8-26-2018

Global governance in addressing marine plastic pollution

Lei Zhang

WORLD MARITIME UNIVERSITY

Dalian, China

Global Governance in Addressing Marine Plastic Pollution

By

Zhang Lei

The People's Republic of China

A dissertation submitted to the World Maritime University in partial Fulfillment of the requirements for the award of the degree of

MASTER OF SCIENCE
In
MARITIME AFFAIRS
(MARITIME SAFETY AND ENVIRONMENTAL MANAGEMENT)

2018

Declaration

I certify all the material in this dissertation that is not my own work has been identified, and that no material is included for which a degree has previously been coffered on me.

The contents of this dissertation reflect my own personal views, and are not necessarily endorsed by University.

Signature: _____

Date: _____

Supervised by: Dr. Tian Baijun
Professor
Dalian Maritime University

ACKNOWLEDGEMENTS

I am sincerely grateful to World Maritime University and Dalian Maritime University for offering me this opportunity to study in Dalian, China. I am profoundly thankful to my supervisor Prof. Tian Baijun, for guiding me through this work and providing me with invaluable advice and insight into the subject matter. His rich knowledge and rigorous research attitude will benefit me in my future professional career and whole life.

I also deeply appreciated all my superiors and classmates in Dalian Maritime University (DMU), ad hoc, Prof. Bao Junzhong, Ms. Wang Yanghua, Mr. Zhao Jian and Capt. Zheng Guoping, for their continuous encouragement which has been a great source of inspiration and confidence for the completion of my studies.

Last but not least, I am everlastingly grateful to my beloved parents and parents-in-law who are always encouraging me by offering their full support and tolerating my long absence during the studies, especially my dear wife SUN YAGUANG who is always taking my duties of caring for the whole family during my studies and helping me out of frustrations and sharing happiness at all times. The success and achievement which I made during my studies in Dalian would not have come true without her love and never-ending support.

ABSTRACT

Title of Dissertation: **Global Governance in Addressing Marine Plastic Pollution**

Degree: **MSc**

Since its introduction in the 1950s, plastics have developed rapidly. The annual production of plastics now exceeds 300 million tons, about 0.1 percent of which goes into the sea as litter. Marine plastic litter has spread all over the ocean. Marine plastic litter is from both land and sea sources, about 80 percent of which comes from land.

Marine plastic litter has many hazards, it can do harm to marine ecological environment and marine biology, and indirectly affects human health in the form of entering the food chain. Marine plastic pollution has been listed as one of the major hazards faced by human beings.

Marine plastic litter has attracted wide attention from the international community and some countries, and has formulated some strategies and regulations have been formulated to control its pollution. But the problem of marine plastic pollution is rapidly deteriorating. Greater efforts should be made to control plastic pollution to save the "cradle of life - the ocean."

China, one of the world's largest producers of plastic and a source of marine plastic litter, has not paid enough attention to the problem of marine plastic pollution. How to control marine plastic pollution is one of the urgent problems in China.

KEY WORDS: Plastic, microplastic, marine pollution, governance, UNEP.

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LIST OF ABBREVIATIONS

CBD	Convention on Biological Diversity
CCAMLR	Conservation of Antarctic Marine Living Resources
CCRF	Code of Conduct for Responsible Fisheries
CMS	Convention on Migratory Species
EU	European Union
EU MSFD	European Union Marine Strategy Framework Directive
EU PRF	European Union Port Reception Facilities
FAO	Food and Agriculture Organization of the United Nations
GES	Good Environment Status
GNA	GhostNets Australia
GPA	Global Programme of Action
GPML	Global Partnership on Marine Litter
ICC	International Coastal Cleanup
IMDCC	Interagency Marine Debris Coordinating Committee
IMO	International Maritime Organization
INC	Intergovernmental Negotiation Committee
IUCN	International Union for Conservation of Nature
LDC	London Dumping Convention
LPMLD	Japan’s Law for Promotion of Marine Litter Disposal
MARPOL	International Convention for the Prevention of Pollution From.

	Ships, 1973 as modified by the Protocol of 1978
MDP	Marine Debris Programme
MDRPRA	Marine Debris Research, Prevention and Reduction Act
MEAS	Multilateral Environmental Agreements
MEM	South Korea Marine Environmental Management Act
MMaL	Marine Macroplastic Litter
MmiL	Marine Microplastid Litter
MPL	Marine Plastic Pollution
MPP	Marine Plastic Pollution
NGOs	Non-Governmental Organizations
NMDMP	National Marine Debris Monitoring Program
OEWG	Open Ended Working Group
UN	United Nations
UNCLOS	United Nations Convention on the Law of the Sea
UNCSD	United Nations Conference on Sustainable Development
UNEA	United Nations Environment Assembly
UNEP	United Nations Environment Programme
UNFSA	United Nations Fish Stocks Agreement
WWF	World Wide Fund for Nature

CHAPTER 1

INTRODUCTION

1.1 Marine Plastic Litter – A Serious Problem Facing Human Beings

The total ocean area is about 336 million km² , accounting for 70.9% of the total area of the earth. The sea is of great value to the earth this is known as the ‘cradle of life’. However, in the exploitation and utilization of Marine environmental resources, human activities inevitably cause pollution and destruction to the marine environment. With the wake of people’s awareness of ecological activities, the problem of marine pollution has been paid more and more attention.

Nowadays, Marine Plastic Litter (MPL) has been listed as with ozone depletion, acidification of the oceans, climate change, global environment problems, including microplastic pollution as a new marine pollution problem has become the global related academic research hot spot (Law & Thompson, 2014). Consequently, it has adversely contributed to the climate change and impacted marine organism’s health. The MPL includes whatever any manufactured or processed plastic waste material

that enters the marine environmental from whichever sources. The seas almost in all parts of the world have been polluted by man-made plastic litter.

Just keep in mind, shipping plays an important role in the development of human societies and international trade, which carries about 90% of the world trade and it, is the life blood of global economy. During ships' operation, a number of plastic wastes are produced from galleys, crew cabins and engine/deck departments.

