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INTERNATIONAL COOPERATION ON MARINE PLASTIC WASTE

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LIST OF ABBREVIATIONS

APEC	Asia-Pacific Economic Cooperation
ASEAN	Association of Southeast Asian Nations
CCNY	City College of New York
CLOMA	Clean Ocean Material Alliance
EU	European Union
EVOH	Ethylene-vinyl alcohol copolymer
G7	Group of Seven
G20	Group of Twenty
GDP	Gross domestic product
MSW	Municipal solid waste
PCE	Personal consumption expenditure
PCBs	Polychlorinated biphenyls
PCE	Personal consumption expenditure
PET	Polyethylene terephthalate
SDGs	Sustainable Development Goals
3Rs	Reduce, Recover, Recycle
UNEA	The United Nations Environment Assembly
UNEP	United Nations Environmental Programme

Introduction

A picture showing a plastic straw thrown away on the sea shore stuck to the nose of a sea turtle shocked people all over the world, many of whom asked companies and governments to respond to the marine plastic waste problem. At the G7 summit held in Canada in 2018, five of the Group of Seven (G7) nations agreed to an ocean plastics charter that includes the goal of reducing single-use plastics. The United States and Japan did not join this charter because the cause-and-effect relationship was unclear and the impact on industry and society was enormous. In Japan, it was widely broadcast that the nation was not a part of this agreement, and this issue was widely recognized among Japanese citizens. At the same time, this decision by the Japanese government was greatly criticized. The Japanese government argued that this issue needed to be discussed not only in developed countries, but also in developing countries, and at the Group of 20 (G20) summit held in Japan in June 2019 a new framework for marine plastic waste issues was launched. Recently, the marine plastic waste problem has been actively discussed at other international conferences such as UNEA and APEC as a new global environmental issue. The growing international public concern has prompted the European Union (EU) government and the governments of some countries mainly in Europe to strictly regulate various plastics. Global chemical companies created an organization to take action to solve the marine plastic waste problem and voluntarily invested heavily in this organization.

I am very concerned that many kinds of frameworks related to the regulation of plastics were discussed at various international conferences without a full understanding the overall picture of the marine plastic waste problem. Relationships between causes and effects, for example, are unclear in most data from previous studies of the marine plastic waste problem.

On that basis, I would like to examine three issues in this paper.

① Why do we need to address the marine plastic waste problem?

② How does the problem affect the ecosystem and environment? How do we evaluate the severity of the problem?

③ How should we solve this problem? What roles should governments play?

The impact of plastics around the world

Plastic has made our lives extremely convenient

Plastics are used throughout our lives and are now essential to our daily existence. They are widely used, for instance, as packaging for storing foods, plastic bags for carrying things or throwing away garbage, and materials for manufacturing household appliances, as well as in automobiles. In addition, plastic is the foundation that supports various industries. In the medical sector, plastic is used for blood transfusion bags, tubes, catheters, syringes, and the like. In the agricultural sector, greenhouses are made of vinyl chloride resin or polyethylene film. In the fishery sector, most fishing gear is made of plastic.[1]

There are various types of plastics. Some are resistant to heat and others are strong. Even if the desired function(s) cannot be achieved with only one plastic, a new product having the strength of two or more plastics can be manufactured by mixing different plastics. For example, if polyethylene with impact resistance, but poor gas barrier properties, and ethylene-vinyl alcohol copolymer (EVOH), with excellent barrier properties, are multilayered, new plastics with impact resistance and long-term storage stability can be manufactured. Many kinds of plastics have been

[1] The Japan Plastics Industry Federation. http://www.jpif.gr.jp/00plastics/conts/iroirona_plastics.pdf. Accessed 19 May 2020.

developed according to the purpose of each product, so there are more than 100 types of plastics.[2]

Compared with other materials, such as iron, non-ferrous metals, paper, and glass, plastic is often superior in terms of functionality and cost. Therefore, plastic has replaced these materials in a number of products. Among packaging materials, for instance, plastics have widely replaced paper and glass in order not only to reduce costs, but also to reduce the need for transportation fuel by extending the expiration date of food and reducing the weight of packaging materials. Kewpie Corporation, one of Japan's major food companies, for instance, has changed the material for its dressing bottles from glass to plastic.[3]

In addition, there is a movement to use plastics to solve social and environmental problems. In the past, automobiles and airplanes were made of metal in order to maintain their body strength. On the other hand, plastic innovations have led to new plastics that are lighter and more durable than iron. Carbon fiber reinforced plastic is an example. According to Boeing, the Boeing 787 fuselage is composed almost half of carbon fiber reinforced plastic and other composite materials. This achieves an average weight reduction of 20 percent compared to conventional aluminum designs.[4]

Similarly, in order to reduce the weight of automobile bodies, there is a movement to change some parts of the bodies of automobiles from metal such as iron to plastic. As a result of the resultant weight reduction, fuel efficiency is improved. Plastics are also expected to contribute greatly to the resolution of global warming, a major environmental problem.

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[2] Plastic Packaging Recycle Council. http://www.pprc.gr.jp/plastics/ppr.html. Accessed 19 May 2020.

[3] Kewpie Corporation. https://www.kewpie.co.jp/dressing/history/. Accessed 19 May 2020.

[4] The Boeing Company. https://www.boeing.com/commercial/aeromagazine/articles/qtr_4_06/article_04_2.html. Accessed 19 May 2020.

Current status and future prospects of plastic production and consumption

As noted above, plastics have advantages in terms of function and cost compared to other materials, so the production and consumption of plastics are dramatically increasing worldwide. Plastic production soared to over 400 million tons per year in 2015, versus 2 million tons in 1950. This will increase to more than 600 million tons by 2035, as more and more applications are adopted.[5]

Packaging plastics, called single-use plastics, account for 36 percent of plastic production. Looking at the production volume of single-use plastics by region, Northeast Asia accounts for 26 percent, North America 21 percent, and Europe 16 percent. Thus, Asia leads the world in this regard.[6]

Global primary plastics waste generation accounted for more than 300 million tons worldwide in 2015, with plastic packaging waste accounting for 47 percent of global plastic waste, half of which came from Asia. China is the world's largest source of plastic packaging waste, but on a per capita basis, the United States is no. 1, followed by Japan and the EU.[7]

[5] *The New Plastics Economy: Rethinking the Future of Plastics*, 2016, Policy File; UN Environment report, *Single-Use Plastics: A Roadmap for Sustainability,* 2018; "Calculating the Total Amount of Plastics." *Science and Children*, Vol. 55, No. 2, 2017, pp. 16–17.

[6] UN Environment report, *Single-Use Plastics: A Roadmap for Sustainability,* 2018

[7] UN Environment report, *Single-Use Plastics: A Roadmap for Sustainability,* 2018; Geyer, Roland, et al. "Production, Use, and Fate of All Plastics Ever Made." *Science Advances*, Vol. 3, No. 7, 2017.

Plastic manufacturing and disposal processes

Many plastic products are manufactured from fossil resources. Plastic materials with the necessary functions are manufactured by polymerizing basic chemicals such as ethylene and propylene obtained by thermal decomposition of naphtha, or by adding additives. Plastic materials are molded and processed into plastic products and used for final applications. Plastic products are broadly divided into single-use plastics such as plastic bags and polyethylene terephthalate (PET bottles), and products that are used repeatedly. After being used as plastic products and thrown away, they are processed and disposed of by recycling, incineration, landfill, and other methods.

The total amount of virgin plastics produced cumulatively by 2015 is estimated to be 8.3 billion tons worldwide. It is also estimated that 6.3 billion tons of plastics waste is generated cumulatively by 2015, 9 percent of it recycled, 12 percent incinerated, and 79 percent stored in landfills or in the natural environment. Some studies estimate that approximately 20 billion tons of plastic waste will be in landfills or the natural environment by 2050 if current production and waste management trends continue.[8]

In Japan, based on the principles stipulated in the Basic Law for the Promotion of Recycling-Oriented Society, Reduce Recover Recycle (3R) plastics and proper treatment have been encouraged. Therefore, Japan has cut down on plastic waste through the reduction of packaging plastics and effective utilization rates, which means the ratio of recycling plastic waste or energy recovery was 85.8 percent in 2017. Nine million tons of plastic waste are generated annually in Japan, of which, 23.4 percent is material recycled, 4.4 percent is chemically recycled,

[8] Geyer, Roland, et al. "Production, Use, and Fate of All Plastics Ever Made." *Science Advances*, Vol. 3, No. 7, 2017, pp. ?? Science Advances, 2017 Jul, Vol. 3(7).

