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Are marine-protected areas sheltered from plastic pollution?

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Plastic is a synthetic and nonmetallic polymer used widely in various industries, such as automotive, construction, electronics, health care, and packaging (PlasticsEurope 2014/2015). It is lightweight, strong, durable, corrosion-resistant, and inexpensive, making it practical to use (Thompson et al. 2004). They come in several types with about 200 kinds currently in production (GESAMP 2015). The versatility and necessity of plastics make them difficult to eliminate. However, there is the growing problem of waste generation with the increase in production.

This *Policy Note* looks into microplastics as the culmination of larger plastics often discarded in the marine environment. It provides recommendations on which plastic types and sources need to be managed and regulated to significantly reduce plastic debris that pollute local marine ecosystems.

Common plastic families and their uses

According to the Department of Trade and Industry (n.d.), polyethylene, polypropylene, polystyrene, and polyethylene terephthalate are the major plastic families used in the Philippines. These plastic families were detected in the marine environment along with other types of plastics. Polyethylene may be in the form of single-use bags, films for food, and other consumer products (PlasticsEurope 2014/2015). In the country, it is often used for sachet packaging (Ang and Sy-Changco 2007). Some polyamides are used in the automotive and electronic products (Wypych 2016). However, most polyamides isolated in the samples are nylon, a type of polyamide used in most fishing nets and gears in the Philippines (Green et al. 2004). In the process of wear and tear, it produces microplastics or, at times, is purposely abandoned or discarded in the sea (Macfayden et al. 2009).

Polyester is commonly used for synthetic fibers, which are also used for textile and strapping materials (Niaounakis 2019). On the other hand, polyethylene terephthalate is used in beverage bottles, packaging films, fibers, and compression molding (Niaounakis 2019). Meanwhile, polyvinyl serves as material for packaging and construction tools, such as pipes, sheets, and flooring (Crawford and Quinn 2017). Polyurethane is used in mattresses and insulation while acrylates are used as superabsorbent material

The Philippines is one of the top three major contributors of plastic marine debris based on waste generation and management schemes. Despite this problem, microplastic pollution remains understudied in the country. Photo: Adam Cohn/Flickr

in consumer products, such as disposable diaper and sanitary napkins (Wypych 2017).

Plastics in the marine ecosystem

The increase in global demand for plastic equates to an increase of plastics waste. Unfortunately, only a small proportion of it is recycled (9%) and incinerated (12%), while the majority is discarded (79%) and often mismanaged (Geyer et al. 2017). It eventually ends up in the marine ecosystem (Jambeck et al. 2015). Plastic debris that enter the marine environment can impair the structure and function of the ecosystem (NOAA 2016). They are pollutants that harm marine life.

Plastic waste can be classified according to size, macro (>25mm), meso (25-5mm) and micro (<5mm) (Crawford and Quinn 2017). Microplastics are further classified according to origin. Primary microplastics are from intentionally produced minute plastic resin pellets, such as those used in the plastics manufacturing process. They can also be manufactured to serve various specific purposes, such as scrubbers and cosmetic microbeads. On the other hand, secondary microplastics are produced from fragmented plastics that underwent structural disintegration of the larger plastics objects (GESAMP 2015).

Microplastic pollution has been given emphasis due to the risk it poses to organisms and the ecosystem. Being small, microplastics are difficult to detect and remove in the environment (Jambeck et al. 2015). Often, marine organisms mistake microplastics for food. When these marine organisms are eaten by higher life forms, such as humans, the microplastics are unintentionally ingested by the latter as well (Crawford and Quinn 2017).

The Philippines is one of the top three major contributors of plastic marine debris based on waste generation and management schemes (Jambeck et al. 2015). However, local field studies on the extent of plastic pollution, particularly on microplastics, are scant. Despite being a global problem, microplastic pollution remains understudied in the Philippines. The characterization of the typologies of the microplastics detected in the marine environment will help in managing vital marine ecosystems.

One such marine ecosystem is Tañon Strait, the country's largest marine protected area located between Cebu and Negros Islands (Aragones et al. 2013; Yu 2016). It is a center of marine shorefish diversity (Baez et al. 2015) and an important migration route of cetaceans (Aragones et al. 2013). Being one of the major fishing grounds in the country (Green et al. 2004), it is heavily exploited and faced with solid waste pollution problems (Baez et al. 2015).

This study focused on the four municipalities in Cebu comprising the eastern Tañon Strait, namely, Badian, Moalboal, San Remigio, and Tabuelan. These municipalities have the same geomorphology and often use Eastern Tañon Strait for fishery and tourism. Water, sediments, and fishes were sampled from eight sites, with one tourism and one nontourism site drawn from each municipality. Samples were analyzed for microplastic occurrence. The study measured microplastic occurrence because it is usually the terminal size of larger plastics after disintegration, although some are purposely manufactured at this size as discussed earlier (GESAMP 2015).