Although the amount of ships' plastic wastes only contributes a small part to worldwide ocean pollution, it should not be ignored. Nowadays, the IMO has put more and more concern on the plastic wastes produced by ships.

IMO has amended The International Convention for the Prevention of Pollution From Ships (MARPOL) annex Ⅴ, which came into force on 1st Mar. 2018. Ship management companies have developed new environmental policies and garbage management plan in accordance with the MARPOL regulation. Flag state control, port state control and national environmental protection departments have paid more attention on the garbage control marine. All these efforts have reduced ships' plastic pollution greatly, but it is still far from enough.

1.2 Objectives of research

This paper will give a view on the seriousness of marine plastic pollution, by emphasizing on marine plastic pollution, analyzing how the marine organism's and human's health is being affected, and illustrating how the global climate is being impacted. This paper will also briefly introduced some international and national

conventions relative to MPL and gives some suggestions for further amendment. For the control of MPL, the public, governments and organizations play very important roles. They should put in more effort to save our living environment. All these aim at raising public awareness to the MPL.

1.3 Structure of dissertation

First, this article will briefly introduce the development of plastic and the relationship between human and plastic, and give a view on present situation of marine plastic pollution, and analyzes its impact on climate change, marine organism and human health. Then, most relative international and some national conventions for prevention of marine plastic pollution will be mentioned and a brief analyses will be given.

The article will focus on the strategies and regulations developed by UNEP, some organizations like PlasticEurope and some states, then analyze them and list suggestions from some scholars. Finally this article will introduce the status quo of marine plastic waste management in China. And give some recommendations on own view.

CHAPTER 2

A REVIEW ON MPL POLLUTION

2.1 Human and plastic

Plastic is hydrocarbon monomer, with or without various kinds of reinforcing materials, additives and fillers, under certain temperature and pressure conditions, plastic or cross-link modeling, the final solid material (product), the high-molecular polymer, commonly known as plastic. In the process of manufacturing and machining, plastic can be modeled by flowing, and can change the shape of body freely. The benefits of plastics, including versatility, resistance and durability to degradation, are well known and have led to the actual so called “age of Plastics”, where almost everything contains this material (Carlo, Stefania & Francesco, 2017).

Having considered the importance of environmental concerns and likely trends in the near future, the need of establishing an effective framework is in essence guiding the parties involved on what are supposed to be pursued. Even though the success of being as an environmentalist in shipping can be achieved in one way or another, the necessity of providing an international framework is of utmost importance in terms of efficiency within the maritime industry. It should be appreciated that IMO is rather active in deliberating a proper way of establishing such an environmental framework,

inter alia, by different approaches from three main pillars, namely technical,

2.1.1 The development and using of plastic

In 1850s, photographer Parkes tried to mix camphor with collodium,and a flexible hard material was formed, named ‘parkesine’, which is the first plastic (Art, 2007). The first man-made plastic – phenolic plastics appeared in 1909. Synthetic aniline formaldehyde plastics were born in 1920. The two plastics played a positive role in greatly promoted the development of the electric and instrument manufacturing industries. By 1930s, polyvinyl chloride, alkyd resin, polystyrene, acrylate, polyamide and other plastics appeared successively. Since the 1940s, with the development of science, technology and industries, petroleum resources have been widely exploited and utilized, and the plastics industry has developed rapidly. The production of plastics increases year by year (Figure 2.1). It is reported that about 335 million tons of plastics are produced in 2016 (PlasticsEurope 2017), and the annual growth rate is about 5% (Anthony & Mike, 2009). Currently, most plastics materials are derived from fossil feedstocks such as natural gas, oil or coal (PlasticsEurope 2017). It accounted for about 8% of oil consumption (Thompson & Swan, 2009). In Europe, only about 5% of oil and gas is employed in the production of plastic materials (Figure 2.2).

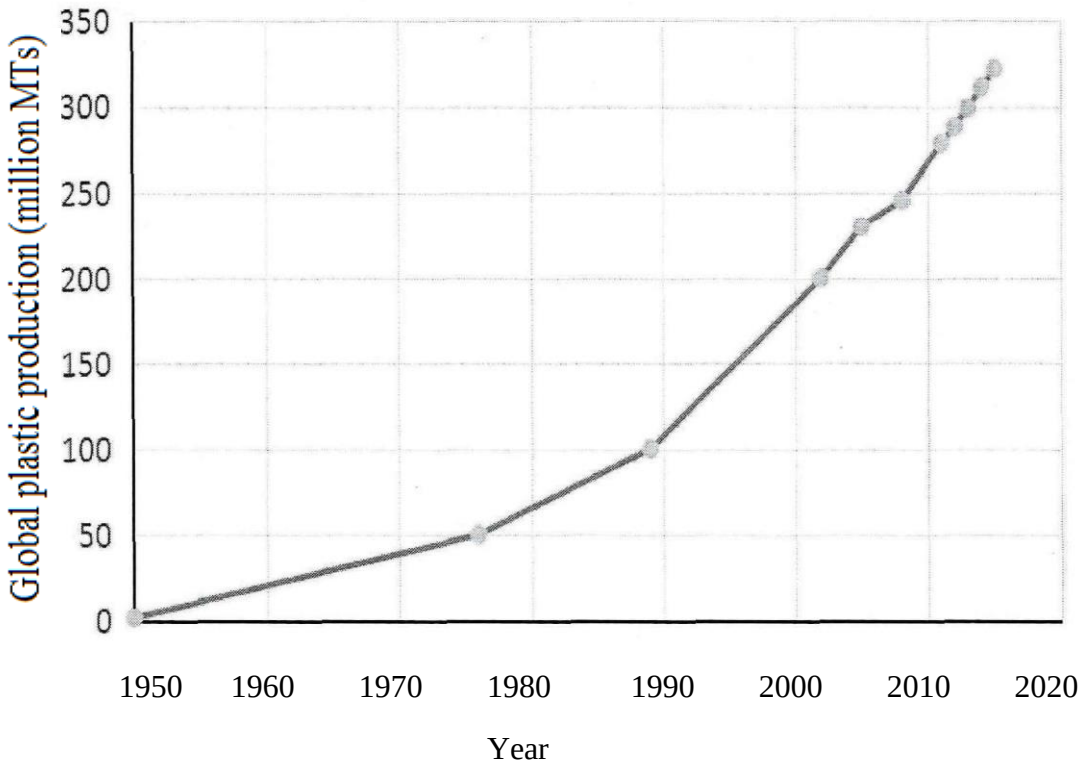

Figure 2.1 Trends in global plastic production over the period 1950-2015 (in million metric tons)