58.0 percent is energy recovered, 8 percent is subjected to simple incineration, and 6 percent goes to landfills.[9]

The volume of plastic waste collected in Europe was 27.1 million tons in 2016 of which 31.1 percent was recycled, 41.6 percent heat recovered, and 27.3 percent landfilled. In addition, 37 percent of recycled plastic waste is recycled outside the EU.[10] The volume of plastic waste collected in United States in 2015 was 34.5 million tons of which, 9.1 percent was recycled, 15.5 percent heat recovered, and 75.4 percent landfilled.[11] Thus, as a method for treating plastic waste, the ratio of heat recovery is high in Japan and the ratio of landfill is high in Europe and the United States

The annual volume of globally traded plastic waste is around 15 megatons (mt), less than 5 percent of the weight of new plastics production in 2012, and China received around 56 percent of global imports by weight.[12] China needs affordable secondary plastics to meet the increased demand for plastic products. The nation has banned plastic waste imports, however, since 2018. Recently, disposal of plastic waste from Japan and the EU, which can no longer be exported to China, has shifted to Southeast Asia. Some of these countries, in turn, are also considering banning imports of plastic waste as China has done, and it is time to reconsider what Japanese and EU waste plastics recycling systems should do.

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[9] The Japan Plastics Industry Federation. Status of production, disposal, recycling and disposal of plastic products in 2017. http://www.pwmi.or.jp/pdf/panf2.pdf. Accessed 19 May 2020.

[10] Plastics Europe. https://www.plasticseurope.org/application/files/5715/1717/4180/Plastics_the_facts_2017_FINAL_for_website_one_page.pdf. Accessed 19 May 2020.

[11] Environmental Protection Agency. https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/plastics-material-specific-data. Accessed 19 May 2020.

[12] Velis, Costas (2014). *Global recycling markets – plastic waste: A story for one player – China.* ISWA. Vienna, September 2014.

Since China banned the import of plastic waste in 2018, exports of plastic waste from developed countries such as Japan have shifted from China to Southeast Asia, such as members of the Association of Southeast Asian Nations (ASEAN). Some Southeast Asian countries, however, have also introduced new regulations on the import of waste plastic. In June 2018, for instance, Thailand and Vietnam introduced regulations for the import of plastic waste for the first time in the ASEAN region. The following month, Malaysia introduced regulations on the import of plastic waste. India completely banned the import of plastic waste on August 31, 2019. In addition, Indonesia is considering restricting or banning the import of plastic waste.[13]

In the past, an international circular economy has been realized in which plastic waste is recycled and reused in countries with low economic costs, so-called emerging Asian countries. On the other hand, it is likely that such nations have started to be concerned about the issue of waste generated by the production activities of developed countries imposed on them.
In principle, where trade should be free, plastic waste has aspects of both goods and waste. Therefore, if a country regulates the import of plastic waste for environmental reasons, this regulation is not necessarily considered an international trade issue. As a result, in order to increase the recycling rate of plastic waste in developed countries, it is necessary to increase the percentage of domestic waste recycling rather than exporting to emerging countries. This is a major hidden issue surrounding plastic waste.

In the past, for example, Japan considered whether to build a domestic plastic waste recycling facility or to export plastic waste to emerging Asian countries such as China and recycle it overseas. As a result and from the viewpoint of economic rationality, Japan decided to export plastic waste to China and other emerging Asian countries and then recycle it overseas. If the product itself is harmful, it is considered bad to export it from developed countries to

[13] JETRO: https://www.jetro.go.jp/biz/areareports/2019/32168afb4b8f0bfe.html. Accessed 19 May 2020.

emerging countries for economic reasons, but plastic waste itself is not dangerous, and it is useful if it is properly recycled. Considering the world as a whole, banning the import of plastic waste by emerging nations would be economically unreasonable in terms of promoting the recycling of plastic waste.

If third-party international organizations, such as the United Nations, truly want to increase the effective use of plastic waste worldwide, they should make efforts to stop emerging nations from regulating plastic waste imports. Otherwise, the recycling of non-economic plastic waste in developed countries is expected to increase, which may lead to a slowdown in the realization of a circular economy.

Trends in marine plastic waste

What is the marine plastic waste problem?

In recent years, the outflow of plastic waste into the ocean has attracted attention as a major global environmental problem. According to some research results, 70-80 percent of marine waste is plastic.[14] In 2015, more than several million tons of plastic were dumped from land into the oceans.[15] A large percentage of the outflow of plastic waste into the oceans of the world is caused by China and Southeast Asian countries. In addition, 16 of the top 20 such nations are middle-income countries and lack infrastructure for plastic waste management.[16] In

[14] Derraik, José G.B. "The Pollution of the Marine Environment by Plastic Debris: A Review." *Marine Pollution Bulletin*, Vol. 44, No. 9, 2002, pp. 842–52.

[15] Geyer, Roland, et al. "Production, Use, and Fate of All Plastics Ever Made." *Science Advances*, Vol. 3, No. 7, 2017.

[16] Jambeck, Jenna R, et al. "Marine Pollution. Plastic Waste Inputs from Land into the Ocean." *Science (New York, N.Y.)*, Vol. 347, No. 6223, 2015, pp. 768–71.

2016, it was estimated that the weight of plastic in the ocean would increase to the level of fish in 2050.[17]

Plastic waste that flows into the ocean can be divided into “macroplastics” that maintain their shape, such as PET bottles, and “microplastics” that are fine plastic pieces 5 mm or less in size. The environmental impact of each plastic is different.Most commonly used plastic products are “macroplastics.” Examples of “microplastics” include cosmetic scrub beads, resin pellets, clothing fibers, and so on. In addition, “macroplastics” are decomposed and micronized with ultraviolet rays to become “microplastics.” A plastic bag is a typical example. The former is called a primary microplastic and the latter is called a secondary microplastic.

Specific environmental impacts

A report published by the United Nations Environmental Programme (UNEP) in 2018[18] shows the environmental and economic impacts of marine plastic waste. In terms of the environmental impact, fish may mistakenly ingest styrene foam products containing toxic chemicals such as butadiene and benzene, or packaging plastics adsorbing toxic chemicals, and eventually enter the food chain for humans as well.

In terms of the economic impact, stranded single-use plastics create visual pollution and are increasingly becoming a priority especially in countries that rely heavily on tourism as a major source of GDP, such as Small Island Developing States. In previous studies, high-level predators such as whales, sea turtles, and – in particular – seabirds were found to eat plastics in

[17] *The New Plastics Economy: Rethinking the Future of Plastics*, 2016, pp. Policy File.

[18] UN Environment report, *Single-Use Plastics: A Roadmap for Sustainability,* 2018

the ocean.[19] It is thought that plastic tends to collect in the tidewaters where seabirds often catch food, so they mistakenly feed on the plastic floating on the surface.[20] In recent years, it has been reported that plankton, fish, shellfish, etc. are ingesting microplastics.[21]

In addition, plastics floating in the ocean contain additives such as antioxidants and flame retardants, and there are concerns about their toxicity. Further, plastic is a highly hydrophobic material, and harmful chemicals such as polychlorinated bihenyls (PCBs) floating in the ocean are also highly hydrophobic, so that harmful chemicals have an affinity for plastic. Therefore, harmful chemicals floating in the ocean are adsorbed on the plastic.[22] Although PCBs were used in capacitors and other insulators until the 1970s, they are now banned from being manufactured as hazardous chemicals.

In this way, there is a concern about the impact of ingesting hazardous chemicals through plastics. Specifically, some researchers hypothesize that this causes intestinal obstructions, gastric ulcers and reduced digestive ability.[23] There has been little evidence of gastric ulcers in seabirds, however, and this hypothesis has not yet been proven.[24]

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[19] Derraik, José G.B. "The Pollution of the Marine Environment by Plastic Debris: A Review." *Marine Pollution Bulletin*, Vol. 44, No. 9, 2002, pp. 842–52.

[20] Ryan, Peter G. "The Incidence and Characteristics of Plastic Particles Ingested by Seabirds." *Marine Environmental Research*, Vol. 23, No. 3, 1987, pp. 175–206.

