Activities of SEAFDEC on reduction of GHGs emissions from fisheries and adaptations to impacts of climate change

Fishing gears such as trawls and dredges require high fuel consumption and thus, their operations greatly impact the environment. Some activities of the project 'Responsible Fishing Technology and Practice' implemented by the SEAFDEC/TD from 2020 to 2024 and funded by the Japanese Trust Fund, had been initiated to address these concerns. The project activities, for example, include the modification and application of fishing gear and practices to mitigate their impacts on the marine ecosystem and optimize the use of energy by the fishing vessels and fishing practices. Such activities are aimed at transferring appropriate and applicable technologies and knowledge to fishers and fisheries officials to optimize energy use in fishing activities.

With the intensification of aquaculture systems in several Southeast Asian countries and the environmental challenges such as those resulting from climate change, both factors – genetic quality and culture management, are equally important. SEAFDEC/AQD, therefore, carried out the project 'Adapting to Climate Change Impacts' from 2016 to 2020 to generate, verify and promote technologies that ensure sustainable production of quality seedstocks for aquaculture and stock enhancement purposes. Many activities had been undertaken, *e.g.* culture of fast-growing species that are disease resistant and can be stocked at high densities; use of recirculating aquaculture systems and integrated multi-trophic aquaculture; implementation of zoning, monitoring, early warning systems; promotion of seaweeds and mollusk farming; and mangrove reforestation for carbon absorption. Furthermore, information on the impacts of climate change has been incorporated in the training courses organized by SEAFDEC/AQD and also in the extension materials that SEAFDEC/AQD has produced.

Way Forward

The characteristics and severity of the impacts of climate change and extreme climate events on the fisheries and aquaculture sector will most likely increase, affecting the most exposed and vulnerable countries and communities that depend on the sector for their livelihoods. It is therefore important that coherent and convergent adaptation and mitigation measures including preparedness for climate disaster response and recovery be mainstreamed in the fisheries and aquaculture sector as a matter of urgency and at an appropriate scale. The region also envisions to focus its plans on monitoring and assessing the perceived impacts of climate change on fisheries and aquaculture, especially through the formulation of guidelines that simplify indicators for inland/floodplain fisheries operations, enhancing the resilience of fisheries communities in anticipating and adapting to changes in the environments, as well as building climate-smart responses in fisheries. The AMSs join the global effort to mitigate the impacts of climate change by establishing ambitious objectives and targets as part of their national policies and plans. These initiatives will aid in the realization of a paradigm shift toward low-emission and promotion of climate-resilient development in all sectors including the fisheries sector.

8.2 Aquatic Pollution

Water is one of the renewable resources crucial for the existence of all beings on earth and is also an essential part of the global ecological system. However, problems on the quality of water have become major concerns in all countries, because of water pollution. As defined, "water pollution is the presence in groundwater of toxic chemicals and biological agents that exceed what is naturally found in the water and may pose a threat to human health and/or the environment. Additionally, water pollution may consist of chemicals introduced into the water bodies as a result of various human activities. Any amount of those chemicals pollute the water, regardless of the harm they may pose to human health and the environment" (Environmental Pollution Center, 2021). Therefore, water pollution or aquatic pollution occurs when the released substances interfere with the beneficial use of the water or with the natural functioning of the ecosystems. Water bodies could become polluted by domestic sewage also known as municipal solid wastes, toxic wastes, sediments, or thermal and petroleum substances. Aquatic pollution could occur not only in marine but also in freshwater environments.

In marine environments, aquatic pollution occurs when substances used or spread by humans, such as industrial, agricultural, and residential waste, particles, noise, excess carbon dioxide, or invasive organisms, enter the ocean and cause harmful effects (Sheppard, 2019). Most of the marine pollution comes from land sources and is washed or blown into the ocean. This pollution damages the environment, the health of all organisms, and economic structures worldwide (National Geographic, 2021). The types of marine pollution can be grouped into marine debris and plastic pollution, ocean acidification, nutrient pollution, toxins, underwater noise, and others. Marine pollution has become an essential issue since at least 8 million tons of plastic end up in our oceans every year (IUCN, 2021), and in 2021, at least 80 million kg of plastics used in the Southeast Asian region will become marine pollution (One Green Planet, 2021).

