | 1 |
| | | Polyvinylidene dichloride (PVDC) | 1 |

Table 2. All plastic-associated organic contaminants with indication of research effort in ASEAN+3 and international regulations. An expansion of Table 1.2.14.9 in the report. Legend: Red = not regulated under any of the three conventions (London Convention/Protocol, Basel Convention and the Stockholm Convention); Green = under the regulation of at least 1 of these conventions.

| Organic contaminants (plastic-associated) | | | |
|---|---|---|---|
| Regulated | No. of papers | Unregulated | No. of papers |
| Hexabromocyclododecane (HBCDD) | 9 | Polycyclic aromatic hydrocarbon (PAHs) | 10 |
| Polychlorinated biphenyls (PCB) | 9 | Hexachlorocyclohexane (HCH): Gamma hexachlorocyclohexane | 6 |
| Hexachlorocyclohexane (HCH): Alpha hexachlorocyclohexane | 6 | Hexachlorobenzene (HCBs) | 5 |
| Hexachlorocyclohexane (HCH): Beta hexachlorocyclohexane | 6 | Hexachlorocyclohexane (HCH): Delta hexachlorocyclohexane | 5 |
| Dichlorodiphenyltrichloroethanes (DDTs) | 4 | UV326/Tinuvin 326 | 4 |
| Polybrominated diphenyl ethers (PBDEs) | 4 | Bisphenol-A (BPA) and its analogues | 3 |
| Pentachlorobenzene (PeCB) | 3 | Irgafos168 and its 2 degradation products: 2,4-di-tert-butylphenol (2,4-DTBP) and tris(2,4-di-tert-butylphenyl)phosphate2) | 3 |
| Organic phosphorus compounds | 2 | UV327 | 3 |
| Aldrin | 1 | Dichlorodiphenyldichloroethylenes (DDEs) | 2 |
| Chlordane | 1 | Irganox 1076 | 2 |
| Dieldrin | 1 | Nonylphenol (NPs) and its antioxidants, plasticisers, and degradation products | 2 |
| Endrin | 1 | UV320 | 2 |

| | |
|---|---|
| Heptachlor | 1 |
| Perfluorooctane sulfonic acid (PFSO), its salts and perfluorooctane sulfonyl fluoride | 1 |
| Organic cyanides | 0 |
| Organohalogen compounds | 0 |
| Organosilicon compounds | 0 |
| Perfluorohexane sulphonic acid (PHSxS), its salts and PHFxS-related compounds | 0 |
| Phenols; phenol compounds including chlorophenols | 0 |
| Polychlorinated dibenzo-furan (Any congenor of) | 0 |
| Polychlorinated dibenzo-p-dioxin (Any congenor of) | 0 |
| Short-chain chlorinated paraffins (SCCPs) | 0 |
| Technical endosulfan and its related isomers | 0 |

| | |
|---|---|
| UV328 | 2 |
| Benzophone-3 (BP-3) | 1 |
| Butylated hydroxytoluene (BHT) | 1 |
| Hexanoic acid, 2-ethyl-, hexadecylester (HEHA) | 1 |
| Irganox 1010 | 1 |
| Nonachlor | 1 |
| Perfluorooctane sulfonamide (PFOSA) | 1 |
| Phthalates esters/phthalic acid esters (PAEs) | 1 |
| Polyhalogenated carbazole (PHCs) | 1 |
| Tris-(2,3-dibromopropyl) isocyanurate (TBC) | 1 |
| UvinualMC80 | 1 |
| UV531/BP-12 | 1 |
| 4-methylbenzylidene camphor (4-MBC) | 1 |
| Pharmaceutical drugs | |
| Tetracycline (TC) | 4 |
| Sulfamethoxazole (SMX) | 3 |
| Ciprofloxacin (CIP) | 2 |
| Sulfamethazine (SMT) | 2 |
| Amoxicillin (AMX) | 1 |
| Cephalosporin (CEP) | 1 |
| Propranolol (PRP) | 1 |
| Sertraline (SER) | 1 |
| Sulfadiazine (SDZ) | 1 |
| Trimethoprim (TMP) | 1 |
| Tylosin (TYL) | 1 |

| | | | |
|---|---|---|---|
| | | Antimicrobial agents | |
| | | Triclosan (TCS) | 2 |
| | | PPCPs (pharmaceuticals and personal care products) | |
| | | Synthetic musks (SMs) | 1 |
| | | Others | |
| | | Lubrication oil | 1 |
| | | 17b-Estradiol, E2 | 1 |