[21] Tanaka, Kosuke, and Hideshige Takada. "Microplastic Fragments and Microbeads in Digestive Tracts of Planktivorous Fish from Urban Coastal Waters." *Sci Rep*, Vol. 6, No. 1, 2016, p. 34351; Desforges, Jean-Pierre, et al. "Ingestion of Microplastics by Zooplankton in the Northeast Pacific Ocean." *Archives of Environmental Contamination and Toxicology*, Vol. 69, No. 3, 2015, pp. 320–30.

[22] Mato, et al. "Plastic Resin Pellets as a Transport Medium for Toxic Chemicals in the Marine Environment." *Environmental Science & Technology*, Vol. 35, No. 2, 2001, pp. 318–24.

[23] Pierce, K.E. & Harris, R.J. & Larned, Lela & Pokras, Mark. "Obstruction and starvation associated with plastic ingestion in a Northern Gannet Morus bassanus and a Greater Shearwater Puffinus gravis,", *Marine Ornithology*, 32, 2004, pp. 187-89.

[24] Rei Yamashita, Kisuke Tanaka and Hideshige Takada. "Marine Plastic Pollution: Dynamics of plastic debris in marine ecosystem and effect on marine organisms." *Journal of the Ecological Society of Japan*, 66, 2016, pp. 51-68.

Evaluation of this issue

It is certain that plastic has the property of adsorbing hazardous chemicals and there are organisms that accidentally ingest plastic. It has not been reported so far, however, that the fish we may eat is seriously polluted or that eating it has affected human health. In other words, although there may be some environmental impact, it cannot be determined at this time whether there are ecological impacts.

In addition, there are concerns about the possibility that living organisms may accidentally ingest harmful chemical substances and adversely affect the ecosystem, but plastic is only a medium. In addition, as pointed out by UNEP, microplastics themselves are also contained in tap and drinking water, but there have been no reports of health damage caused by them. Therefore, the first priority is to eliminate harmful chemical substances in the ocean.

Plastic waste is flowing into the ocean mainly from China and Southeast Asia. It is important that countries, companies, and non-profit organizations work together to build a proper plastics recycling system for emerging Asian countries, rather than restricting the use of single-use plastics in developed countries.

International Efforts to Solve the Marine Plastic Waste Problem

Efforts by the G7, G20, or the UN

At the G7 Elmau Summit in 2015, marine plastic waste was first discussed.[25] In addition, at the United Nations Summit in September 2015, Sustainable Development Goals (SDGs) were

[25] Leaders' Declaration G7 Summit 7-8 June 2015 https://sustainabledevelopment.un.org/content/documents/7320LEADERS%20STATEMENT_FINAL_CLEAN.pdf#search='G7+Elmau+Summit+marine+plastic. Accessed 19 May 2020.

adopted as goals to be achieved by 2030.[26] The 14th goal is to conserve and sustainably use the oceans, seas, and marine resources for sustainable development, and, by 2025, this would be expected to prevent and/or significantly reduce marine pollution of all kinds, including marine debris and nutrient pollution, in particular, from land-based activities.[27]

In February 2017, UNEP launched Clean Seas, a global campaign aimed at eradicating a major cause of marine litter. Specifically, by 2022, it required control of the use of microplastics contained in cosmetics, etc., and excessive and wasteful single-use plastics. More than 50 countries have already declared their participation in this initiative.[28]

In addition, the United Nations Ocean Conference was held in 2017, and it was agreed that a long-term and reliable strategy for the use of microplastics and plastics, especially the reduction of plastic bags and single-use plastics, would be implemented[29] Many participating countries have announced policies such as the reduction of various single-use plastic products that are often dumped into the sea. At the G7 Summit held in Charlevoix, Canada in 2018, the "Ocean Plastics Charter" was adopted (except for the United States and Japan). The charter calls for a significant reduction in the use of single-use plastics.[30]

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[26] UN: Sustainable Development Goals https://sustainabledevelopment.un.org/sdgs. Accessed 19 May 2020.

[27] UN: Transforming our world: the 2030 Agenda for Sustainable Development https://sustainabledevelopment.un.org/post2015/transformingourworld. Accessed 19 May 2020.

[28] UNEP: Surfing a wave of change: Clean Seas campaign celebrates two years of action https://www.unenvironment.org/news-and-stories/story/surfing-wave-change-clean-seas-campaign-celebrates-two-years-action. Accessed 19 May 2020.

[29] UN: Our ocean, our future: call for action https://www.un.org/ga/search/view_doc.asp?symbol=A/RES/71/312&Lang=E. Accessed 19 May 2020.

[30] Ocean Plastics Charter https://www.canada.ca/en/environment-climate-change/services/managing-reducing-waste/international-commitments/ocean-plastics-charter.html. Accessed 19 May 2020.

The G20 summit held in Japan in 2019 did not impose any single-use plastic usage reduction targets for each country. It did, however, agree to the "G20 Implementation Framework for Actions on Marine Plastic Litter"[31] to collect plastic waste, promote related innovation, and conduct international cooperation. This framework has been agreed to by all G20 participating countries, including the United States and Japan.

Thus, while the "Ocean Plastics Charter" is aimed at reducing the use of single-use plastics as one main target, the "Marine Plastic Waste Countermeasure Implementation Framework" is aimed at solving this problem with a different approach. As will be described in detail in the following discussion, the former is a regulation approach that is being undertaken mainly in Europe, while the latter is a promotion approach that Japan is trying to adopt. We will examine the evaluation of these two approaches later.

The EU Approaches to Reduce Marine Plastic Waste

In 2015, the European Commission published the Circular Economy Package,[32] showing how the EU can reduce plastic waste. This package consists of an action plan for transition to a circular economy and amendments to the Waste Directive. The main goals of the revised Waste Directive are: "By 2030, reduce the recycling rate of local government waste to 65 percent." "By 2030, reduce the recycling rate of container and packaging waste to 75 percent." "By 2030, landfill waste" to 10 percent or less of municipal waste." As for plastics, it also describes measures to reduce marine plastic waste to achieve the SDGs.

[31] G20 Implementation Framework for Actions on Marine Plastic Litter https://www.g20karuizawa.go.jp/assets/pdf/G20%20Implementation%20Framework%20for%20Actions%20on%20Marine%20Plastic%20Litter.pdf#search='Marine+Plastic+Waste+Countermeasure+Framework. Accessed 19 May 2020.

[32] Closing the loop - An EU action plan for the Circular Economy http://ec.europa.eu/environment/circular-economy/index_en.htm. Accessed 19 May 2020.

In addition, the European Commission announced its plastics strategy in 2018 under the Circular Economy Package.[33] The reasons behind the adoption of this strategy include an increase in plastic waste in Europe, a low rate of waste recycling and effective utilization, an increase in marine waste, and an increase in greenhouse gas emissions. This strategy presents two visions, 14 goals, and about 40 specific measures. The goals that are particularly relevant to addressing the marine plastic waste problem are as follows.

- By 2030, all plastic packaging in the EU market will be reusable or recyclable in a cost-effective manner.
- Separate collection and recycling of European plastics by 2030.
- Capacity is quadrupled compared to 2015, creating 200,000 new jobs in related industries in Europe.
- Improved methods for separating and collecting plastics, innovation, and enhancement of recycling capacity have eliminated exports of unsorted plastics, and the value of recycled plastics as a raw material for industry will increase in Europe and abroad.

The main action plans to achieve these goals are as follows.

- Revision of the Waste Containers and Packaging Directive: Preparation of harmonized rules to ensure that all plastic packaging materials in the EU market are recycled in a cost-effective manner by 2030;
- Analysis, including public consultation, to determine the scope of laws and regulations on single-use plastics;
- Formulation of measures to reduce the loss and disposal of fishery equipment in the ocean (including recycling targets, extended producer responsibility schemes, recycling funds, and deposit systems);
- Start of process to regulate the use of oxidized plastics through REACH;
- Formulation of measures to reduce plastic pellet leakage;
- Direct funding for infrastructure and innovation through the European Fund for Strategic Investment and other EU funding methods;
- International commitments on plastics and marine litter, as amended by the UN, G7, G20, the Malpol Convention, and the Regional Marine Treaty, including the development and efforts of practical tools in the field of fisheries and aquaculture; and
- Support for formulation of international industrial standards for separated plastic waste and recycled plastic.

[33] European Strategy for Plastics in a Circular Economy http://ec.europa.eu/environment/circular-economy/pdf/plastics-strategy.pdf. Accessed 19 May 2020.