Similarly in freshwater environments, aquatic pollution happens when toxic substances enter water bodies such as lakes, rivers, and so on, getting dissolved in them or lying suspended or depositing on the bed degrading the quality of the water. These pollutants could seep through and reach the groundwater ending up in our drinking water. The most common pollutants in marine and freshwater environments are municipal solid wastes and industrial discharges.

Municipal solid wastes

Municipal solid wastes (MSW), more commonly known as trash or garbage, consisting of everyday items that humans use every day and then throw away, *e.g.* product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paints, batteries, among others, and come from our homes, schools, hospitals, and businesses. MSW also includes marine debris and microplastics. Industrial discharges are contaminants coming from different types of industry and comprise non-domestic pollutants, *e.g.* metals, metalloids, chemicals, organic and inorganic matters.

In the past decades, water pollution from marine debris and microplastics has become one of the global issues discussed in many international forums. A study on the source of marine debris had exposed that plastic materials are the most common debris making up between 60 % and 80 % (Avio *et al*., 2017) contributing to the main concerns in aquatic pollution because of their durability and ability to resist degradation. **Table 78** shows the projected amount of MSW generated daily by the Southeast Asian countries by 2025 compared to that of 2012.

Researchers first reported finding tiny beads and fragments of plastic, especially polystyrene in the oceans in the early 1970s. The term 'microplastics' which was introduced in the mid-2000s refers to plastic particles that are smaller than 5.0 mm in size (United Nations Environment Programme, 2021). Plastic debris can fragment into smaller pieces of microplastics by abiotic and biotic factors referred to as secondary microplastics while other man-made microplastics that can be found in marine environments are categorized as primary microplastics. Current research studies show that every part of the earth has revealed the presence of plastic events in the water, snow, and ice in the South pole (Isobe *et al*., 2017).

Meanwhile, marine debris is also found in growing quantities in a variety of habitats. Due to its characteristics, *i.e.*, its water buoyancy, colors, sizes, and shapes, some marine debris like natural food sources could result in accidental ingestion by marine organisms which could lead to deaths. Additionally, microplastics can accumulate in marine organisms and end up in humans through the food chain. Although the evidence is yet insufficient to quantify the long-term effect of microplastics in humans, most microplastics often contain additives, such as stabilizers or flame-retardants and other possibly toxic chemical substances that are harmful to humans ingesting them.

An estimated 88 - 95 % of marine debris load in the oceans 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

Table 78. Amount of municipal solid wastes (MSW) generated daily by Southeast Asian countries in 2012 and 2025

Southeast Asian Countries	2012					2025		
	Urban population[1]	MSW generated daily (kg)[2]		Components of MSW		Urban population[1]	MSW generated daily (kg)[2]	
		Per capita per day	Total (mt)	Types	%		Per capita per day	Total (mt)
Brunei Darussalam	282,415	0.87	247	plastic	91.46	426,000	1.30	554
				misc	5.66			
				lumber	2.88			
Cambodia[3]	n/a	n/a	n/a	plastic	27.00	n/a	n/a	n/a
				others	78.00			
Indonesia[4]	n/a	n/a	85,000	plastic	45.00 – 70.00	n/a	n/a	150,000
Lao PDR	1,916,209	0.70	1,342	n/a	n/a	3,776,000	1.10	4,154
Malaysia	14,629,641	1.52	21,918	n/a	n/a	27,187,000	1.90	51,655
Myanmar	12,847,522	0.44	5,616	n/a	n/a	28,720,000	0.85	21,012
Philippines[5]	n/a	n/a	43,684	plastic	61.90	n/a	n/a	n/a
				others	38.10			
Singapore	4,839,400	1.49	7,205	plastic	55.00	5,104,000	1.80	9,187
				paper	25.00			
				others	20.00			
Thailand	22,453,143	1.76	39,452	plastic	68.00	29,063,000	1.95	56,673
				others	32.00			
Viet Nam	24,001,081	1.46	35,068	plastic	64.50	40,505,000	1.80	72,909
				others	36.00			