Microplastic abundance and characteristics

Results of laboratory tests showed that microplastic abundance in the water of Tañon Strait ranged from 0 to 1.5 items/liter. Meanwhile, its abundance in the sediments ranged from 0 to 39.72 items/kilogram dry weight. These results were higher compared to microplastic occurrence in some bodies of water in other countries, such as China (Zhao et al. 2014), but lower compared to those in Europe (Lorenz et al. 2019). China and the Philippines have almost the same waste management scheme (Jambeck et al. 2015).

The standing stock of microplastics in a marine ecosystem depends on several factors, such as the use of the specific body of water. Although not significant, sites used for tourism had relatively higher microplastic abundance compared to sites not used for tourism. However, microplastics are labile and easily transported by wind and current (Hamid et al. 2018).

Meanwhile, microplastic abundance in the rabbitfishes ranged from 0 to 2 items per fish in the following order: *Siganus virgatus, Siganus guttatus, Siganus canaliculatus*, and *Siganus spinus*. These results are comparable to other studies on rabbitfishes in other countries (Baalkhuyur et al. 2018). Although the tests done in this study were limited to extracted microplastics from the gut of the fishes, there is likely occurrence of human exposure because salted fish gut, locally known as "dayok", is a common delicacy among Filipinos (Bucol et al. 2019). Fishes are also processed as a whole, including the visceral organs, in making fish brine or fish paste (Woodland 1997). Some fishes are also added to animal feeds for farmed organisms (Hantoro et al. 2019).

Plastic debris that enter the marine environment can impair the structure of the ecosystem. They are pollutants that harm marine life. In this photo, a seahorse has sought refuge alongside a discarded plastic bag in Subic, Philippines. Photo: Klaus Stiefel/Flickr

A direct relationship between size of the species and microplastic abundance rate was observed. This suggests that the larger the size of the species, the more likely they are contaminated with microplastics. Since microplastic ingestion is often associated with food intake, organisms with larger food requirements are more likely to ingest more microplastics.

For all compartments studied, the majority of microplastics isolated were fragments with a size smaller than 1 mm and white in color. However, the shape, not color, often suggests the origin of the plastics (Wu et al. 2019). In many instances, fragments are from larger plastics that underwent fragmentation (Wu et al. 2019), implying that the microplastics isolated in the samples were from larger plastic debris that ended up in the marine environment.

The most abundant plastic types isolated in the water samples were polyethyelene while polyamide was abundant in the sediments. Polyethylene, which has the lightest density among the polymers detected in the samples, was the most abundant in the surface water. Polyamide, denser than polyethylene, was abundant in the sediments. Regardless of being originally lightweight, these polymers may become dense due to the accumulation of organisms, such as bacteria or algae on the plastic surface and eventually settle in the sediments. They can also be redistributed in the water column due to storm, turbulence, salinity, and turbidity (Anderson et al. 2016). Other plastic types isolated in the samples were polyester, polyethylene terephthalate, polyvinyl chloride, polyurethane, and acrylates.

Policy implications and recommendations

The relatively high microplastic occurrence in Tañon Strait shows that the Philippines has been contributing a substantial volume of plastic debris into the marine ecosystem. This calls for proper waste disposal to mitigate the problem of plastic pollution. Evidence also suggests that these pollutants are most likely generated from single-use plastic items, hence the need to shift from the current throw-away society.

These microplastics are from plastics largely used in the packaging industry. As such, policies to reduce single-use packaging, particularly polyethylene-based plastics, should be pursued. Although critics claim that these are tangible items, single-use plastics have received so much scrutiny and thus may leave more complex plastic objects unobserved (Nielsen 2019). While this tenet may hold true, banning single-use plastic bags and wrappers can substantially reduce the waste stream in the country. Nonetheless, this may not be economically sound considering the preference of Filipinos for sachets over bottles due to economic constraints (Ang and Sy-Changco 2007). The adoption of policies that provide economic incentives to manufacturers to find substitutes, such as biopolymers (Hopewell 2009; Nielsen 2019), is therefore highly recommended. Another direction would be the use of disincentives or take-back schemes (Hopewell 2009; Nielsen 2019) if fossil-based sachets are used by manufacturers to package their products.

The abundance of polyamides should also lead to the prohibition of discarding nets in seas, which is notoriously a common practice in the Philippines. The occurrence of other polymers possibly coming from textiles, construction materials, diapers, and sanitary napkins, is a clear indication that these materials are improperly disposed of. Hence, options on how to treat this type of wastes should be considered. These may include recycling and energy recovery, especially for the residual wastes, such as diapers and sanitary napkins.

This study is limited to only one body of water in the Philippines. Future research should therefore sample other bodies of water, including freshwater ecosystems, to track the sources and sink of plastic pollution in the country.

References:

Ang, R. and J. Sy-Changco. 2007. The phenomenon of sachet marketing: Lessons to be learned from the Philippines. *Advancing Knowledge Development in Marketing* 18:5–15.

Aragones, L., L. Talaue-McManus, M.A.A. Roque, A.K.S. Amor, and E.O. Keith. 2013. Dolphin watching in the southern Tañon Strait protected seascape, Philippines: Issues and challenges. *Science Diliman* 25(2):1–33.