In European environmental regulations, the EU Commission mainly establishes directives on regulations and requires each EU member state to take actions to comply with the regulations described in the directives within a certain period of time.

As a directive related to the action on the marine plastic waste problem, first of all, the EU Plastic Bags Directive as regards reducing the consumption of lightweight plastic carrier bags was established in 2015.[34]

Approximately 100 billion plastic bags are consumed annually in the EU, which translates to an annual consumption of 200 per capita. Furthermore, the recycling rate of plastic bags is about 7 percent, and disposal into the environment, especially the impact on the marine environment, has become a problem. This directive is intended to address the marine plastic waste problem.

"In the sea, they (discarded plastic bags) have a devastating effect on marine life that gets entangled in plastic debris or ingests it in the form of microplastics."

The directive requires each EU member state to take actions to comply with either of the following by the end of 2018:

A. Reduce the annual per capita usage of plastic bags with a thickness of more than 15 μm and less than 50 μm to 90 sheets or less by 2019 and 40 sheets or less by 2025.
B. Charge for the cost of plastic bags with a thickness of more than 15 μm and less than 50 μm, or implement an equally effective measure.

Plastic bags with a thickness of less than 15 μm are not regulated probably because they are broadly used to wrap various fresh foods for the purpose of keeping them fresh. In addition,

[34] DIRECTIVE (EU) 2015/720 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 29 April 2015 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32015L0720&from=EN. Accessed 19 May 2020.

plastic bags with a thickness of more than 50 μm are likewise not regulated probably because they can be easily reused. The appropriateness of the thickness subject to this regulation, however, is not necessarily clear.

Based on this EU directive, each EU country takes action on this regulation. In France, for example, single-use plastic bags with a thickness of less than 50 μm for shopping were prohibited in 2016; in 2017, single-use plastic bags were prohibited altogether. This does not apply to bags that contain a certain percentage or more of biomass material, however, and can be composted at home.[35] Italy has banned the use of regular plastic bags since 2012. Biodegradable and evacuable plastic bags, plastic bags with a certain thickness or more, and recycled plastic raw materials used in a certain percentage, and bags made of paper and natural fibers, though, are not prohibited. In addition, in 2017, non-prohibited plastic bags with a thickness of less than 15 μm were limited to those that could be provided for a fee and were fertilizable and had a biomass percentage of 40 percent or more. In Germany, the Federal Ministry of the Environment and the German Retail Association have agreed to charge for more than 80 percent of plastic bags distributed at retail stores by 2018.[36] Based on the agreement, since July 2016, customers have been paying for plastic shopping bags provided at supermarkets. The price of plastic bags is determined by the retailers.

[35] Article 75 of the Law https://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000031044385&categorieLien=id. Accessed 19 May 2020; Government in France https://www.ecologique-solidaire.gouv.fr/sites/default/files/Questions-r%C3%A9ponses%20sur%20les%20sacs%20autres%20que%20les%20sacs%20de%20caisse.pdf. Accessed 19 May 2020.

[36] German Economic Institute : https://www.iwkoeln.de/en/press/iwd/beitrag/adriana-neligan-the-fate-of-plastic-bags.html. Accessed 19 May 2020.

In addition, the Directive on the Reduction of the Impact of Certain Plastic Products on the Environment was established in 2019.[37] This directive requires each EU member state to take actions to comply with the following:

By 2021, the sale of cutlery, plates, straws, drink mixers, cotton bud sticks, and balloon sticks for single-use domestic use will be prohibited, as will be expanded polystyrene goblets and trays. For beverage cups and food containers, including plastic lids, it is necessary to set significant reduction targets and take specific measures to achieve them. In addition, the government is required to impose extended producer responsibility on companies that manufacture plastic food containers and packaging. Specifically, the government is required to create a regulatory system in which these manufacturers bear the costs related to the disposal of discarded products.

Some countries also regulate plastic containers and packaging. For example, France passed a law banning single-use plastic cups, glasses, and dishes in August 2016; this will come into force in January 2020.[38] Container and packaging plastics that already contain food and drinks at the time of sale, and plastics that are made of biomass material and that can be composted at home for more than 50 percent, however, are exempt from regulation. In order to continue to be exempt from this regulation after 2025, at least 60 percent must be made of biomass materials. Furthermore, in October 2018, the scope of regulation was expanded to

[37] DIRECTIVE (EU) 2019/904 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 5 June 2019 https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32019L0904&from=EN. Accessed 19 May 2020.
[38] Law of August 30, 2016: https://www.legifrance.gouv.fr/eli/decret/2016/8/30/DEVP1604757D/jo/texte. Accessed 19 May 2020.

include straws, cutlery, beverage container lids, food trays, ice cream containers, salad bowls, food containers, and muddlers.[39] These products will also be regulated from January 2020.

The US Approaches to Reduce Marine Plastic Waste

As a regulation related to plastic products, the U.S. government has banned the manufacture, packaging, and distribution of cosmetics containing microbeads under the Microbead-Free Waters Act of 2015.[40, 41] Production has been banned since July 2017, and sales have been banned since July 2018.

Other regulations relating to plastics include various plastics regulations in U.S. states and cities. For example, Seattle is generally known as an environmentally conscious city. For the first time in a major U.S. city, plastic straws and cutlery have been banned there. Compostable products are excluded.[42]

California is the first U.S. state to ban plastic bags. Despite opposition movements led by trade associations, the regulation was finally passed by a November 2016 referendum. It should be noted that biodegradable plastics, that is, compostable plastics, are not excluded from this regulation.[43]

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[39] Law of October 30, 2018 (Article 28): https://www.legifrance.gouv.fr/eli/loi/2018/10/30/AGRX1736303L/jo/texte. Accessed 19 May 2020.

[40] Microbead-Free Waters Act of 2015: https://www.congress.gov/bill/114th-congress/house-bill/1321/text. Accessed 19 May 2020.

[41] FDA: https://www.fda.gov/cosmetics/cosmetics-laws-regulations/microbead-free-waters-act-faqs. Accessed 19 May 2020.

[42] Seattle Public Utilities: http://www.seattle.gov/utilities/services/recycling/reduce-and-reuse/plastic-bag-ban. Accessed 19 May 2020.

[43] National Conference of State Legislatures: https://www.ncsl.org/research/environment-and-natural-resources/plastic-bag-legislation.aspx. Accessed 19 May 2020.

In 2013, New York City passed a ban on plastic food containers made of expanded polystyrene, but the food and beverage industries were fiercely opposed to it. The ban came into force in January 2019 after a trial concluded that plastic food containers made of expanded polystyrene cannot be recycled in an economically or environmentally friendly manner.[44] The reasons for this conclusion were that:

> After being mixed and collected, it was not possible to sort properly. It was mixed with the paper and other things, preventing the recycling of other materials. However, it has been pointed out that it takes time to secure the quantity for economical recycling. There is no recycling market at present and there are no buyers for collected products.[45]

In Boston, single-use plastic bags with handles are banned. Plastic bags for newspapers, vegetables, meat, fish, frozen foods, laundry, and garbage disposal, however, are exempt from this regulation. Retailers can only supply recyclable paper bags or compostable or reusable plastic bags. In addition, they must be sold for 5 cents or more. Violators are warned the first time, fined $50 the second time, and $100 the third time.[46]

Japan's Approaches to Reduce Marine Plastic Waste

In Japan, the Containers and Packaging Recycling Law was enacted in 1995 to promote the reduction and recycling of container and packaging waste, which accounts for the majority of general waste.[47] In addition, in order to break away from the existing economic system of mass

[44] NYC Government: https://www1.nyc.gov/assets/dsny/site/resources/recycling-and-garbage-laws/collection-setout-laws-for-business/foam-ban. Accessed 19 May 2020.

[45] NYC Government: https://www1.nyc.gov/assets/dsny/docs/2017-05-12FoamDetermination_FINAL.pdf . Accessed 19 May 2020.

[46] Boston City Government: https://www.boston.gov/sites/default/files/imce-uploads/2018-12/basics_english.pdf. Accessed 19 May 2020.

[47] The Law on the Promotion of Sorted Collection and Recycling of Containers and Packaging: https://elaws.e-gov.go.jp/search/elawsSearch/elaws_search/lsg0500/detail?lawId=407AC0000000112. Accessed 19 May 2020.

production, mass consumption, and mass disposal, to implement the 3Rs, and to properly dispose of waste, the Basic Law for Establishing the Recycling-Based Society was established in 2000.[48] Furthermore, the Law on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (the Law on Promoting Green Procurement) was established in 2010.[49] This law stipulates that public organizations take the initiative in using products and services with low environmental impact.