[1] *World Bank Report (2012)*
[2] *Hoornweg & Perinaz (2012)*
[3] *Fauna and Flora International (2020)*
[4] *World Bank Group (2018) cited in Sari* et al. *(2020)*
[5] *SEA Circular (2020); Note: Data as of 2014*

several smaller rivers before flowing to the South China Sea (Schmidt *et al*., 2017; Hatta & Nishiwaki, 2018). Nowadays, numerous tonnes of debris is not properly managed, recycled, or disposed of (Jambeck *et al*., 2015). In 2010, five AMSs, namely: Indonesia, Philippines, Viet Nam, Thailand, and Malaysia, were among the largest sources of mismanaged plastic wastes entering the oceans. Such a situation recognizes the urgency to act to contain the problem so that the 34th ASEAN Summit in Bangkok, Thailand in June 2019 adopted the "Bangkok Declaration on Combating Marine Debris in the ASEAN Region," which aims to "promote cooperation for the protection, restoration and sustainable use of the coastal and marine environment, and respond and deal with the risk of pollution and threats to the marine ecosystem and coastal environment, with particular respect to the ecologically sensitive areas."

Status of marine debris and microplastic pollution in Southeast Asia

Marine debris and microplastics in the aquatic environment have been attracting global attention. Several studies have demonstrated that marine organisms are mostly affected by entangling and ingesting marine debris (Galgani *et al*., 2019), and also by taking up microplastics which accumulate in their tissues as toxic pollutants or if at all, because these are very tiny, could enter the circulation and gain access to the liver via the portal vein (Avio *et al*., 2017; Yong *et al*., 2020). The long-term accumulation of microplastics in liver tissues and chronic inflammation could lead to liver diseases and metabolic problems (Yong *et al*., 2020). Thus, the impacts of marine debris and microplastics are of major concern globally but studies on marine debris and microplastics are still insufficient, particularly in the Southeast Asian region. The few studies carried out in the region concluded that pollution from plastic debris was predominantly of the marine debris and microplastics present in every marine ecosystem such as in mangroves, water, sediments, and biota.

In Brunei Darussalam, Qaisrani *et al*. (2020a) reported that plastic materials were found abundantly among the debris on the beaches, comprising plastics, miscellaneous materials, and lumber. Although publications on microplastics are still limited in the country, one study on the contamination in a beach area by Qaisrani *et al*. (2020b) indicated that a beach in Brunei Darussalam had been contaminated by microplastics even if that beach rarely has human activities.

In Cambodia, the data came mainly from Koh Sdach Village which indicated that nearly a third of household wastes (by weight) comprised plastic and plastic materials. Additionally, 52 % of the respondents in a survey expressed that fishing nets are discarded by fishers directly into the ocean. There is no publication on the situation of microplastics in marine ecology in Cambodia.

In the study by Irianto & Dwiyitno (2020), the results showed that the Indonesian waters are a potential ecosystem for microplastics pollution. For example, in Sumba, Indonesia, microplastics were found through the water column (5 m, 50 m, 100 m, 300 m, and near the sea bottom) with 82 % of microplastics found at the thermocline area which is less than 100 m water in depth (Cordova & Hernawan, 2018). MP particles were also found in the gastrointestinal tracts of some fishes, *e.g. Trichiurus* sp. (hairtail) and *Johnius* sp. (croaker) with sizes ranging from 0.12 mm to 5.00 mm (Ismail *et al*., 2019).