Source: https://www.statista.com/statistics/282732/global-production-of-plastics-since-1950/

Due to its light weight, no rust, no decay, cheap, insulation and other characteristics, plastics spread around the world at an amazing speed. While enriching people's life, plastics are becoming more and more important in all walks of life and bring convenience and material benefits to people. For example, the application of plastic products in the food industry can minimize food waste. Plastic packaging can reduce water and oxygen, and extend the storage time of food (José, 2002). Plastics are also widely used in various manufacturing industries, such as automobile and aviation. On the one hand, lightweight and solid plastic parts can reduce the overall mass of the body of automobile and airplane and speed it up; on the other hand, it can reduce energy consumption and carbon emissions (Anthony & Mike, 2009). These are only

a small part of the application of plastics in our lives, and they are also but they mirror of the diversified use and good properties of plastics that have led to today's global production of plastics.

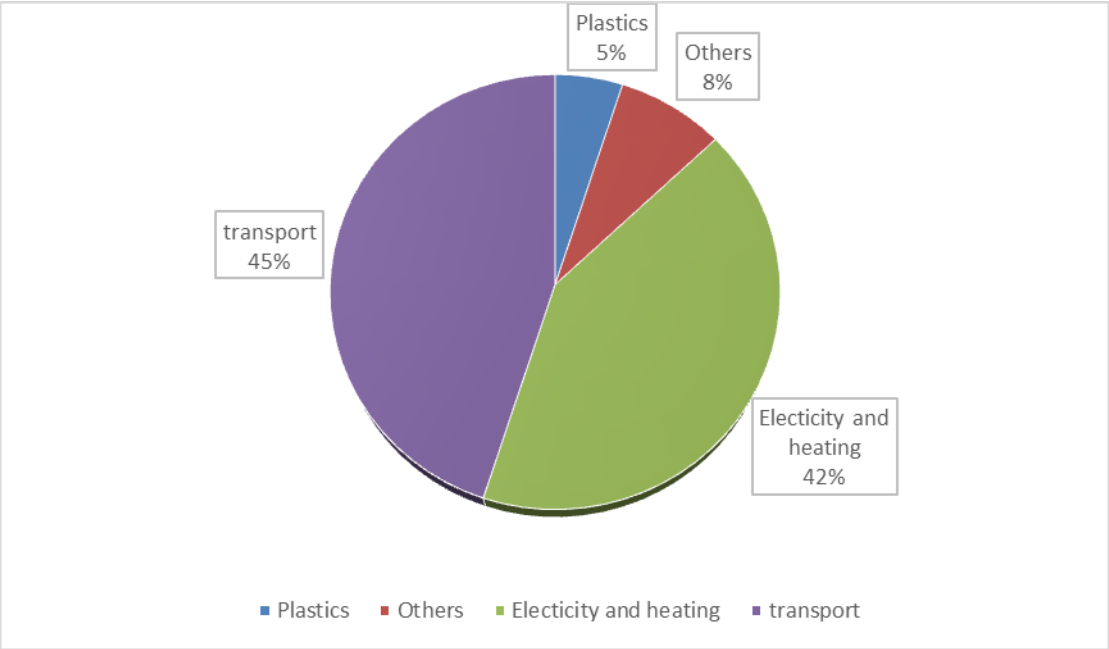

Figure 2.2: The production from oil and gas in Europe

Source: Plastics – The facts (2017), an analysis of European plastics production, demand and waste data.

2.1.2 How many plastics in the ocean?

A study in the 1970 s of the United States National Academy of Sciences estimated that 0.1% of the plastic, flooded from the land by the river and or storm into the sea, or dumped from ships at sea (Li, 2014). In 2010, 12.7 million tons of plastic waste were imported into the ocean from land (Jambeck, Geyer, Wilcox, Siegler, Perryman, Andrady, Narayan, & Law, 2015). Malaspina marine research team of the Spanish

National Research Council found that the five largest concentrations of plastic litter in the world's oceans basically coincide with the five largest circulation areas on the surface of the ocean (Cozar, Echevarria, Gonzalez-Gordillo, Irigoien, Ubeda, Hernandez-Leon, Palma, Navarro, Garcia-de-Lomas, Ruiz & Fernandez-de-Puelles, 2014). The pan Pacific garbage patch, for example, between California and Hawaii, has been expanding over the past 60 years to 10 million tons (Li, 2014).

The exact proportion of plastic waste in the marine litter remains unclear. However, studies have shown that 60-80 percent of marine waste is made of plastic (Peter, 2015). MPL comes from a variety of sources, from landfills to sudden leaks from shipping vessels (David, Francois, Richard & Morton, 2009), which causes the problem of the pollution very difficult to manage. As the increasing plastic production poses great threat to environment, use and disposal becomes important. Recently, research has estimated the amount of floating plastic waste in the world's oceans. Using 1,127 plankton trawl data and a numerical model (Cózar et al., 2014) speculated that 7,000 to 35,000 tons of plastic waste(0.2-100mm) were floating on the surface of the Atlantic, Pacific and Indian oceans. Eriksen et al. used another model (Lebreton, Greer & Borrero, 2012), combined with five subtropical ocean circulation, Australian offshore, Bay of Meng and the Mediterranean by 680 floating net data, estimated that there were 5.25 trillion plastic particles on the surface of the ocean, weighing about 268940 tons (Eriksen, Lebreton, Carson, Thiel, Moore, Borerro, Galgani, Ryan & Reisser, 2014) (Figure 2.3) (Sebille, England & Froyland, 2012). Sebille et al. using 11, 000 trawl data and numerical models of marine waste, estimated that 100, 000 to 236, 000 tons, about 15 to 51 trillion plastic particles floating on the ocean surface (Sebille, Wilcox, Lebreton, Maximenko, Hardesty, Van Franeker, Eriksen, Siegel, Galgani & Lavender, 2015).