In response, companies have been promoting the development of recycling technologies and manufacturing that takes into account the effective use of resources. The industry has set recycling and reduction targets for containers and packaging, including plastic containers and packaging, and has followed up on the results.[50] For example, the reduction target for plastic bottles for beverages was set at 25 percent in FY 2020 less than 2004, and in FY 2018, at 23.6 percent, this goal had almost been reached. Likewise, the recycling target was set at 85 percent in FY 2020 compared to FY 2004, and in FY 2018 it was 84.6 percent. Similarly, we set the reduction target of 16 percent for plastic containers and packaging in FY 2020 compared to FY 2004, and in FY 2018 it was 17 percent.

As a result of these efforts, Japan has a very high rate of 85.8 percent of plastics being used effectively.[51] On the other hand, it has been pointed out that some of the waste is flowing into the ocean. The Ministry of the Environment surveyed the types and amounts of marine litter

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[48] The Basic Law for Establishing the Recycling-Based Society: https://elaws.e-gov.go.jp/search/elawsSearch/elaws_search/lsg0500/detail?lawId=412AC0000000110. Accessed 19 May 2020.

[49] The Law on Promotion of Procurement of Eco-Friendly Goods and Services by the State and Other Entities (Act on Promoting Green Procurement): https://elaws.e-gov.go.jp/search/elawsSearch/elaws_search/lsg0500/detail?lawId=412AC1000000100. Accessed 19 May 2020.

[50] 3R Promotion Group Liaison Meeting: http://www.3r-suishin.jp/?p=601. Accessed 19 May 2020.

[51] The Japan Plastics Industry Federation. Status of production, disposal, recycling and disposal of plastic products in 2017. http://www.pwmi.or.jp/pdf/panf2.pdf. Accessed 19 May 2020.

in 10 locations near Japan and found that the proportion of plastic in marine waste was very high.[52] In addition, analysis of the types of plastic spilled into the ocean revealed a high proportion of fishery tools. In view of the fact that marine plastic waste has been attracting international attention, as the chair of the G20 in 2019, Japan has set forth its policy on addressing this issue. Specifically, the Resource Recirculation Strategy for Plastics**,** which was formulated in May 2019, set forth measures for keeping marine plastic waste in mind.[53] In this strategy, there is a policy to require payment for plastic bags. The Action Plan to Counter Marine Plastic Waste announced at the same time states the following contents.[54]

1. Reinforce the process of domestic waste plastics as well as recycling facilities
2. Adequately maintain and manage fishing gear by fisheries
3. Collect of plastic waste being (illegally) dumped
4. Promote conversion to alternative materials through innovations
    a. Roadmap for Popularizing Development and Introduction of Marine Biodegradable Plastics Formulated
    b. Creating the organization of public-private partnership working to solve marine plastic waste (Clean Ocean Material Alliance)
5. International contributions to facilitate measures in developing countries
6. The feature of this action plan is not to regulate the use of plastics, but to promote the development of technologies for bioplastics and alternative materials, and to declare that Japan will lead cooperation efforts in developing countries.

[52] Fact-Finding Survey of Marine Litter Conducted by the Ministry of Environment: https://www.env.go.jp/press/104995.html. Accessed 19 May 2020.

[53] Resource Circulation Strategy for Plastics: https://www.env.go.jp/press/106866.html. Accessed 19 May 2020.

[54] The Action Plan to Counter Marine Plastic Waste: https://www.env.go.jp/press/106865.html. Accessed 19 May 2020.

Comparative evaluation of plastic and other materials

Various international organizations such as the United Nations are actively working to stop the use of single-use plastics, especially for containers and packaging. It is doubtful, however, that the evaluation of the impact on the environmental load when the use of single-use plastics is stopped is being performed appropriately. For example, if consumers bring their own bags and do not use shopping bags, a net reduction will occur. On the other hand, when single-use plastic is not used as a material for food packaging or beverage containers, it is necessary to use an alternative material. In the past, people have shifted from materials such as metal, glass, and paper to plastics because of their high functionality. Given the current state of technology, a major issue is whether a change of material from plastic would have a positive effect on the environment. For this reason, evaluations are made based on related prior papers.

The Department of Chemical Engineering at City College of New York (CCNY) is undertaking an effort to analyze the total amount of municipal solid waste (MSW) and its impact on the environment from the types of municipal waste and the materials used in the United States.[55]

According to the results thus far, MSW generally tends to rise in proportion to an increase in the nominal gross domestic product (GDP) of a region or country. This correlation leads to the hypothesis that, as the economy grows and people become more affluent, more materials and resources are consumed, resulting in proportionally higher waste. Specific data analysis shows that per capita GDP in the $5,000 to $110,000 range generates two to six pounds of MSW per person per day. This shows that, regardless of the region, economic activity uses up

[55] Tsiamis, Demetra A, et al. "Role of Plastics in Decoupling Municipal Solid Waste and Economic Growth in the U.S." Waste Management, Vol. 77, 2018, pp. 147–55.

certain materials, which are ultimately discarded as waste, and put a burden on the environment. On the other hand, in many advanced countries, there is a movement to break the proportional relationship by developing and using products with low environmental impact and establishing a material recycling system. This is called decoupling. First, the growth rate of MSW is lower than the growth rate of the per capita GDP and personal consumption expenditure (PCE). This is called relative decoupling. Then, as the per capita income rises, the rate of waste generation actually decreases. This is called absolute decoupling.

In Europe, there is a considerable amount of research in this area, showing that citizens need to be motivated to change their behavior to reduce waste or environmental impact, regardless of the affluence of the country or region. The main effective motivator has been identified as tax fines or economic incentives (earnings to consumers).[56] Other research shows that, in addition to tax incentives, consciousness-raising and education campaigns help create absolute decoupling between per capita GDP and the amount of MSW.[57] Other research shows that the collection of fees for waste generation and bans on landfills have an immediate effect on the diversion (effective use) of waste.[58]

A survey by the CCNY Department of Chemical Engineering made the following assumptions: In the United States, where there are no national policies, directives, or taxes on MSW generation, people are acting at the cost of desirable goods associated with consumer demand. Therefore, reduction in material consumption due to policy outcomes was not

[56] Zorpas, A. A., Lasaridi, K., Abeliotis, C., Voukkali, I., Loizia, P., Georgiou, A., Bikaki, N., et al., 2014. Waste prevention campaign regarding the waste framework directive. In: Fresenius Environmental Bulletin, Vol. 23, pp. 2876–83.

[57] Montevecchi, F., 2016. Policy mixes to achieve absolute decoupling: a case study of municipal waste management. Sustain. (Switzerland) 8 (5).

[58] Katsifarakis, K. et al., n.d. Protection and restoration of the environment XI. In: International Conference Proceedings.

considered, and the decoupling between MSW generation and economic growth was attributed to changes in the materials used.

In addition, the survey quantitatively analyzed the hypothetical scenario in which plastic materials were replaced with glass, metal, and other materials, and plastic waste was not generated at all. The results indicated that, in the United States, the total weight of alternative packaging required was about 4.5 times the weight of the reduced plastic packaging. Also, the total weight of the alternative materials required in place of plastics used in other product applications was about 3.2 times the weight of the reduced plastics.

Between 1960 and 2013, MSW increased 2.88 times on a weight basis in the United States, while the corresponding figure for plastics was 84 times. This was due to the tendency for consumers to buy cheaper, more functional plastic products, and a shift from paper, metal, and glass to plastic in almost all applications. For example, in the container and packaging sector, plastic waste increased from 120,000 tons in 1960 to 13,980,000 tons in 2013. On the other hand, glass increased by approximately 3.1 million tons from 6,190,000 tons to 9,260,000 tons, and metal decreased by approximately 2.3 million tons from 4,660,000 tons to 2,400,000 tons. As a result, absolute decoupling between per capita GDP and the increase in MSW, especially since 1995, has been identified.

If the shift from paper, metal, and glass to plastic does not take place, MSW could increase by 30 to 40 percent compared to the current level. That is, by using plastic instead of conventional materials, the total amount of waste and raw materials is reduced. At the same time, it is pointed out that the shift to plastics has contributed to the reduction of environmental impact, such as lowering the amount of energy required for manufacturing and lessening the impact on global warming.

