

Towards the Management of Marine Litter and Microplastics in the Southeast Asian Region

Pontipa Luadnakrob and Sukchai Arnupapboon

Management of aquatic pollution that include marine litter, e.g. marine debris, microplastics, and abandoned, lost or otherwise discarded fishing gear, is one of the most challenging issues that need to be addressed through global cooperative efforts. In the Southeast Asian region, the severity of the issue on marine litter requires strong collaboration for the development of preventive approaches to mitigate their impediments to sustainable economic growth. Innovation, research, and development of technologies to reduce marine litter are necessary for the well-being and sustainable management of biodiversity and natural resources. Recently, SEAFDEC has made some efforts to assess the condition of marine litter in the Southeast Asian region through several projects supported by the Japanese Trust Fund. This article highlights the initiatives as well as the ongoing and planned activities of SEAFDEC in collaboration with the ASEAN Member States (AMSSs) and academic institutions to understand the impacts of marine debris and microplastics on the environment.

The ASEAN-SEAFDEC Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030 (Southeast Asian Fisheries Development Center, 2020) supports the United Nations Sustainable Development Goal (SDG) 14: “Conserve and sustainably use the oceans, seas, and marine resources for sustainable development” and its Target 14.1: “*By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution.*” Guided by Resolution No. 11: “*Increase awareness and support the reduction of impacts of aquatic pollution and marine debris, including abandoned, lost or otherwise discarded fishing gear (ALDFG), and microplastics/microbeads on fisheries and aquaculture;*” and Plan of Action No. 26: “*Assess and manage the impacts of aquatic pollution and marine debris, including abandoned, lost, or otherwise discarded fishing gear (ALDFG) and microplastics/microbeads, on fisheries and aquaculture,*” SEAFDEC has been undertaking activities that aim to address the issues on marine debris and microplastics in the Southeast Asian region. Along the lines of such efforts, the ASEAN Member States (AMSSs) endorsed the “ASEAN+3 Marine Plastics Debris Cooperation Action Initiative” at the 21st ASEAN Plus Three Summit in Singapore in November 2018, supported the “ASEAN Framework of Action on Marine Debris” at the Special ASEAN Ministerial Meeting on Marine Debris in Bangkok, Thailand in March 2019, and adopted “Bangkok

Declaration on Combating Marine Debris in the ASEAN Region” at the 34th ASEAN Summit in Bangkok, Thailand in June 2019.

Marine litter is defined by the United Nations Environment Programme as “any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine and coastal environment” (United Nations Environment Programme, 2021). Generally originating from people’s activities in rivers, coastal areas, and seas, marine litter threatens the environment and organisms. The most common type of marine litter are plastics which are categorized as megaplastic (> 100 mm), macroplastic (> 20 mm), mesoplastic (5–20 mm), microplastics (< 5 mm), and nanoplastics (< 100 nm) (Barnes *et al.*, 2009). In fact, about 60–80 percent of the world’s litter is composed of plastics (Avio *et al.*, 2017), contributing to the main concerns in marine pollution because of their durability and ability to resist degradation.

An estimated 90 percent of marine plastic wastes had been blamed to 10 rivers in Asia and Africa, one of which is the Mekong River which is about 4,300 km long and flows through six countries in Indochina and splits into several smaller rivers before flowing to the South China Sea (Hatta & Nishiwaki, 2018). Plastics are highly in demand in the daily lives of humans for comfort, and come in forms of plastic bags, plastic bottles, food packaging, among others. Nowadays, numerous tonnes of plastic litters are not properly managed, recycled, or disposed of (Jambeck *et al.*, 2015). In 2010, five AMSSs, namely: Indonesia, Philippines, Viet Nam, Thailand, and Malaysia, were among the largest sources of mismanaged plastic wastes entering the oceans (**Figure 1**).