Baalkhuyur, F.M., E. Bin Dohaish, M. Elhalwagy, N. Alikunhi, A. AlSuwailem, A. Røstad, D.J. Coker, M.L. Berumen, C.M. Duarte. 2018. Microplastic in the gastrointestinal tract of fishes along the Saudi Arabian Red Sea coast. *Marine Pollution Bulletin* 131:407–415.

Baez, S., C. Grubb, M. Stiles, and G. Ramos. 2015. Love letter to Tañon Strait. Washington, D.C.: Oceana.

Bucol, L, E. Romanos, S. Cabcaban, L.M. Siplon, G.C. Madrid, A. Bucol, and B. Polidoro. 2019. Microplastics in marine sediments and rabbitfish (Siganus fuscescens) from selected coastal areas of Negros Oriental, Philippines. *Marine Pollution Bulletin* 150:110685.

Crawford, C.B. and B. Quinn. 2017. *Microplastics pollutants*. Amsterdam, Netherlands: Elsevier.

Department of Trade and Industry (DTI). n.d. Securing the future of Philippine industries. Makati City, Philippines: DTI. https://www.dti.gov.ph/ (accessed on October 30, 2019).

Geyer, R., J.R. Jambeck, and K.L Law. 2017. Production, use, and fate of all plastics ever made. *Science Advances* 3:e1700782.

Green, S.J., J.O. Flores, J.Q. Dizon-Corrales, R.T. Martinez, D.R.M. Nuñal, N.B. Armada, and A.T. White. 2004. The fisheries of Central Visayas, Philippines: Status and trends. Quezon City, Philippines: Department of Environment and Natural Resources and the Bureau of Fisheries and Aquatic Resources.

Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP). 2015. Sources, fate and effects of microplastics in the marine

environment: A Global Assessment. London, United Kingdom: GESAMP.
Hamid, F.S., M.S. Bhatto, N. Anuari, P. Mohan, and A. Periathamby. 2018. Worldwide distribution and abundance of microplastic: How dire is the situation? *Waste Management & Research* 36(10):873–897.
Hantoro L., A.J. Lohr, E.G. van Belleghem, B.M. Widianarko, and A.M. Ragas. 2019. Microplastics in coastal areas and seafood: Implications for food safety. *Food Additives & Contaminants: Part A* 36(5):647–711.
Hopewell, J., R. Dvorak, and E. Kosior. 2009. Plastics recycling: Challenges and opportunities. *Philosophical Transactions of the Royal Society* 364:2115–2126.
Jambeck, J., R. Geyer, C. Wilcox, T. Siegler, M. Perryman, A. Andrady, R. Narayan, and K.L. Law. 2015. Plastic waste inputs from land into the ocean. *Science* 347(6223):768–771.
Loren, C., Roscher, L, Meyer, M., Hildebrandt, L, Prume, J., Loder, M., Primpke, S. and G. Gerdt. 2019. Spatial distribution of microplastics in sediments andsurface waters of the southern North Sea. *Environmental Pollution* 252:1719-1729.
Niaounakis, M. 2017. *Management of Marine Plastic Debris*. Amsterdam, Netherlands: Elsevier.
Nielsen, T.D., J. Hasselbach, K. Holmberg, and J. Stripple. 2019. Politics and the plastic crisis: A review throughout the plastic life cycle. In *WIREs Energy and Environment*. Hoboken, NJ: Wiley Periodicals Inc.
National Oceanic and Atmospheric Administration Marine Debris Program (NOAA). 2016. Report on marine debris impacts on coastal and benthic habitats. Silver Spring, MD: NOAA Marine Debris Program.
PlasticsEurope. 2014/2015. An analysis of European plastics production, demand and waste data. https://www.plasticseurope.org/application/files/5515/1689/9220/2014plastics_the_facts_PubFeb2015.pdf (accessed on July 20, 2018).
Thompson, R., Y. Olsen, R. Mitchell, A. Davis, S. Rowland, A. John, D. McGonigle, and A. Russel. 2004. Lost at sea: Where is all the plastic? *Science* 304(5672):838.
Woodland, D. 1997. Siganidae. Rabbitfishes (Spinefoot). In *FAO Identification Guide for Fishery Purposes*, edited by K.E. Carpenter and V. Nien. Kolonia, Micronesia: The West Central Pacific.
Wu, P., J. Huang, Y. Zheng, Y. Yang, Y. Zhang, F. He, H. Xhen, G. Quan, J. Yan, T. Li, and B. Gao. 2019. Environmental occurrence, fate and impacts of microplastics. *Ecotoxicology and Environmental Safety* 184:109612.
Wypych, G. 2016. *Handbook of polymers*. 2nd ed. Ontario, Canada: ChemTec Publishing.
Yu, J.M. 2016. Cebu Economic Factbook 2016. Cebu City, Philippines: Cebu Economic and Business Unit.

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