Lastly, the emergence of the coronavirus pandemic in 2020 has resulted in a re-evaluation of the hygiene advantages of single-use plastics. Disposable plastic has been used as one of the measures to stop the spread of the coronavirus infection. Starbucks, for example, has suspended the service of putting coffee into cups brought by customers for the time being, and many supermarkets, such as Trader Joe's, are asking customers not to bring their own shopping bags into their stores.

Conclusion

It is clear that plastic is not only inexpensive and highly functional, but also has advantages in reducing waste, suppressing global warming, and improving sanitation. Regarding concerns about the marine environment cited by groups who wish to ban the use of single-use plastics, examples have been shown that have impacts, such as plastic straws stuck in sea turtles. It remains questionable, however, to what extent this is an imminent threat to humanity as a whole, or how serious it will be. The dumping of plastics on the coasts of emerging Asian countries certainly has an impact on local tourism. It is questionable, though, whether the prohibition of single-use plastics is really the best solution. It is believed that the major cause of the problem is that the plastic waste is not properly managed in emerging countries.

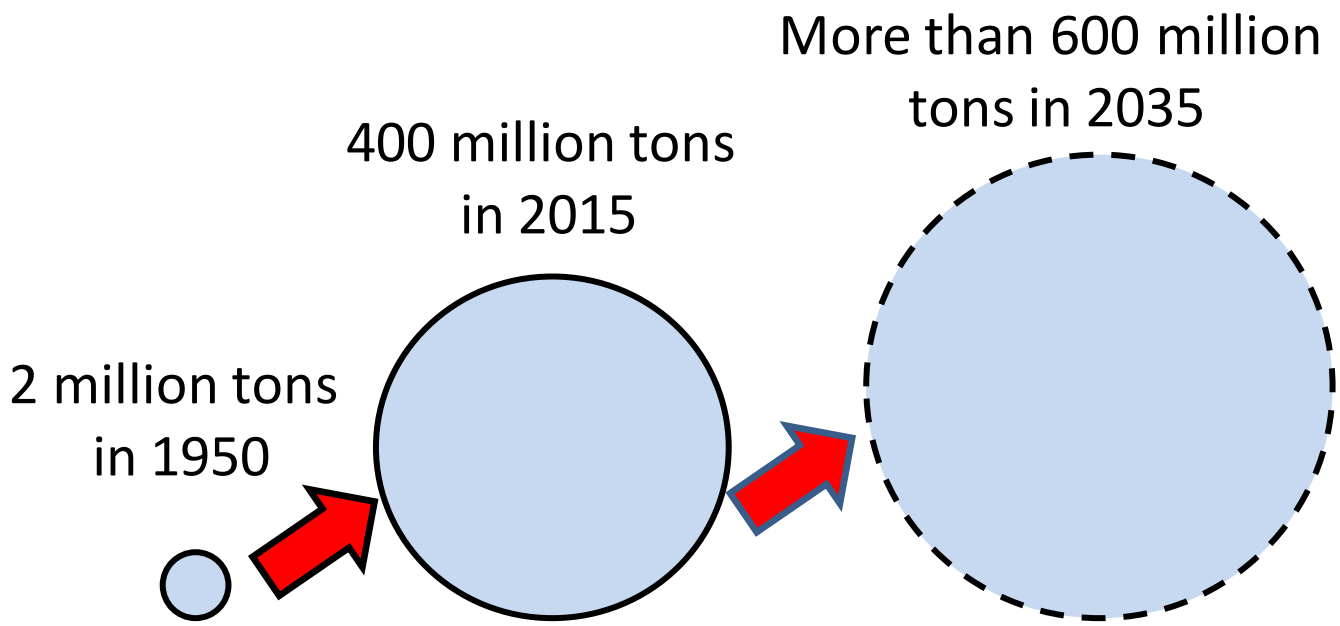
Therefore, based on in the results of my research, it is dangerous to simply ban single-use plastics. This is because the effects on humankind and the entire global environment may not be correctly evaluated. I suggest it is important that countries which are advanced in waste management systems (including plastics) support the actions of emerging countries where waste management systems are not efficient, including recovering plastics that which have already been disposed on coasts etc. At the same time, it is the mission of developed countries to

promote the technological development of materials with even less environmental impact in the future. It is very difficult to develop a new material that satisfies every function, cost, and improvement of the global environment but we have to always try our best.

As a result of these considerations, the current policy to address the marine plastic waste problem should not be a European approach which means regulating single-use plastics, but rather a Japanese approach which means cooperation with emerging countries and supporting innovation. In the future, it is necessary to comprehensively compare and evaluate various materials including plastics for various environmental effects. Furthermore, there is a social demand for a comparative evaluation of which material should be used for which purpose, including the effects on cost, function, and hygiene.

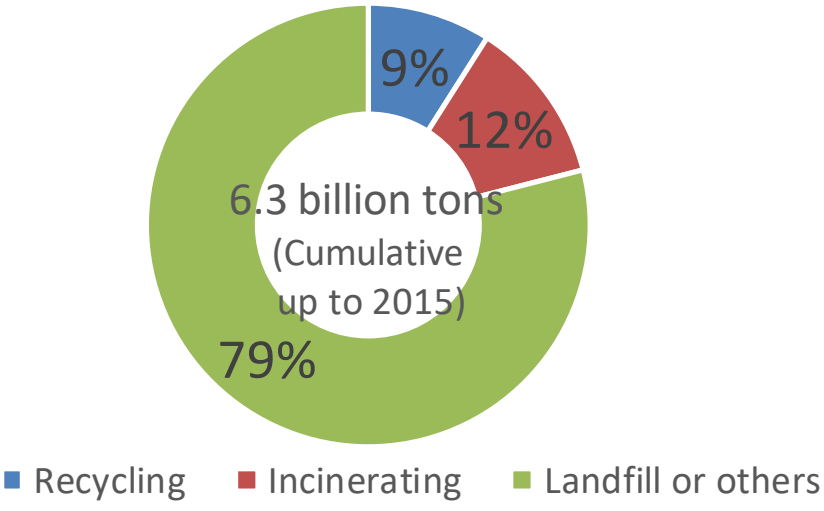
Tables and Figures

Figure 1. Current Status and Future Prospects of Plastic Production



Source: Calculating the Total Amount of Plastics.

Figure 2. Plastic Waste around the World



Source: Geyer, Roland, et al. "Production, Use, and Fate of All Plastics Ever Made."

Figure 3. International Efforts to Solve the Marine Plastic Waste Problem (since 2015)

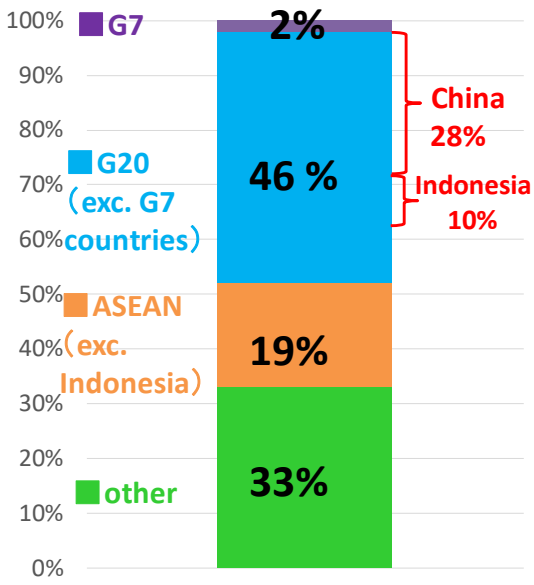
2015	Jun : (G7 Elmau Summit) Referring to marine plastic litter Sep : (UN Summit) Adoption of SDGs (EU) Adoption of "EU Rules to Reduce Plastic Bag Use"
2017	Jul : (G20 Germany) Adoption of "G20 Action Plan on Marine Litter" Dec : (UNEA-3) Adoption of "Combating Marine Plastic Litter and Microplastics" (Referring to the need for legally binding policies)
2018	Jan : Publication of "EU Plastic Strategy" Jun : G7 Canada Adoption of "Marine Plastic Charter" (Excluding Japan and U.S.) Nov : (ASEAN+3) Adoption of "Marine Plastics Debris Cooperative Action Initiative"
2019	Jan : (Japan) The Foundation of Clean Ocean Material Alliance Jan : (WBCSD) The Foundation of Alliance to End Plastic Waste May : (Japan) Publication of "Resource Circulation Strategy for Plastics" Jun : (G20 Japan)