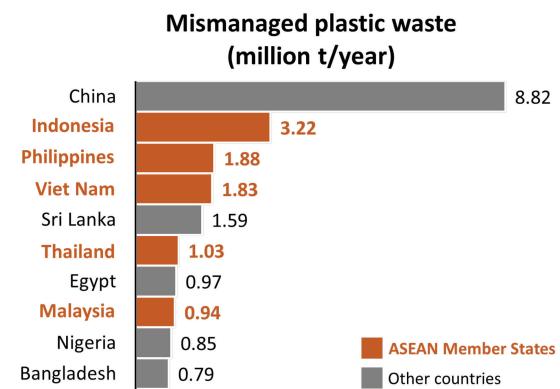


Figure 1. Top 10 countries with mismanaged plastic waste ranked by volume (million t/year) in 2010

(Source: Jambeck *et al.*, 2015)

Harmful impacts of marine litter on marine animals

During the 2013 International Coastal Cleanup, the top ten debris items recorded were, in descending order: cigarette butts, plastic food wrappers, plastic beverage bottles, plastic bottle caps, straws and stirrers, plastic grocery bags, glass beverage bottles, other plastic bags, paper bags, and beverage cans; and seven of these items are made of plastic (Secretariat of the Convention on Biological Diversity, 2016). Reports have indicated that many marine organisms (*e.g.* invertebrates, fishes, turtles, whales) ingest plastic litter in their search for food that generally led to their deaths. For example, a dead sperm whale that was washed ashore near Kapota Island in Indonesia in 2018, was found to have ingested plastic litter that comprised 115 pieces of drinking cups, 25 plastic bags, plastic bottles, two flip-flop slippers, and a bag containing more than a thousand pieces of strings, all in all weighing about 6 kg (BBC News, 2018). In Kuala Penyu, Malaysia, a whale shark washed ashore in 2019 was found to have starved to death after ingesting a large plastic bag that caused physical obstruction in its gastrointestinal tract that led to its death (Chan, 2019). In Thailand, the number of deaths among marine animals in 2016 due to marine litter was 355 that included 11 dugongs, 180 sea turtles, and 164 dolphins and whales (Thaitrakulpanich, 2016). Moreover, a pilot whale was found dead at a canal in Songkhla Province, Thailand in 2018 and upon examination, its stomach was found to contain plastic bags and other plastic items weighing around 8 kg (Sriring, 2018).

Studies on microplastics in Southeast Asia

In the oceans, most plastics are broken up into smaller particles by the pressure from waves, water current, and wind, and these small plastic bits are called microplastics or nanoplastics. Several studies have demonstrated that marine organisms could take up microplastics and nanoplastics, which could be accumulated in their tissues as toxic pollutants (Avio *et al.*, 2017). In the South Pole, which is supposed to be the least marine polluted area, it was found that there were plenty of plastic pieces in the water, snow, and ice with sizes smaller than 5 mm (Isobe *et al.*, 2017). However, studies on marine litter and microplastics are still insufficient, particularly in the Southeast Asian region, although a few studies carried out in the region included a study in Malaysia by Mobilik *et al.* (2014) who assessed the amount and distribution of marine debris during different monsoon seasons in public beaches and found more than 7,000 items during the southwest monsoon, around 6,000 items during northeast monsoon, and around 3,000 items during intermediate monsoon. The total weight of all items collected was around 863 kg including 87 % plastic and the rest were timber, rubber, metal, glass, and cloth. The study on contamination of microplastics in bivalves, namely: *Danax* sp. and *Paphia* sp. by Tharamon *et al.* (2016) indicated

that for both species, the most prevalent type of microplastics was fiber both in Chaolao Beach (82 %) and Kungwiman Beach (79 %) in Chanthaburi Province, Thailand. Sediment cores collected from Japan, Malaysia, Thailand, and South Africa indicated that the amount of extracted microplastics increased toward the surface. From the core samples at the surface sediment, the amount of microplastics varied from 100 pcs/kg in the Gulf of Thailand to 1,900 pcs/kg in Tokyo Bay (Matsuguma *et al.*, 2017). In Sumba, Indonesia, the microplastics found in the water column (5 m, 50 m, 100 m, 300 m, and near the sea bottom) consisted of fibers, granules, and other plastic forms; and around 82 % of microplastics were found at the thermocline area which is less than 100 m water depth (Cordova & Hernawan, 2018).