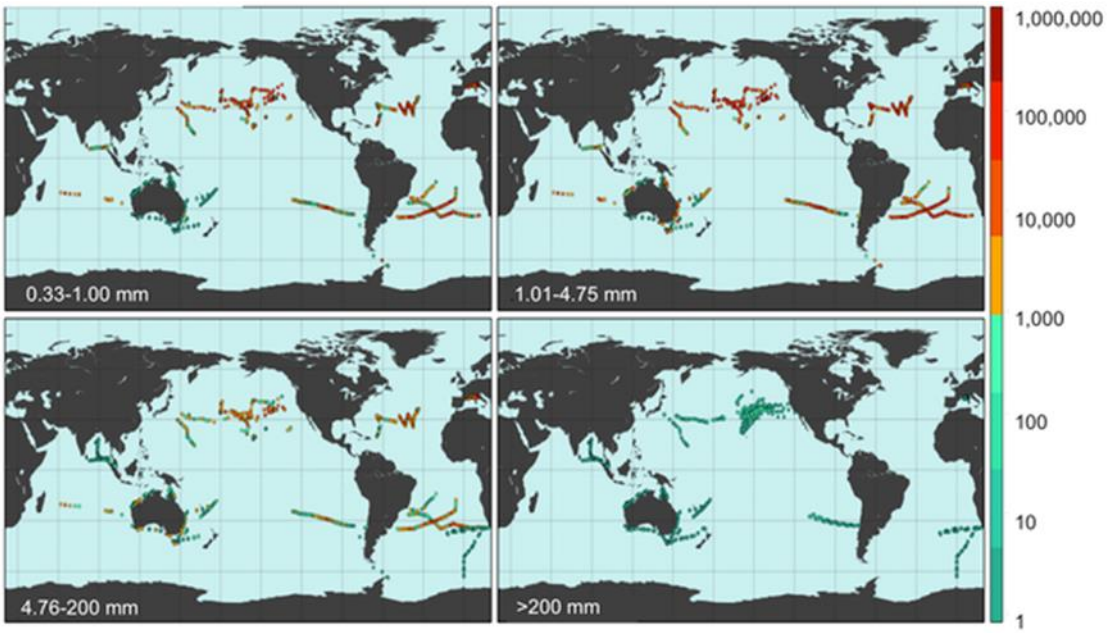

Figure 2.3: Field locations where count density was measured

Source: Eriksen M, Lebreton LCM, Carson HS, Thiel M, Moore CJ, et al. (2014) Plastic pollution in the World's Oceans: More than 5 Trillion Plastic Pieces Weighing over 250,000 Tons Afloat at Sea. PLOS ONE 9(12): e111913.

2.2 Marine macroplastic litter (MMaL)

Marine litter is made up of solid substances which are discarded or dumped into the sea, including glass, metal, paper, textile, wood, rubber and plastics. Some of these materials can be biodegradable (such as paper, wood or fine fiber), but plastic will remain in the ocean for a long time (Jose, 2002; Law, 2014). Large plastics are defined as any particle, fragment, or fiber that is present in the ocean with a maximum diameter of more than 5 mm (Barnes, Francois, Richard & Morton, 2009).

2.2.1 The sources of MPL

MPL comes from land and sea sources. Land-based plastic litter is blown or washed into the sea by wind, rain or waste water (Ryan, 2015). The specific pollution sources are as follows:

(1), with the discharge of rain water, the stormwater channel collects the runoff water generated during the rainstorm. Drains are discharged directly into nearby streams, rivers, or polluted seas. Street litter is washed up in storm drains and then dumped directly or indirectly into the ocean;

(2), sewage overflows and sewers carry sewage and rain. Sewage overflow is one of the main sources of marine plastic waste;

(3), littering. People littering along the coast with things like food packaging and drink containers, cigarette butts and plastic beach toys, which become Marine waste.

(4), landfills. Plastic gets into the ocean from landfills in coastal areas or near rivers. For example, much of the garbage in many estuaries in the United States comes from nearby landfill sites (Nollkaemper, 1994);

(5), Industrial activities. Industrial products that are mishandled inland may become MPL. A well-known example is the small plastic resin particles in the Marine environment, about 2 to 6 mm in diameter, which are the raw materials for various plastic products (Jose, 2002). The raw materials for these plastic products were accidentally leaked into the sea during processing.

All types of ships and offshore industrial platforms are also potential Marine sources of plastic waste. Sea-based plastic litter may come from accidental loss, littering or illegal disposal. It may also be a tradition or previous waste management practices. The sources of Sea-based plastic waste are as follows:

(1), commercial fishing, including the failure of commercial fishermen to check fishing, produces Marine litter, gears, or when they discard fishing gear or other waste overboard;

(2), recreational boating. Entertainers may discard rubbish on board, such as bags, food packaging and fishing gear;

(3), merchant ships, military and research vessels, whose plastic waste may be accidentally released or blown into the water by wind or intentionally thrown out of the boat. Large ships can carry household goods for months. Crews produce solid waste every day, which can turn into MPL if it is not safely and properly stored;

(4), offshore platform and the exploration of oil and gas. Oil and gas platform activity may have intentionally or accidentally brought plastic garbage to the Marine environment, including hard hats, gloves, gallon storage barrels, investigation material and personal waste. Offshore exploration and resource extraction also produce MPL.

2.2.2 The adverse impact of MMaL

Countless marine animals have been killed or harmed by large amounts of MMaL, mainly because they have been entangled in plastic, or because they have ingested plastic fragments as food. MMaL is known to harm or kill marine mammals, turtles and seabirds by wrapping it around them. The most dangerous ones are fishing line, single wire, six packs and packing strapping. Once caught up in the plastic, the animals can be drown or suffocated. Such as the plastic seal neck collar (nets or plastic) as its growth and tightening may kill them or cut off the artery (Jose, 2002).