In the assessment made by Mobilik *et al*. (2014) on the amount and distribution of marine debris during the different monsoon seasons in the public beaches of Malaysia, the results showed that there were more than 7,000 debris items during the southwest monsoon, around 6,000 during the northeast monsoon, and around 3,000 during intermediate monsoon, and consisting mainly of plastic. The presence of microplastic in the water, sediments, fish, and zooplankton in the marine environment was determined and polypropylene was the most abundant type of microplastic found in the surface water and sediments in Kelantab Bay (Saipolbahri *et al*., 2020). Nine of 11 sampled commercial fish species contained microplastics while at the Terengganu Coast, microplastics were also present in zooplankton including fish larvae, cyclopoid, shrimicroplastics, polychaetes, calanoids, and chaetognaths, ingesting 0.14, 0.13, 0.01, 0.007, 0.005, and 0.003 particles per individual, respectively (Amin *et al*., 2019; Karbalaei *et al*., 2019).

Results of the survey carried out in the waters of Myanmar in 2018 to determine the amount and nature of microplastics, showed that the mean levels of microplastics at the surface layer was from 8,000 to 27,000 microplastics per km^2. Moreover, the most abundant fragments found in Rakhine and Delta area were fibers which were most abundant in the Tanintharyi Coast (Thein, personal communication, 2021).

During the clean-up of Manila Bay, Philippines conducted in 2014, it was revealed that most of the solid wastes collected were plastics and plastic materials. microplastics are ubiquitous and continually accumulate in the Philippine ecosystem, like in the first microplastic study conducted by Argamino and Janairo (2016), the presence of microplastics was recorded in the acid-digested soft tissue of the mussel *Perna viridis*. Newly published studies have also confirmed the contamination of microplastics in the marine environments of the Philippines including in the sediments, waters, and finfish resources (Kalnasa *et al*., 2019; Espiritu *et al*., 2019; Bucol *et al*., 2020; Abiñon *et al*., 2020).

In Singapore, a study in 2018 showed that about one-third of domestic wastes that its populace disposed of comprised packaging wastes. Such solid wastes include not only plastic and paper packaging but also other types of packaging materials, such as metals and glass (Ministry of Environment and Water Resources, 2021).

Thailand could be considered as the highest consumption per capita of plastics in Asia (Corben, 2017). Plastics were the most abundant debris type found in Angsila, Bangsaen, Samaesarn Beach areas (Thusharia *et al*., 2017) followed by other materials such as glass bottles, polystyrene foam, ropes, cans, and others (Department of Coastal and Marine Resources, 2021). In the study on microplastics carried out in Phuket Province by Akkajit *et al*. (2019), who assessed the contamination of microplastics in Kalim, Tri Trang, and Patong Beaches, the results indicated that microplastics varied in abundance from 1 to 35 items m-2 with fiber comprising the majority of microplastics found in the samples. Results of a study on the contamination of microplastics in bivalves, *Danax* sp. and *Paphia* sp. by Tharamon *et al*. (2016) indicated that the most prevalent type of microplastics was the fiber that was found in Chaolao Beach and Kungwiman Beach in Chanthaburi Province, Thailand. A study also confirmed the presence of microplastics in the stomach contents of some economically important fish species (*Panna microdon*, *Dendrophysa russelli*, *Johnius borneensis*, and *Johnius weberi*) caught in the lower Gulf of Thailand and fibers were the major forms of microplastics (Azad *et al*., 2018). An analysis of the sediment cores collected in Thailand indicated that the number of extracted microplastics increased toward the surface so that at the surface sediment, the number of microplastics was 100 pcs/kg (Matsuguma *et al*., 2017).

Viet Nam has always treated with serious concern their plastic wastes situation as it affects the marine environment (Danh & Hoi, 2019). Most of the country's beaches are polluted with debris and plastic wastes. Of the plastic wastes, it was found that almost all kinds are related to fishery activities (culturing, exploiting, trading, etc.) followed by single-use plastics and other domestic wastes (International Union for Conservation of Nature, 2019). Microplastic contamination in surface waters varied with the lowest concentrations recorded in the bays and the highest in the rivers, with fibers dominating the fragments in most environments (Strady *et al*., 2021). When the number of microplastics was investigated in shorelines from Da Nang Beach by Nguyen *et al*. (2021), the results showed that synthetic fiber was the most predominant type of microplastics present.