Initiatives of SEAFDEC related to management of marine debris

In an effort toward addressing the issues on marine debris and microplastics in the Southeast Asian region, SEAFDEC collaborated with relevant organizations and agencies to implement several projects in improving research techniques and provided technical support to AMSs in building the capacity of their human resources in conducting sampling survey and data analysis on the impacts of marine litter on the environment. Specifically, the SEAFDEC Training Department (SEAFDEC/TD) conducted a preliminary assessment of marine litter on the seafloor of Sri Racha in Chon Buri, Thailand (**Figure 2**) in January 2015 (Yasook *et al.*, 2015). About 1.9 km² area was swiped using otter board



Figure 2. Survey area: Sri Racha, Chon Buri, Thailand in 2015

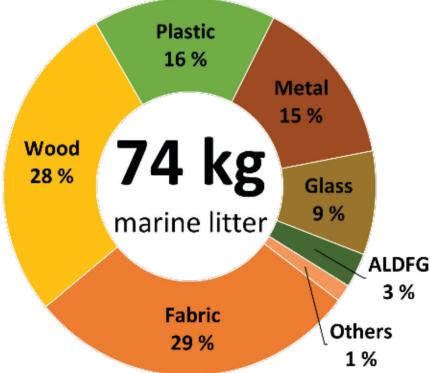


Figure 3. Composition of marine litter at the seafloor of Sri Racha, Chon Buri, Thailand, collected during the 2015 survey

bottom trawl, collecting about 74 kg of marine litter items that composed of fabric, wood, plastics, metal, glass, ALDFG, and other items (paper, rubber, and coal) (**Figure 3**). However, further study is necessary to compare the marine litter in other locations and seasons of the country.

During the Collaborative Research Survey in August–October 2018, SEAFDEC/TD collaborated with the Burapha University in Chantaburi Campus, Thailand, to carry out the study on the distribution of marine litter at the seafloor of the Gulf of Thailand using the M.V. SEAFDEC 2 (Arnupapboon *et al.*, 2019). This resulted in the collection of more than 700 pieces of items during the otter board trawl operations. **Figure 4** shows the preliminary analysis of the marine debris hotspots in the Gulf of Thailand. Moreover, studies on the accumulation of microplastics in fish, sea bottom, and seawater were also carried out. Once the reports of the surveys and studies are completed, the overall results of the collaborative survey would be shared among the AMSs through trainings and workshops to enhance the capacity of researchers in the region.

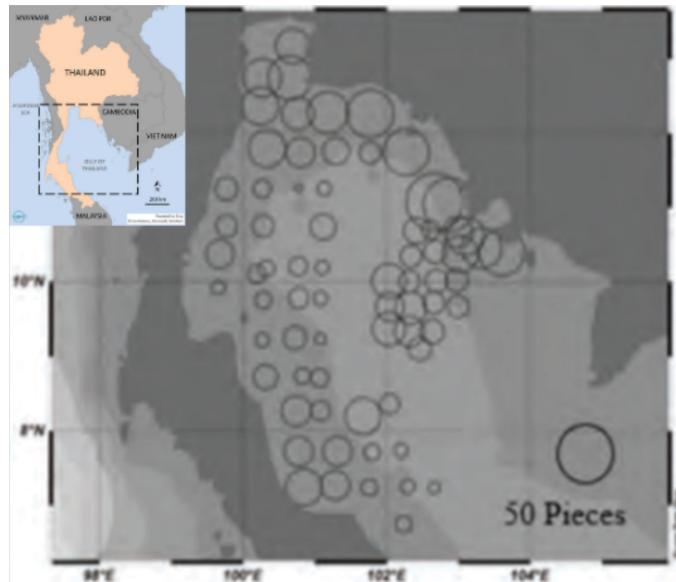


Figure 4. Marine debris distribution and density at sea bottom in the Gulf of Thailand during the 2018 survey