Marine life may mistake plastic waste for prey and eat it accidentally. After the plastic waste is ingested by the organism, it may pass through the intestinal tract without causing harm and be eliminated from the body. However, chances are that plastic litter can clog a living organism's throat or digestive tract, causing hunger or malnutrition. In addition, the plastic litter accumulated in the intestines gives the animals a false sense of satiety, causing them to stop eating and slowly starve to death. Sharp pieces of plastic intake will damage the gut and could lead to infection, pain or death (Barnes et al., 2009). In a summary of 340 studies, Gall and Thomposon point out that 693 species of Marine life have been persecuted by Marine waste, 92 percent of which has been caused by MML (Gall & Thomposon, 2015)。

Plastic floating in the ocean increases the substrate, the impact of exposure to the spawning and reproduction ability, in the north Pacific subtropical gyre, the increase of plastic content offers halobates sericeus more Spawning carriers, eggs were positively correlated relationship between how much density increase of plastic content, and the eggs and larvae of the halobates sericeus prey can accelerate the energy transfer between different communities, so as to affect the ocean biological community structure and composition (Gall & Thomposon, 2015). In addition, habitats can be provided for Marine organisms such as hydroids, bivalves, foraminifera, and other sessile and dynamic creatures (Carson, Nerheim, Carroll, & Eriksen, 2013; Goldstein, Carson, Eriksen, 2014; Gregory, 2009). These changes in the floating matrix may change the population dynamics of species dependent on these matrices and increase their abundance. It also makes it easier for attached organisms to enter new ecosystems, increasing their chances of becoming invasive species (Barnes, 2002; Gregory, 2009).

In addition to the direct impact on the marine environment, large plastic waste is

slowly biodegradable or physically decomposed, becoming an important source of marine microplastic litter (MMiL). Plastic degradation can occur in all environments, and the rate of degradation is controlled by a variety of environmental factors. The main means of plastic degradation include photooxidation to initiate exposure to ultraviolet (UV) light, and heat can accelerate the degradation process (Andrady, 2015). Therefore, plastic is more stable and durable in marine environments than on land because of the low temperature of seawater and the decay of ultraviolet rays in the water column. The development of biofilms on plastic fragments will reduce the exposure of plastic surfaces to UV light and may delay the degradation process. Studies have shown that in marine environments, the stable chemical properties of plastics are difficult to change significantly over hundreds or even thousands of years (Andrady, 2011; Thomposon et al., 2004).

2.3 Research on the pollution of Marine Microplastics Litter (MMiL)

Research on MMiL dates back to the 1970s. In science, American Woods Hole Oceanographic Institution researcher Carpenter et al. (1972) reported large amounts of polystyrene particles exist in the coastal waters east of American Long Island and southern New England (Average abundance: 0.0-2.6 cubic meters per cubic meter, up to 14 cubic meters per cubic meter). Since then, however, the research on microplastics has not been paid enough attention (Carpenter & Smith, 1972). It wasn't until 2004, when Thomposon published an article on microplastics in science, that the problem was recognized and became a hot topic (Figure 2.4).

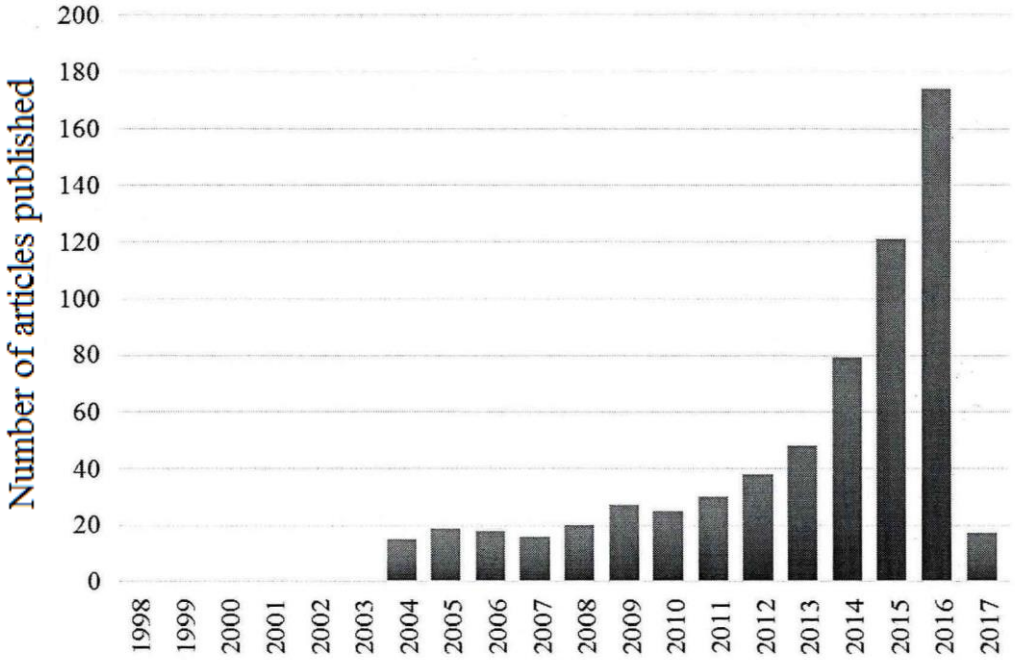

Figure 2.4: The trend of publication on microplastic research from 1998 to 2017

Source: Peter, G. R., (2015). A Brief History of Marine Litter Research, Springer International Publishing. Marine Anthropogenic Litter. (2015), 1-25.

