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).

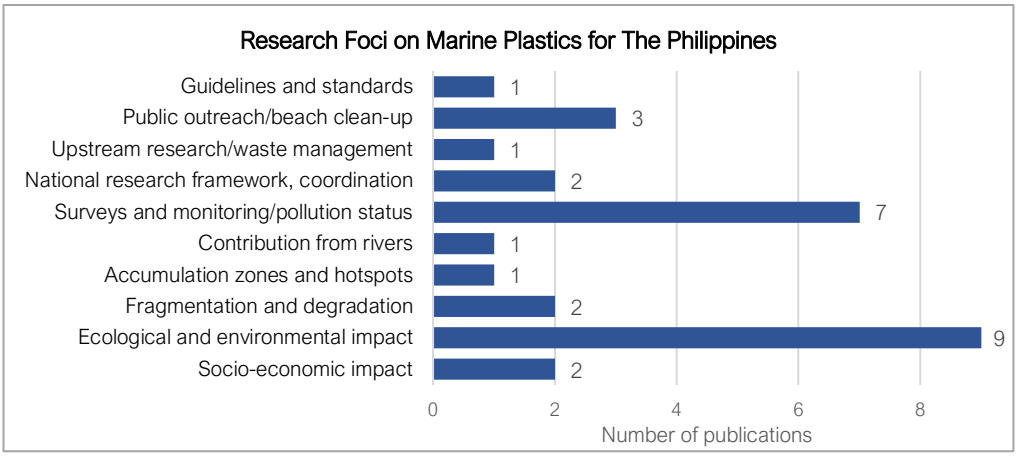

Figure 1.2.7.1. Marine plastic research conducted in The Philippines.

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) 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) 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) 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) 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) 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) 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) 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) 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) 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) 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) Uni of the Philippines Diliman	Examine the potential threat on microplastic pollution on feeding ecology of sardines	2014-2016
Argamino and Janairo (2016) De La Salle Uni	Assess the presence of microplastics in edible bivalves cultured in Bacoor Bay, Cavite, Philippines	Jan 2016
Abreo et al. (2016b) 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) 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) 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).

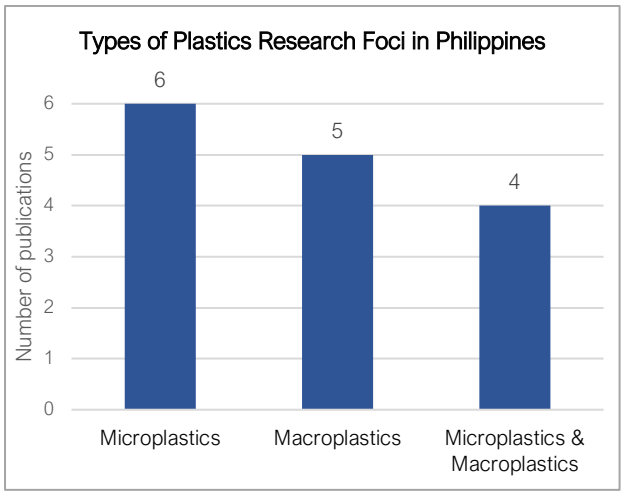

Figure 1.2.7.3. Distribution of marine micro-/macro-plastics researched in the Philippines.

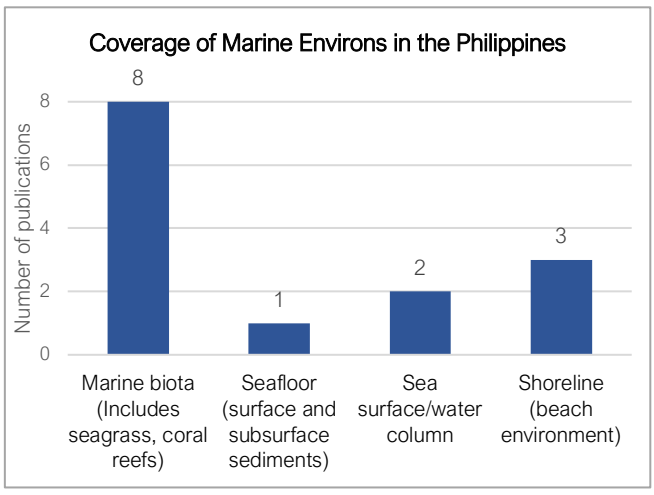

Figure 1.2.7.4. Distribution of marine environs researched in the Philippines.

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.