From November to early December 2019, SEAFDEC/TD organized the shipboard training for researchers from various research agencies on marine debris observation utilizing the M.V. SEAFDEC 2 while it was on a survey cruise in the inner part of the Gulf of Thailand. Back-to-back with the shipboard training, SEAFDEC/TD also conducted the Collaborative Research Survey on Marine Debris in the Gulf of Thailand using the M.V. SEAFDEC 2. The shipboard training and collaborative research were facilitated under the Japanese Trust Fund Project on Offshore Fisheries Resources Exploration in Southeast Asia. Moreover, while conducting regular surveys onboard the research vessels of SEAFDEC, SEAFDEC/TD also initiated the development of appropriate method of visual observation of floating marine litter. Subsequently, the method would be shared with the researchers from the AMSs to enhance their knowledge and capacity to study marine debris in the waters of their respective countries.

In 2020, SEAFDEC/TD organized the “Technical Ad Hoc Meeting on Marine Debris in Thailand” in Samut Prakan, Thailand with participants from Japan, Thailand, and SEAFDEC/TD. The Meeting was aimed at establishing a collaborative research between SEAFDEC and the Science and Technology Research Partnership for Sustainable Development (SATREPS) Programme of the Government

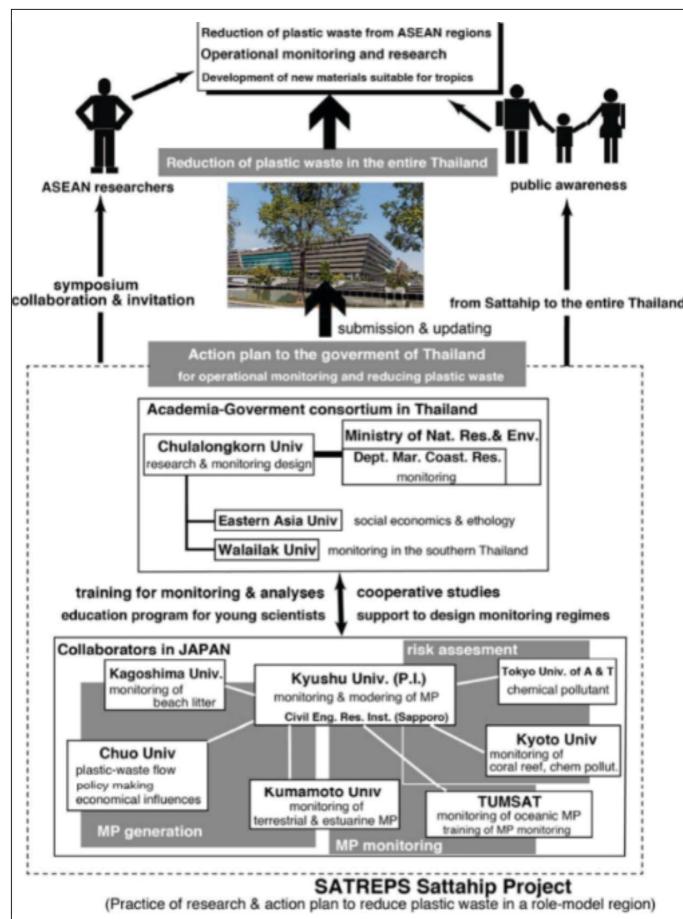


Figure 5. Conceptual framework of the Marine Debris in Thailand Project

of Japan that promotes international joint research. Under SATREPS, the proposed “Project on Marine Debris in Thailand” was presented through a conceptual framework shown in **Figure 5**. The proposed collaborative research is aimed at 1) establishing a center of excellence regarding marine plastic pollution research in Southeast Asia; and 2) supporting, justifying, and updating the action plan issued by the Southeast Asian countries on the management of marine litter.