Microplastics have been shown to exist in all parts of the ocean, such as the ocean surface (Cozar et al., 2014; Eriksen et al., 2014), ocean sediments (Cozar et al., 2014; Eriksen et al., 2014), and polar marine environments (Lusher, Tirelli, O'Connor & Officer, 2015). The harm of MMaL to marine life is physical damage, and the main pollution routes including winding and feeding; MMiL particles and plankton has the same size range, microplastic particles can be eaten by marine organisms (especially low trophic level) as a prey and swallowed, eventually entering the food chain causing, more profound impact on the ecosystem (Syberg, Khan, Selck, Palmqvist, Banta, Daley, Sano, & Duhaime, 2015)

2.3.1 The sources of MMiL

Marine plastic particles (MPP) have two types: (a) the primary plastic particles, refers to the particle size of less than 5mm of artificial industrial products, such as plastic pellets, cosmetics, air freshener and waste in the process of plastic products processing; (b) secondary plastic particles, mainly formed by the fragmentation of large size plastic waste (Barnes, 2009; Syberg et al., 2015). Due to the accumulation and rapid growth of large plastic waste in the ocean, the number of secondary plastic particles has an absolute advantage in the Marine environment (Andrady, 2011). Degradation is a chemical process in which the quality of polymer molecules is reduced. After degradation, plastic garbage embrittlement cracking into fragments are usually invisible to the naked eye, when the pieces to the degradation, the containing carbon atoms into carbon dioxide, when all organic carbon in the plastic be transmuted, this process is called complete mineralization.

Plastic degradation can be divided into five types: biodegradation, photodegradation, thermal oxidation degradation, thermal degradation and hydrolysis. When MPL is exposed to sunlight, it can initiate photooxidation degradation due to the radiation of UV B. Once this degradation is initiated, simultaneous thermal oxidation and degradation can be carried out. At this point, no further UV exposure is required, and degradation can continue. Other degradation pathways are less efficient than photodegradation. But when plastic waste in seawater is exposed to sunlight, its degradation rate is extremely low. Andrady et al.(2011) compared the several kinds of common plastic packaging's degradation rate respectively exposed in sea water and in the air, the results show that the degradation rate in the air is much higher than in the seawater. The low degradation rate of plastics in seawater is mainly due to low temperature and low oxygen content. Compared with the environment of sea water and sea bottom, plastic waste is the main source of MMiL in the beach at the fastest and most effective degradation rate. This shows that beach cleaning is not only a

sanitary work, but also an important ecological work. Therefore, cleaning up the plastic waste before embrittlement can effectively reduce the accumulation of plastic particles in the ocean.

2.3.2 The distribution of MMiL

Plastic particles are found in oceans and sediments around the world, with the largest abundance ever recorded at 1*〖10〗^5 per cubic metre (Wright et al., 2013). Plastic particles are found on beaches, surface of seawater, entire water columns and ocean floors, and even in the most remote polar marine environments (Lusher et al., 2015). Because of the Ekman convergence zone effect, ocean circulation is one of the hot spots for the accumulation of plastic particles (Sebbile et al., 2012). Recent results show that the maximum abundance of plastic particles in the north Pacific subtropical circulation has reached 32.76 per cubic meter of seawater, with plastic particles per cubic meter of seawater weighing 250 milligrams (C6zar et al., 2014; Eriksen et al., 2014). Also in the Pacific subtropical circulation area its abundance and weight reach 26898 and 70.96 grams per square kilometer of sea surface respectively.

The abundance of Marine plastic particles increases with time. In the north Pacific subtropical circulation zone, the average abundance and weight of plastic particles between 1999 and 2010 was two orders of magnitude higher than during the 1972-1987 period (Law et al., 2014). The abundance of plastic particles in the north Atlantic and the North Sea has been increasing for many years (Thompson et al., 2004). 24 years continuous analysis of samples taken from the northwest Atlantic results show that the abundance of plastic is on the increase, at the same time the size

of the plastic garbage reduced, in the 90 s to an average of 10.66 mm to 5.05 mm, and the size of the 69% of these pieces of plastic in 2-6 mm this range (Law et al., 2010).

2.3.3 The adverse impact of MMiL

Small size (< 5mm) is one of the most important physical properties of plastic particles. Plastic particles and some of the plankton, benthos, have a similar size and many predators cannot distinguish the prey from particulate matter similar to size, so the plastic particles can be feeding of marine organisms. It is because the particles are of similar size and density to the food of marine life. In the world, 267 species of marine life have been affected by MMiL, and this figure will increase with the study of small organisms. The Mediterranean fin whale, the world's largest filter feeder, can swallow up to 70, 000 liters of seawater at a time, and studies have shown that small particles of plastic in the water can be eaten in large quantities by it (Fossi, 2012). In addition to being ingested directly by marine life, plastic particles are also eaten up into the food chain by adsorbing them on the surface. Bhattacharya et al. (2015) showed that chlorella dinoflagellates and chlorella dinoflagellates could absorb plastic particles, and their photosynthetic rate was also inhibited. Studies of plastic particles and three species of seaweed have found that plastic particles increase the release of algae polymers, which may be one of the ways in which plastic particles interfere with the ocean's carbon cycle.

The plastic particles themselves can not only cause physical damage to Marine life, but also bring potential chemical harm. A series of chemicals are used as additives in the production of plastic products. These chemicals can enhance specific properties

of plastic products, but some plasticizers, such as titanate plasticizers, brominated flame retardants, lead, etc., are harmful to life. These harmful plasticizers can be released from the plastic particles and have the effect of causing cancer and interfering with endocrine balance (Rochman, Hoh, Hentschel & Kaye, 2013b). At the same time, plastic particles have a high surface volume ratio and can absorb hydrophobic Persistent Organic Pollutants (POPs). Recent studies have shown that plastic particles can absorb not only POPs, but also metal ions (Akhbarizadeh, Moore, Keshavarzi & Moeinpour, 2017). There are few studies on the accumulation of plastic particles containing plasticizers and adsorbing persistent organic and heavy metals in the food chain.

Due to wide existence of the microplastic in the ocean and its biological inertia, persistence, its surface hydrophobic properties can quickly form a biofilm, which makes it a lot of small and large Marine life ideal habitat. Microplastics can float and transport organisms, changing their natural distribution, and turning floating creatures into non-native or even invasive species (Gregory, 2009). Tom et al. named microplastics and their adherent communities "platicphere", the results showed that the microplastic on the biological community and its surrounding communities is obviously not the same in the sea water, at the same time some adherent microbes is conditional pathogenic bacteria. When Marine life, especially economic life, eats microplastics, it may induce corresponding diseases.