Harmful impacts of marine debris and microplastics on aquatic organisms and humans

Plastic waste is one type of water pollutions, becoming one of the most serious global issues due to its durability that could persist for years without being degraded or decomposed in the marine ecosystem. The physical effects of plastic debris have been demonstrated in marine organisms, like for example, the incidence of entanglement, suffocation, and disruption of digestion in birds, fishes, mammals, turtles, and the like. While microplastics can enter the systems of marine organisms and humans through ingestion and inhalation, they could cause adverse impacts as these are sources of toxic chemicals such as phenanthrene, mercury, cadmium, and polychlorinated biphenyls (PCBs) that are persistent organic pollutants (POPs).

As a result of the increased utilization of plastic materials, the impact of marine debris on various organisms has been going worst. During the 2013 International Coastal Cleanup, the top ten debris items included cigarette butts, plastic food wrappers, plastics, 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). Many marine organisms, *e.g.* invertebrates, fishes, turtles, marine mammals, ingest plastic debris in their search for food that generally led to their deaths. Abreo *et al*. (2016a) reported the first evidence in the Philippines of plastic ingestion by the beaked whale *Mesoplodon hotaula* and confirmed the susceptibility of cetaceans to plastic ingestion. Results of the necropsy of a dead adult turtle conducted in Brgy. Lapu-Lapu, Agdao, Davao City, Philippines showed that several plastic materials had caused a blockage in the pyloric end of the stomach leading to its death (Abreo *et al*., 2016b). A dead sperm whale near Kapota Island in Indonesia in 2018 was found to have ingested plastic litter that comprised drinking cups, plastic bags, plastic bottles, slippers, and a bag containing more than a thousand pieces of strings, in all weighing about 6 kg (BBC News, 2018 as cited in Luadnakrob & Arnupapboon, 2021). In Thailand, the number of deaths among marine endangered species in 2016 due to consuming fishing gear and plastic-based wastes was 355 and over 95 % of these are turtles and dolphins (Thaitrakulpanich, 2016). Additionally, marine debris can affect the ecosystems and biodiversity by acting as transport for invasive species or smothering benthic fauna (Todd *et al*., 2010).

Microplastics are widely distributed in marine environments such as in the beach, mangrove areas, seawater, sea bottom, and biota, among others. It can enter the systems of marine organisms through ingestion causing adverse impacts. Yong *et al*. (2020) compiled recent findings related to the potential toxicity and detrimental effects of micro- and nanoplastics (NPs) and established that ingesting microplastics/NPs could result in behavioral abnormalities in fish in terms of feeding, and movements of adults and larvae as well as reproduction in adults, and also the occurrence of changes in blood cells, brain appearance, metabolites, key metabolic enzymes, and oxidative stress-induced enzymes.

Even though the long-term consequences of the accumulation of microplastics in mammals and humans are yet unclear

(Yong *et al*., 2020) but several fishery consumers are concerned that microplastics could be harmful to the consumers as these could be a source of toxic poisoning. Therefore, based on food safety concerns, the contamination of microplastics in fish and fishery products could impede the sustainable development of fisheries as an important economic sector of the Southeast Asian region.

Mitigating debris pollution from the fisheries sector of Southeast Asia

As a marine environment utilizer, the fisheries sector occupies a high proportion of the marine areas, particularly the coastal areas identified as the most polluted areas. This sector could be impacted by the direct dumping of pollutants into the ocean. Therefore, the role of the fisheries sector would form key success in combating aquatic pollution, particularly those of fishers and fisheries communities by cooperating in all efforts to combat marine debris and microplastics pollution.