Moreover, SEAFDEC Inland Fishery Resources Development and Management Department (SEAFDEC/IFRDM) is assessing the uptake of microplastics by freshwater fishes to determine the presence of microplastics in commercially exploited freshwater fishes considering that consuming these microplastic-contaminated fishes could pose potential risk to humans (Kaban *et al.*, 2021). This Project is being supported by Japan-ASEAN Integrated Fund (JAIF).

Way Forward

Currently, several projects are being implemented by SEAFDEC that aim to address the issues on marine debris and microplastics in the Southeast Asian region. Under the SEAFDEC/TD project “Responsible Fishing Technology and Practice” in 2020–2024, one of the activities is aimed at developing environment-friendly fishing gear and practices to prevent and significantly reduce marine debris. Through the project “Sustainable Utilization of Fisheries Resources and Resources Enhancement in Southeast Asia” in 2020–2024, the second leg of the Collaborative Research Survey in the Gulf of Thailand would be pursued to collect baseline data on marine debris, develop standard procedures on marine



Sampling of microplastics from seawater



debris observation, enhance the capacity of researchers on marine debris and microplastics research, and strengthen the network of Southeast Asian researchers engaged in research on marine debris and microplastics. Regional training courses on microplastics and marine debris would also be organized to support the marine debris and microplastic research program, by strengthening the capacity of researchers from the AMSs on marine debris and microplastic surveys, and analysis as well as development of strategies for the management of marine debris and microplastics.

Furthermore, several activities would be undertaken under the project “Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia” during 2021–2022. Short descriptions of such activities are shown in the **Box**.

Box. Activities lined up for 2021–2022 under the project “Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia”

- Gathering of information to estimate the amount of ALDFG in pilot sites
- Conduct of workshop on information exchange and development of technical guide to mitigate incidence of ALDFG
- Conduct of survey in the Gulf of Thailand to evaluate the impacts of microplastics on fishery resources
- Evaluation of the amount of marine debris collected by different types of fishing gears during fishing activities at sea
- Assessment of the microplastics in marine and freshwater fish
- Capacity building of officers and researchers from the AMSs on the study methods for management of marine debris and microplastics
- Establishment of the Project website and communication materials
- Development of a technical manual for marking of fishing gears



Trial on visual observation and recording of floating marine litter onboard the M.V. SEAFDEC 2