Table 3. All plastic-associated inorganic contaminants (mostly heavy metal or its compound) with indication of research effort in ASEAN+3 and in international regulations. An expansion of Table 1.2.14.10 in the report. Legend: Red = not regulated under any of the three conventions (London Convention/Protocol, Basel Convention and the Stockholm Convention); Green = under the regulation of at least 1 of these conventions.

| Inorganic contaminants (heavy metals and/or its compounds) | | | | |
|---|---|---|---|---|
| Regulated | No. of papers | | Unregulated | No. of papers |
| Lead (Pb) and lead compounds | 6 | | Manganese (Mn) | 1 |
| Cadmium (Cd) and cadmium compounds | 5 | | Strontium (Sr) | 1 |
| Copper (Cu) | 5 | | Tin (Sn) | 1 |
| Zinc (Zn) | 3 | | Aluminium (Al) | 0 |
| Arsenic (As) | 2 | | Astatine (At) | 0 |
| Chromium (Cr) and Hexavalent chromium compounds | 2 | | Barium (Ba) | 0 |
| Nickel (Ni) | 2 | | Cesium (Cs) | 0 |
| Antimony (Sb); antimony compounds | 1 | | Cobalt (Co) | 0 |
| Mercury (Hg) and mercury compounds | 1 | | Molybdenum (Mo) | 0 |
| Asbestos (silicate dust and fibres) | 0 | | Silver (Ag) | 0 |
| Beryllium (Be) | 0 | | Titanium (Ti) | 0 |
| Cyanides - Inorganic cyanides | 0 | | Uranium (U) | 0 |
| Fluorides - Inorganic fluorine compounds excluding calcium fluoride | 0 | | | |
| Iron (Fe) | 0 | | | |
| Selenium (Se) and selenium compounds | 0 | | | |
| Tellurium (Te) and tellurium compounds | 0 | | | |
| Vanadium (V) | 0 | | | |

# APPENDIX V – TABLE OF ADOPTION OF RELEVANT TREATIES IN ASEAN+3

| Treaty | Competent International Org. | BRN | KHM | CHN | IDN | JPN | ROK | MYS | MMR | PHL | SGP | THA | VNM |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1982 United Nations Convention on the Law of the Sea (UNCLOS) and Agreement on Part XI | | 1996 | Signed in 1983 | 1997 | 1985 | 1996 | 1996 | 1996 | 1996 | 1984 | 1994 | 2011 | 1994 |
| 1973/1978 International Convention for the Prevention of Pollution from Ships (MARPOL) and Annex I | IMO | 1986 | 1994 | 1983 | 1986 | 1983 | 1984 | 1997 | 1988 | 2001 | 1990 | 2007 | 1991 |
| 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention) / 1996 Protocol | LC/LP COP | N / N | N / N | 1985 / 2006 | N / N | 1980 | 1993 | N / N | N / N | 1973 / 2012 | N / N | N / N | N / N |
| 1973/1978 International Convention for the Prevention of Pollution from Ships (MARPOL) - Annexes II to V | IMO | Annex II<br>No Annex III-V | Annex II-V | Annex II-V | Annex II-V | Annex II-V | Annex II-V | Annex II-V | Annex II-V | Annex II-V | Annex II-V | Annex II<br>No Annex III-V | Annex II-V |
| 1989 Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal / 1995 Amendment | COP BC | 2002 / 2002 | 2001 / N | 1991 / 2001 | 1993 / 2005 | 1993 | 2008 | 1993 / 2001 | 2015 / N | 1993 / N | 1996 / N | 1997 / N | 1995 / N |
| 1998 Rotterdam Convention on the Prior Informed Consent Procedure for Certain Hazardous Chemicals and Pesticides in International Trade | RC COP | N | 2013 | 2005 | 2013 | 2004 | 2003 | 2004 | N | 2006 | 2005 | 2004 | 2007 |
| 2001 Stockholm Convention on Persistent Organic Pollutants (POPs) | SC COP | N | 2006 | 2004 | 2009 | 2004 | 2007 | Signed 2002 | 2004 | 2004 | 2005 | 2005 | 2002 |
| 1992 Convention on Biological Diversity (CBD) | CBD COP | 2008 | 1995 | 1992 | 1994 | 1993 | 1994 | 1994 | 1994 | 1993 | 1995 | 2004 | 1994 |

Legend [table updated as of 18 June 2020]

Date is of signature of the instrument
N : No Adoption/Ratification/Accession
COP : Conference of Parties

# APPENDIX VI – INVENTORY OF SCIENTIFIC RESEARCH PUBLICATION ON MARINE PLASTIC POLLUTION IN ASEAN+3

Inventory database available online on CIL website: https://cutt.ly/kstW1Qy