Some of the programs initiated in the Southeast Asian region that need cooperation from stakeholders in the fisheries sector include the following:

- Studies on abandoned, lost, or otherwise discarded fishing gear (ALDFG)
- Conservative campaign on marine debris by encouraging volunteer fishers to keep all wastes produced in fishing vessels, garbage, or damaged fishing gears to bring to shore and dispose of properly to prevent and mitigate direct dumping of marine debris
- Encouraging aquaculture facilities to bag their garbage and dispose of them properly on land
- Setting up of pilot fishery communities to come up with useful products like building materials from plastic wastes available in the communities
- Building up or improving the capacity of fishery communities to be able to easily manage wastes

Activities of SEAFDEC to address issues on marine debris and microplastics

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 by conducting research and providing technical support to AMSs in the capacity building of their human resources to conduct sampling surveys and data analysis. In 2015 for example, SEAFDEC/TD conducted a preliminary assessment of marine debris on the seafloor of Sri Racha in Chon Buri, Thailand (Yasook *et al*., 2015). About 1.9 km2 area was swiped using otter board bottom trawl and collected about 74 kg of marine litter items that composed of fabrics, wood, plastics, metals, glass, ALDFG, and other items (paper, rubber, and coal).

During the Collaborative Research Survey in the Gulf of Thailand using the M.V. SEAFDEC 2 which was conducted in 2018, SEAFDEC/TD collaborated with the Burapha University in Chantaburi Campus, Thailand, to carry out the study on the distribution of marine debris at the seafloor of the Gulf of Thailand, and with Chulalongkorn University, Thailand to carry out the study on microplastics contamination in seawater, seafloor, and fish.

Subsequently, 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. The research technique established during the training would be shared with the other 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, to establish the 5-year collaborative research between SEAFDEC and Chulalongkorn University, through the Science and Technology Research Partnership for Sustainable Development (SATREPS) Programme of the Government of Japan that promotes international joint research activities. The proposed 5-year 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.

In 2021, SEAFDEC/TD sought funding from the Japan-ASEAN Integration Fund (JAIF) for the proposed Project “Regional Collaborative Research and Capacity Building for Monitoring and Reduction of Marine Debris from Fisheries in Southeast Asia,” which is aimed at enhancing regional collaborative research and capacity building of the fisheries sector in Southeast Asia through the application of scientific knowledge in regional policies for monitoring and reducing marine debris. Moreover, it is expected that the Project would reinforce the contribution of the fisheries sector in addressing the issues on marine debris in Southeast Asia by reducing its negative impacts and encouraging positive actions in cooperation with fishers, the private sector, and other relevant sectors in the AMSs.

Meanwhile, SEAFDEC/IFRDMD which is mandated to promote the sustainable development of inland fisheries takes part in the national pilot study of Indonesia on the presence of microplastic contaminants in freshwater fishes. Results of such pilot study would be used to formulate the appropriate workplan for monitoring and analyzing the presence and risks of microplastic contaminants in freshwater fishes to humans and the environment. Furthermore, the said workplan would also include identifying and reducing or eliminating the sources of microplastics in the freshwater ecosystem. It is also envisioned that the results of this pilot study would provide the methodology and information necessary in establishing the standardized sampling programs and a more comprehensive understanding of microplastics' absorption in freshwater fishes. Ultimately, the results would lead to the identification of the scientific evidence on the microplastic contaminants in the food supply chain and the risks of such pollutants to humans and the environment.

On the other hand, industries are also among the main sources of marine pollution in the region, especially in the form of petroleum or oil spills common in the region. For example, the oil spill accident was caused by a bursting pipeline in Koh Samet, Thailand in 2013. The accident affected the coastal and marine environment in the Gulf of Thailand, and a marine biologist said it would take years before marine life returned to normal in the worst-affected area (The New York Times, 2013). An explosion aboard a power barge off the Philippine Island of Guimaras in 2020 has spilled up to a quarter-million liters of fuel oil, threatening not only the local communities but also the mangrove and seagrass habitats. It was recalled that the mangroves off Guimaras had been affected by the Philippines' biggest ever oil spill in 2006, when an oil tanker sank, spilling half a million liters of fuel and affecting 648 hectares (1,600 acres) of mangrove forests and seagrass areas, which were already recovering that is why cleanup efforts had been enhanced to keep the latest oil spill away from the recovering mangrove swamps. The effect of crude oil on marine life, such as adult fish, may experience reduced growth, enlarged livers, changes in heart and respiration rates, fin erosion, and reproduction impairment. Fish eggs and larvae can be especially sensitive to lethal and sublethal impacts. Even when lethal impacts are not observed, oil can make fish and shellfish unsafe for humans to eat (NOAA, 2021).