Reisser et al. (2014) studied microplastics along the coast of Australia and found that diatoms are the most abundant adherent organisms. Analysis of microbial communities in different types of MPL results show that although the cyanobacteria is the major fouling organisms, but the plastic on the microbial community will still differ according to the location and different types of plastic. A pathogenic bacterium

folliculinid ciliate (Halofolliculina spp.) that attacks coral skeletons in the Indian Ocean and the southern ocean has been found on plastic waste in the north Pacific Ocean (Goldstein, 2012). Except to the physicochemical properties of plastic matrix, other factors such as geography, physicochemical environment and biology also influence the biological adhesion of its surface. Amaral-Zettler et al. studies (2015) show: the north Atlantic and north Pacific subtropical gyre of plastic litter has significant differences in microbial community structure, and the north Atlantic "plasticphere" biological structures will vary with the latitude. The study shows that "plastic ring" biological biological geographical characteristics, which means that the plastic substrate in the spread of invasive species, harmful algae and potential pathogens will change according to the different geographical position, so the effect of plastic garbage in the global marine ecosystem will change due to different region. It is of great importance to study the regional "plasticphere" organisms to understand their impact on the Marine ecosystem and Marine waste supervision policies.

2.4 Research on MMiL in China

As early as the 1980s, researchers in China reviewed the mechanism, cause and harm of marine plastic waste to Marine life (Fan & Li, 1988). Since then, China's monitoring and research on Marine plastic waste has never been interrupted. The state oceanic administration released by China's marine environment in 2011-2015 to the communique plastic litter accounted for the proportion of China's offshore, including floating trash and garbage on the beach, more than 70% of the ocean trash. The proportion of plastic waste on the ocean floor increased from 57 percent in 2011 to 87 percent in 2015, and this proportion will continue to increase with the

accumulation of plastic waste on the ocean floor.

However, the research on plastic microparticles in China has just started. In 2014, East China Normal University reported the pollution of floating microplastics in the Yangtze river estuary and its adjacent waters, becoming the first case of microplastics pollution in coastal zones in mainland China. In the past three years, East China Normal University, Yantai Institute of Coastal Zone Research，Chinese Academy of Sciences, The University of Hong Kong, The Education University of Hong Kong and other research units have carried out some exploratory work, and gained some basic data. Survey area from north to south including: Dalian, Caofeidia and Shandong peninsula in the Bohai rim region, Yangtze river estuary, Oujiang river estuary, Jiaojiang river estuary, Pearl river estuary, and Hong Kong area, Guangxi Beibu gulf area, Hainan island and other area (Zhou et al., 2016). The investigation included water bodies, tidal flats, soil and sediment, sediment, etc. The investigation involved microplastics contamination in bivalves.

Overall, Marine micro plastic investigation and research have just started in our country, the micro plastic in China offshore environment pollution status quo and the understanding of the complex behavior in the ecological system, is still very limited, micro plastic for the coastal zone and its adjacent sea area pollution situation is unclear, including micro plastic type, size, time and space distribution, sources and tending towards and ecological risk, etc.

CHAPTER 3

International and national governance in addressing MPP

3.1 The global level of MPP management

At the international level, some Multilateral Environmental Agreement (MEAS) and soft law have been formed. These documents have played a positive role in controlling MPP.

3.1.1 Multilateral Environmental Agreements (MEAS)

The multilateral environmental agreement (MEAS) is a binding international agreement. So far, three MEAS are closely related to Marine waste. The United Nations Convention on the Law of the Sea (UNCLOS) provides a broad legal framework for questions relating to marine litter. Although there is no special provision in the UNCLOS compact to emphasize the problem of litter contamination, it does encourage states to formulate laws and regulations to prevent and control marine pollution. The International Convention for the Prevention of Pollution From Ships (MARPOL 73/78) is one of the most important international instruments,

processing rules on marine pollution including prevent and reduce the ship pollution, accidental pollution and pollution in daily operation. Annex V of MARPOL concerns marine garbage pollution and prohibits the discharge of plastics from ships to the sea. The Convention on the Prevention of Marine Pollution by Dumping of Waste and other matters is known as London Dumping Convention (LDC). The LDC aims to prevent marine pollution by regulating the dumping of wastes and other substances into the marine environment. 1996 Protocol to the LDC, by introducing reverse lists, is more restrictive than the convention in regulating waste dumping. Plastic is not included in the "reverse list", so dumping it at sea is prohibited.

Other global MEAS also have provisions or are working to reduce marine waste, including agreements on biodiversity and species: Convention on Biological Diversity (CBD), Convention on Migratory Species (CMS) and United Nations Fish Stocks Agreement (UNFSA); Agreements for chemicals and waste: Stockholm Convention on Persistent Organic Pollutants (Stockholm Convention) and Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and Their Disposal (Basel Convention).

3.1.2 Soft law

Soft law is generated with the evolution of globalization trend and the introduction of the concept of global governance. Soft law document is not legally binding but will produce the actual effect of the code of conduct, is a former legal norms, is also the prelude to the international legislation or guide, legal stage or prototype, before can reflect the emerging of the international law of the possible future directions (UNEP,

2016). At present, the soft law is the most significant mechanism to deal with MML. There is no binding multilateral environmental agreement on reducing MML and microplastics as the main objective.

Currently, there are several global soft laws related to marine waste. The Food and Agriculture Organization of the United Nations' (FAO) Code of Conduct for Responsible Fisheries (CCRF) for abandoned, lost or discarded fishing tackle problems in other way, requires states to take appropriate measures, including the research and use of selective and harmless environment and high efficiency of fishing equipment and technology. The Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-based Activities is currently the only global intergovernmental mechanism for addressing land-source pollution, requiring countries to adopt national action plans to address land-source pollution. Marine waste is a kind of important land-based pollutant concerned by GPA. The Honolulu Strategy--A Global Framework for Prevention and Management of Marine Litter puts forward a method to reduce land-based and marine litter, but gives no measurable goals or schedule. On the basis of the Honolulu Strategy, the United Nations Environment Programme (UNEP) established the Global Partnership on Marine Litter (GPML) in 2012.