Figure 4. Estimated Amount of Plastic Waste Dumped into Our Oceans by Country in 2010

【MMT/Year】

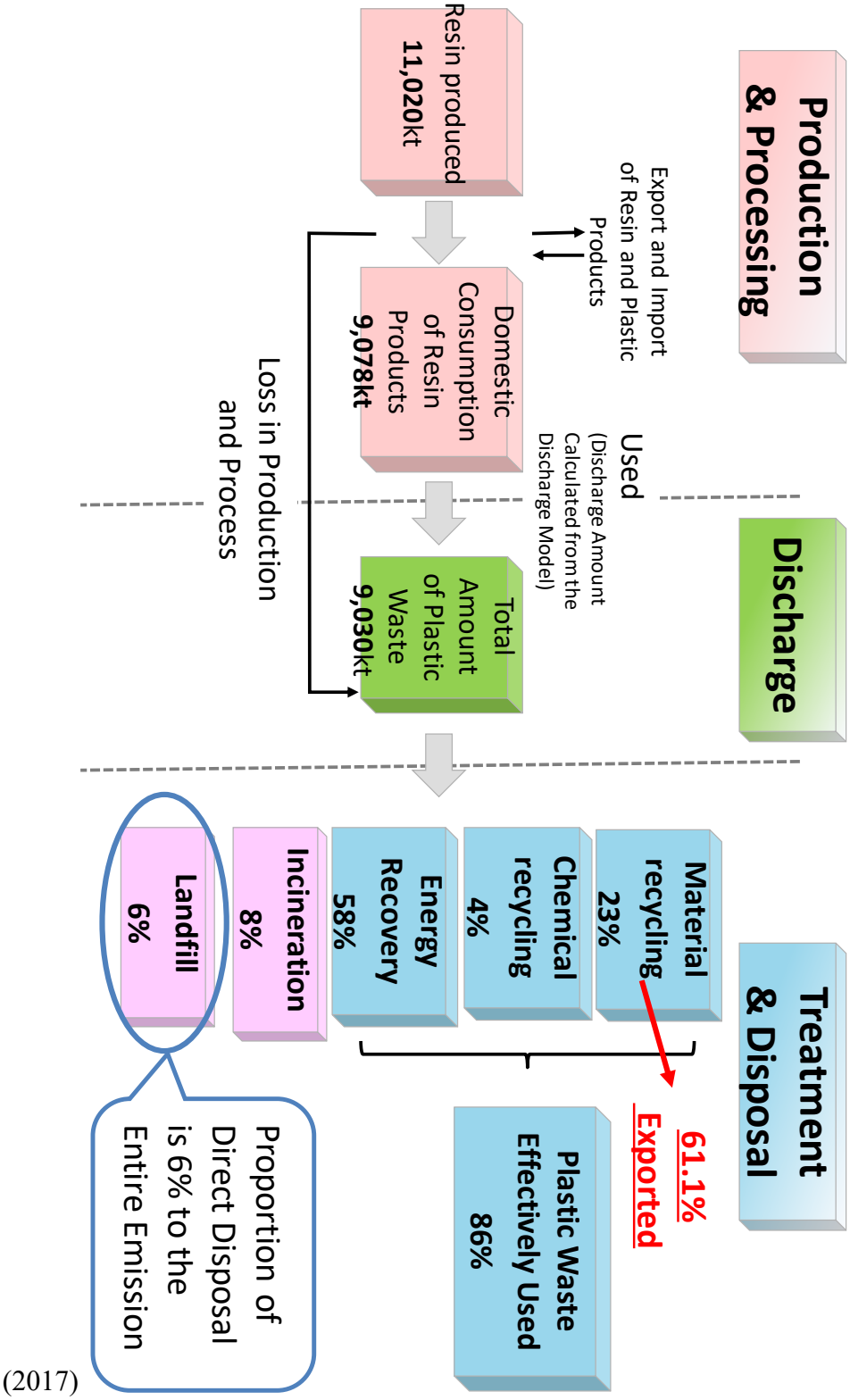
1	China	1.32～3.53
2	Indonesia	0.48～1.29
3	Philippines	0.28～0.75
4	Vietnam	0.28～0.73
5	Sri Lanka	0.24～0.64
6	Thailand	0.15～0.41
7	Egypt	0.15～0.39
8	Malaysia	0.14～0.37
9	Nigeria	0.13～0.34
10	Bangradesh	0.12～0.31
20	U.S.	0.04～0.11
30	Japan	0.02～0.06

Grand Total **4.78～12.75MMT／Year**



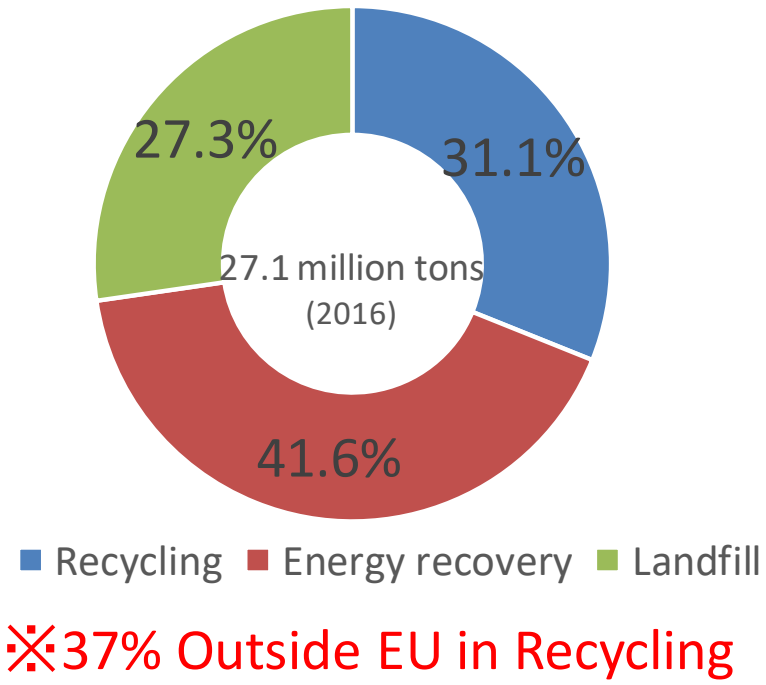
Source: Jambeck et al. Plastic waste inputs from land into the ocean, Science (2015).

Figure 5. Plastic Recycled in Japan



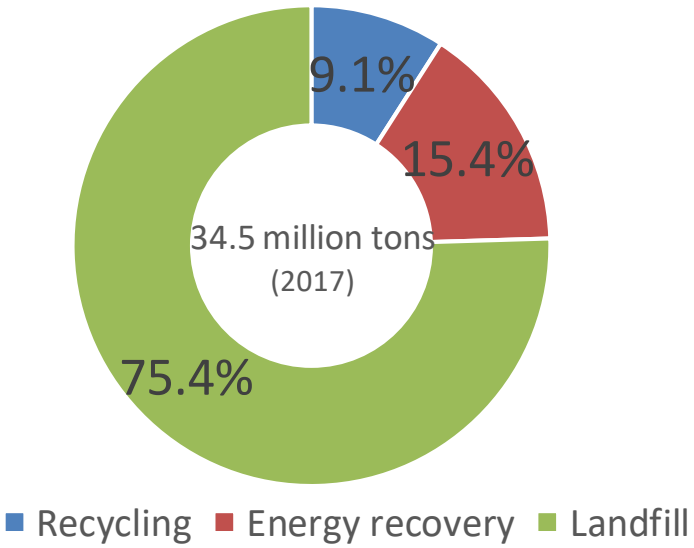
Source: Plastic Waste Management Institute.