Recommendations on combating marine debris and microplastics by the fisheries sector

Marine debris pollution could not be separated from that of microplastics, as its impact on the environment is also getting severe due to the increased use of quantities of plastics in many areas of our modern lives, such as for clothing, packaging, storage, and the like. Currently, plastic products are commonly used in the Southeast Asian countries, and the demand for plastic items has even increased. The MSW generated daily by the Southeast Asian region could be estimated at 201,807 mt a day at 0.79 kg per capita per day and is projected to increase to 445,841 mt a day at 1.13 kg per capita per day by 2025 (World Bank, 2012) as shown in Table 78. It has also been predicted that microplastics contamination would be present in all marine ecology including beaches, mangroves, seawater, sea bottom, biota, and many more.

To achieve regional success in reducing aquatic pollution and preventing its adverse impacts on the environment, it is necessary to focus on policy solutions and management of plastic wastes. Various legal instruments and supporting programs have been developed including regional soft-law instruments, namely: the Bangkok Declaration on Marine Debris and the ASEAN Framework for Action on Marine Debris which include the need to mitigate the occurrence of marine debris and microplastics in the Southeast Asian region. These efforts demonstrate ASEAN's commitment to advance concrete action in environmental protection. The ASEAN Framework of Action on Marine Debris could be accessed at https://asean.org/storage/2019/06/3. -ASEAN-Framework-of-Action-on-Marine-Debris-FINAL.pdf.

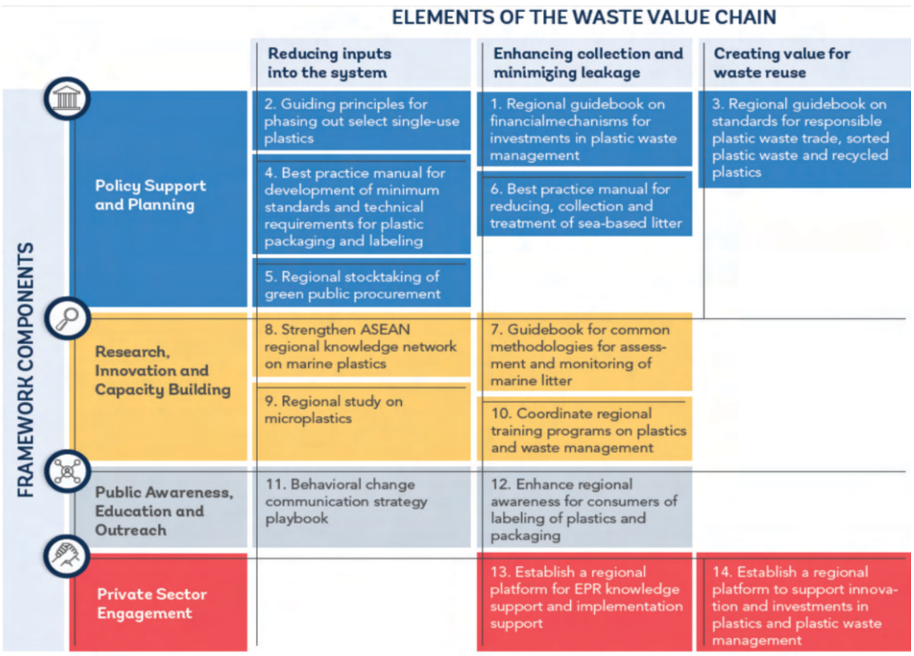

Figure 103. Summary of Plan of Action for Combating Marine Debris in Southeast Asian Region (ASEAN Secretariat, 2021)

As a follow-up, the ASEAN Regional Action Plan for Combating Marine Debris (2021-2025) was developed from October 2019 to July 2020 through extensive consultation with relevant experts and stakeholders. This regional action plan proposes the phased implementation of a systematic and integrated response to guide regional actions in addressing the issue of marine plastic pollution in ASEAN over the next five years (2021-2025). The potential solutions along the value chain to overcome unsustainable plastic consumption, waste management, and marine debris pollution were identified. There are 3 elements of west value chine 4 framework components and 14 regional actions for the Asian Member states (**Figure 103**). The Actions are aimed at addressing plastic issues along the value chain and are categorized according to the four Framework of Action Components (ASEAN Secretariat, 2021).