References

- Arnupapboon, S., Noranarttragoon, P., Serywuth, S., Nguyen, V. M., Amornpiyakrit, T., & Chanrachkij, I. (2019). Sustained Utilization of SEAFDEC Vessels through Collaborative Research Surveys: Marine Resources Survey of the Gulf of Thailand Using the M.V. SEAFDEC 2. *Fish for the People*, 17(2), 16–25. <http://repository.seafdec.org/handle/20.500.12066/5519>
- Avio, C. G., Gorbi, S., & Regoli, F. (2017). Plastics and microplastics in the oceans: From emerging pollutants to emerged threat. *Marine Environmental Research*, 128, 2–11. <https://doi.org/10.1016/j.marenvres.2016.05.012>
- Barnes, D. K. A., Galgani, F., Thompson, R. C., & Barlaz, M. (2009). Accumulation and fragmentation of plastic debris in global environments. *Philosophical Transactions of the Royal Society B: Biological Sciences*, 364(1526), 1985–1998. <https://doi.org/10.1098/rstb.2008.0205>
- BBC News. (2018, November 20). *Dead sperm whale found in Indonesia had ingested “6kg of plastic.”* https://www.bbc.com/news/world-asia-46275742?ocid=socialflow_twitter
- Chan, J. (2019, February 8). *Wildlife Dept: Sabah whale shark died of starvation after eating plastic bag.* <https://www.malaymail.com/news/malaysia/2019/02/08/wildlife-dept-sabah-whale-shark-died-of-starvation-after-ingesting-plastic/1720958>
- Cordova, M. R., & Hernawan, U. E. (2018). Microplastics in Sumba waters, East Nusa Tenggara. *IOP Conference Series: Earth and Environmental Science*, 162, 012023. <https://doi.org/10.1088/1755-1315/162/1/012023>
- Hatta, K., & Nishiwaki, S. (2018, September 17). *About 90% of marine plastic waste originates in 10 rivers in Asia, Africa: study.* <https://mainichi.jp/english/articles/20180917/p2a/00m/0na/002000c>
- Isobe, A., Uchiyama-Matsumoto, K., Uchida, K., & Tokai, T. (2017). Microplastics in the Southern Ocean. *Marine Pollution Bulletin*, 114(1), 623–626. <https://doi.org/10.1016/j.marpolbul.2016.09.037>
- Jambeck, J. R., Geyer, R., Wilcox, C., Siegler, T. R., Perryman, M., Andrade, A., Narayan, R., & Law, K. L. (2015). Plastic waste inputs from land into the ocean. *Science*, 347(6223), 768–771. <https://doi.org/10.1126/science.1260352>
- Kaban, S., Muthmainnah, D., Wibowo, A., Suzuki, T., Rais, A. H., & Sulit, V. T. (2021). Highlighting the Importance of Studying Microplastics in Freshwater Fishes. *Fish for the People*, 19(1), 48–51.
- Matsuguma, Y., Takada, H., Kumata, H., Kanke, H., Sakurai, S., Suzuki, T., Itoh, M., Okazaki, Y., Boonyatumonond, R., Zakaria, M. P., Weerts, S., & Newman, B. (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. <https://doi.org/10.1007/s00244-017-0414-9>
- Mobilik, J. M., Ling, T. Y., Husain, M. L., & Hassan, R. (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.
- Secretariat of the Convention on Biological Diversity. (2016). *Marine Debris: Understanding, Preventing and Mitigating the Significant Adverse Impacts on Marine and Coastal Biodiversity.* In *CBD Technical Series* (Issue 83). <https://www.cbd.int/doc/publications/cbd-ts-83-en.pdf>
- Southeast Asian Fisheries Development Center. (2020). *Resolution and Plan of Action on Sustainable Fisheries for Food Security for the ASEAN Region Towards 2030.* <http://repository.seafdec.org/handle/20.500.12066/6583>
- Sriring, O. (2018, June 3). *Plastic bags jam stomach of dead pilot whale in Thailand.* <https://www.reuters.com/article/us-thailand-whale-idUSKCN1IZ08W>
- Thaitrakulpanich, A. (2016, December 23). *355 Threatened Marine Animals Killed in 2016.* <https://www.khaosodenglish.com/news/2016/12/23/355-threatened-marine-animals-killed-2016/>
- Tharamon, P., Praisanklul, S., & Leadprathom, N. (2016). การปนเปื้อนของไมโครพลาสติกในหอยสองฝ่ายหาดเจ้าหลาน และชายหาดคุ้งวิมาน จังหวัดจันทบุรี [Contamination of Microplastic in Bivalves at Chaolao and Kungwiman Beaches, Chanthaburi Province]. *Khon Kaen Agr. J.*, 44(1), 738–744. http://marine.chanthaburi.buu.ac.th/documents/research/file_research/2016-02.pdf
- United Nations Environment Programme. (2021). *Marine litter.* <https://www.unep.org/explore-topics/oceans-seas/what-we-do/working-regional-seas/marine-litter>
- Yasook, N., Thimkrap, T., & Manomayithikan, K. (2015). The study on benthic litter around the coastal of Sri Racha, Chon Buri Province. *SEAFDEC Technical Seminar 2015*, 1–2. <http://repository.seafdec.or.th/handle/20.500.12067/640>

About the Authors

Ms. Pontipa Luadnakrob is Fishery Oceanographer at SEAFDEC Training Department based in Samut Prakan, Thailand (Email: tipa@seafdec.org)

Mr. Sukchai Arnupapboon is the Head of Fishing Ground and Fishery Oceanography Section, Research and Development Division of SEAFDEC Training Department based in Samut Prakan, Thailand (Email: sukchai@seafdec.org)