Figure 6. Plastic Waste Treatment in the EU (2016)



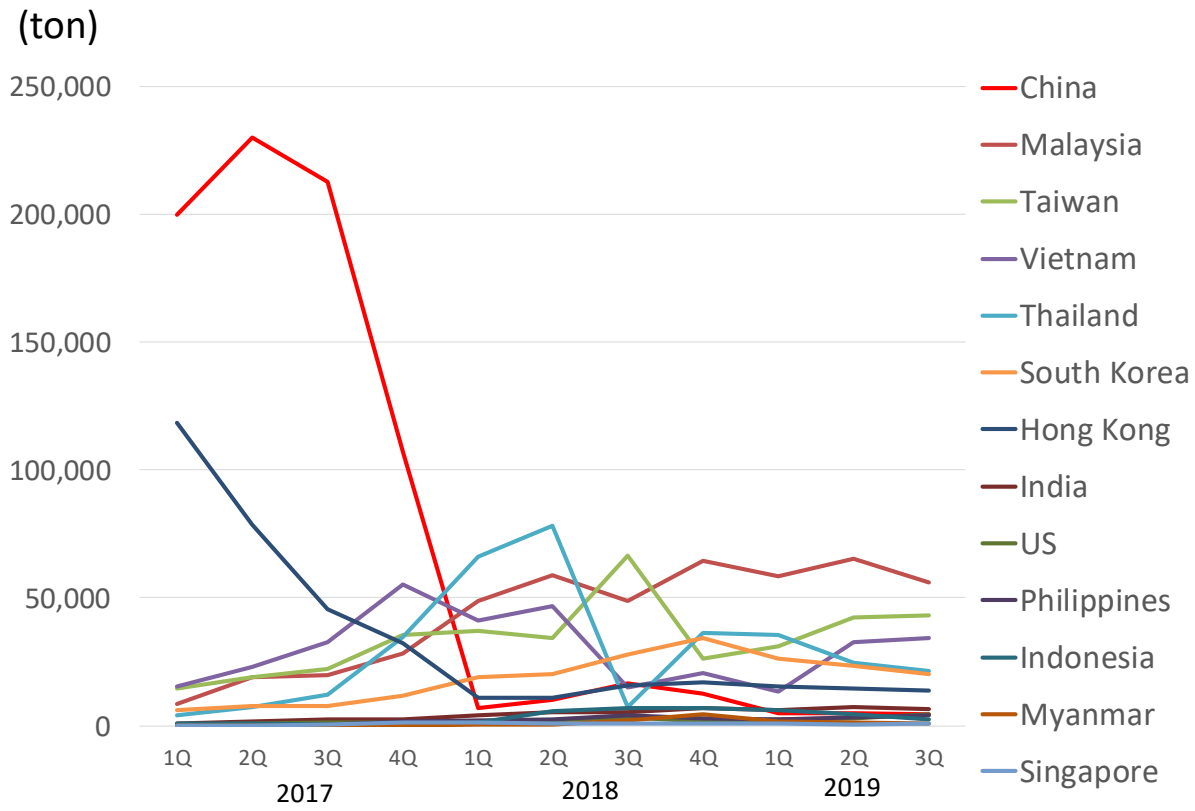
Source: Plastics - the Fact 2017, Plastics Europe.

Figure 7. Plastic Waste Treatment in the US (2017)



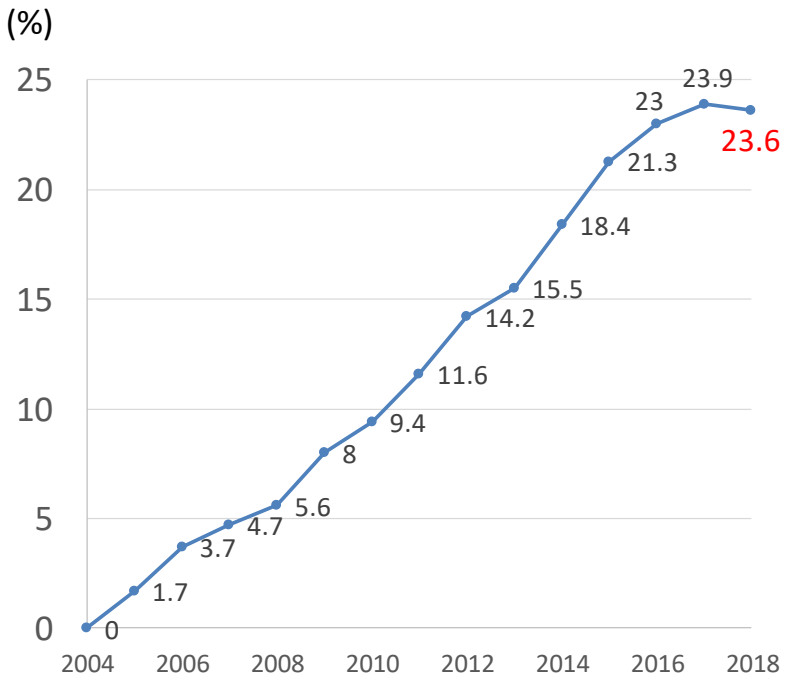
Source: United States Environmental Protection Agency.

Figure 8. Waste, Paring and Scrap, of Plastics Exported from Japan



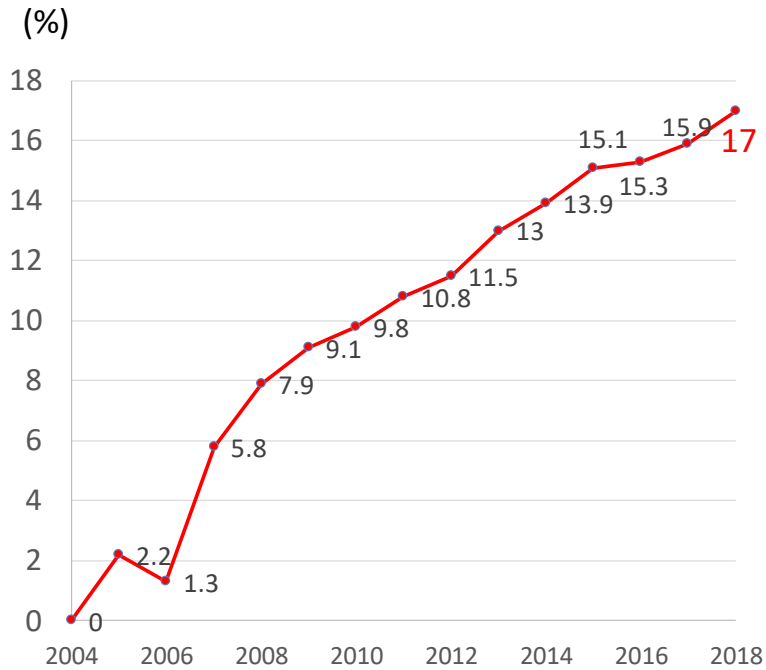
Source: Trade Statistics of Japan.

Figure 9. Reduction Rate per Unit of Plastic Bottles in Japan (Compared to FY2004)



Source: 3R Promotion Group Liaison Meeting.

Figure 10. Reduction Rate of Plastic Packaging in Japan (Compared to FY2004)



Source: 3R Promotion Group Liaison Meeting.

Figure 11. Monitoring Survey Implemented in 2016

at 10 Different Points in the Sea Around Japan

	weight	Cubic capacity	Number
Plastic	23.3%	48.4%	65.8%
Metal	0.4%	0.5%	4.0%
Cloth	0.2%	0.1%	0.8%
Glass, Pottery	0.6%	0.2%	2.8%
Paper	0.0%	0.01%	0.3%
Wood	12.8%	7.0%	7.3%
Other Artifacts	4.7%	2.4%	3.1%
Natural Objects	58.0%	41.3%	15.9%

Source: Fact-Finding Survey of Marine Litter Conducted by the Ministry of Environment (Result of Survey on Drifted Garbage).

Figure 12. Waste Plastics Dumped into the Ocean around Japan

Classification	Weight	Cubic Capacity	Number
Plastic Beverage Bottles	7.3%	12.7%	38.5%
Other Plastic Bottles	5.3%	6.5%	9.6%
Containers （Seasoning Containers, Trays, Cups, etc.,）	0.5%	0.5%	7.4%
Plastic Bags	0.4%	0.3%	0.6%
Cutlery (straws, knives, forks, etc.,)	0.5%	0.5%	2.7%
Fishing Nets, Ropes	41.8%	26.2%	10.4%
Buoys	10.7%	8.9%	11.9%
Styrofoam Buoys	4.1%	14.9%	3.2%
Other Fishing Equipment	2.7%	2.6%	12.3%
Other Plastic Products （cigarette lighters, syringes, etc.,）	26.7%	26.9%	3.3%
Total	100%	100%	100%

Source: Fact-Finding Survey of Marine Litters Conducted by the Ministry of Environment (Result of Survey on Drifted Garbage).

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