Furthermore, with the concerns in reducing marine pollution issues, a resolution was adopted by the United Nations under Goal 14 of its "Sustainable Development Goals," specifying in Target 14.1 that: "*By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution*" (UN, 2017). Recently, the "Sustainable Development Goals" became the measurement guide for countries in the region to develop their respective resolutions to address aquatic pollution issues.

Way Forward

In implementing the aforementioned recommendations, the contribution and cooperation of the fisheries sector could form the key success in combating aquatic pollution in the Southeast Asian region. The specific roles of the fisheries sector are therefore summarized below:

- The fisheries sector plays a significant role in improving marine debris and microplastics situation because its activities directly affect the aquatic ecology, and to mitigate the seriousness of the situation, governments should establish national and regional policies and action plans that put more focus on the fisheries sector, *e.g.* strengthen the fishing ports' sewage and garbage management to handle the debris originating from fishing vessels

- Publish guidebooks for the fisheries sector on combating debris and microplastic pollution that provide the guiding principles in reducing and/or eliminating the number of marine debris and microplastics in the marine ecosystem

- Research institutions and the academe to conduct studies on new fishing technologies and practices, and promote the results of such studies to the stakeholders in the fisheries sector, *e.g.* use of biodegradable fishing gear and fishing gear marking would facilitate decomposition and disposal of fishing gears, and ensure that fishing gear are disposed of in a sustainable manner, and subsequently, reduce the impacts and numbers of ALDFG at sea that continue to catch fish and other animals for a long period

- Study and monitor the effect of marine debris and microplastics generated by the fishery sector from damaged fishing vessels and equipment to the reduced potential catch and a potential drop in fishery product demand

- Build up the awareness of fishers through the promotion of fishers' awareness programs or activities integrating activities on combating marine debris and microplastics pollution, promotion of the practices and achievements of the programs to encourage fishers to take actions on their own towards minimizing pollutions in the oceans by controlling the dumping of marine debris and microplastics into the waters

- Establish fishery combatting marine debris and microplastic working group and platform to put each plan into action in cooperation with supporting bodies, and share knowledge and implementation successes and failures with the ASEAN Member States (AMSs), especially taking into consideration the best practices, design principles and experiences in combating marine debris for the benefit of all AMSs

8.3 Impacts of COVID-19 Pandemics on Fisheries and Aquaculture

The coronavirus disease 2019 (COVID-19) was declared a global pandemic by the World Health Organization (WHO) on 11 March 2020 as a rapid response to prevent further infections mainly in people. Since then, COVID-19 has immensely threatened public health, created an economic crisis, and destabilized food security. Since the onslaught of the virus has been worldwide, associated measures had been enforced to decrease the extent of risks and the numbers of infected persons, and mortality rates, such as social distancing, transportation restrictions, and home confinements, travel bans, business closures, among others, consequently affecting global economy resulting in uncertainties not only in the livelihood opportunities but also in the sustainability of supplies at the international and domestic supply chains (UN, 2020).

All aspects of the fisheries supply chain, *e.g.* capture fisheries, aquaculture, transportation, post-harvest processing, and trading of fish and fishery products have been strongly impacted by the measures to contain COVID-19 outbreaks. As the Southeast Asia region has been a major contributor to the world's total fish and fisheries production, therefore, such measures could also result in disruptions to fish production and fish consumption across the value chains in the region (FAO, 2021). While much attention has been focused on the impacts on fisheries