In 2012, the The United Nations Conference on Sustainable Development (UNCSD) adopted the outcome document entitled "the future we want". Paragraph 163 of the document sets out the hazards caused by marine pollution, including marine and land-based sources, and requires member states to implement relevant conventions and plans to achieve the goal of " significant reductions in marine litter" by 2025. The United Nations general assembly approved a resolution 70/1: Transforming our world: the 2030 Agenda for Sustainable Development. Target 14 requires

conservation and sustainable use of oceans and their resources, and clearly emphasized to reduce the marine pollution of all kinds.

3.2 Regional level of MPP management

In addition to the global agreement and the soft law instruments, there are several regional agreements and instruments dealing with the management of marine litter and addressing the problem of marine litter through regional coordination.

The UNEP Regional Seas Programme has successfully organized and implemented regional marine litter management activities around the world. 18 Regional Seas Programme (Caribbean Region, East Asian Seas, Eastern Africa Region, Mediterranean Region, North-West Pacific Region, Western Africa Region, Caspian Sea, Black Sea Region, North-East Pacific Region, Red Sea and Gulf of Aden, ROPME Sea Area, South Asian Seas, South-East Pacific Region, Pacific Region, Arctic Region, Antarctic Region, Baltic Sea, North-East Atlantic Region) through the Marine conservation documents legally binding area, to evaluate the status of the regional marine litter, compiled with regional marine litter management plan of action, activity organization and International Coastal Cleanup (ICC), etc.

The European Union (EU) has several initiatives to tackle the problem of marine litter, most relevant of which is the EU Marine Strategy Framework Directive (EU MSFD), which is the backbone of its marine policy. MSFD requires that the member states in 2020 achieve or keep a Good Environment Status (GES) target, with marine litter within the 11 GES descriptor, and attains that marine litter won't cause harm to the offshore and coastal environment, and sets the specific monitoring indicators

(Galgani, Hanke, Werner, & De Vrees, 2013). The problem of marine pollution is solved through the EU Waste Legislation, regulations on packaging waste (including plastic bags) and recycling economic methods.

In addition, relating to the problem of MPP, there are the Convention on the Protection of the Marine Environment of the Baltic Sea Area, 1992 (Helsinki Convention) annex IV, the EU Port Reception Facilities (PRF) directive, the marine litter monitoring initiatives and fishing (clearance) project of the Convention for the Protection of the Marine Environment or the North-East Atlantic (OSPAR Convention) and The Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean adopted in 1995 (Barcelona Convention), etc. In the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) also launched a marine litter management plan, specific actions including monitoring marine litter, assessment the risk of mammals winding by plastic packaging, seabirds gut hooking damage, as well as to the fishermen and fishing boat operators such as publicity and education, etc.

3.3 National level of MPP management

Local and national actions has been always the main method to reduce the plastic pollution, including ban on plastic (microbead, plastic bags, etc.), fishing gear recycling incentives, and actively and measurable progress has been made.

Japan's Law for the Promotion of Marine Litter Disposal (LPMLD), adopted in 2009, aims to control and reduce the marine litter. The Law authorizes the central government to formulate a marine litter policy, the basic guidelines for promoting

comprehensive and effective measures to combat marine litter, adopted in 2010. The policy clarifies the responsibilities of all parties in the disposal of marine litter, sets up a coordinating committee and a committee of experts to promote the countermeasures against marine litter, and emphasizes personal, public and international cooperation.

When a country does not have a special national marine litter act, it solves the problem by including provisions in a wider range of legislation. In South Korea, for example, in 2009 the South Korean Marine Environmental Management Act (MEM) of authorization for the marine litter management plan, cleared the state, local and personal obligations to prevent Marine pollution, adopted the polluter pays principle, and asked to promote research and international cooperation in the field of the Marine environment, etc.

The United States in 2006 passed the Marine Debris Research, Prevention and Reduction Act (MDRPRA), established the Interagency Marine Debris Coordinating Committee (IMDCC), whose duties include marine litter identification, impact assessment, removal and prevention activities. The Marine Debris Programme (MDP) and the National Marine Debris Monitoring Program (NMDMP) were implemented to investigate and eliminate the sources of marine litter and standardize the data of marine garbage, so as to evaluate the status and trend of marine litter scientifically. Some cities in the United States have "zero waste" plans, such as New York City's goal of reducing emissions by 3 million tons by 2030; some states have introduced a system of paid use of plastic bags in 2017 to further control and reduce the use of plastic bags. It has also introduced legislation to ban the use of plastic beads in personal care products from 2017.

Some countries respond to the Marine waste challenge not by legislation but by establishing a comprehensive national policy framework. The policy itself is not binding, but it can promote the adoption and revision of laws and regulations in different departments through national policy and strategy-oriented legislation. The Netherlands has established its own marine litter policy based on the policy framework of the European Union and other regional and international policies. For the Netherlands, the key legal framework for policy formulation is the EU MSFD. In addition, the marine litter policy of the Netherlands covers solid waste management, raw material chain management, new material management and producer responsibility. Efforts shift from solid waste management to source management.

3.4 Other social forces play a role in the management of MPL

3.4.1 Based on social civil power

A bottom-up approach to reducing Marine pollution could have substantial effects. GhostNets Australia (GNA), for example, has worked with a coalition of aboriginal communities from northern Australia to remove fishing gear, removing more than 13,000 abandoned nets and rescuing more than 400 sea turtles (Ghostnets, 2015), and determined the priority clear the net area, forbidden net area and so on (Wilcox C,2016). Through publicity and education, public awareness of the impact of MPL can be enhanced, and interaction between communities and scientists can change the behavior of coastal people in using and removing plastics.

Nongovernmental organizations (NGOs) are also influential community governance

actors. Large NGOs such as Greenpeace, the World Wide Fund For Nature (WWF) and the International Union for Conservation of Nature (IUCN) have special marine plans/investments. Other NGOs have taken positive action, such as “Beat the Microbead” international action, which can query through the website or mobile application which products including/no beads (Beat the Microbead, 2015). For the problem of MPL, different groups represent different positions and adopt different methods, resources and ideologies. Community groups and NGOs, the governance can influence is different, which may change the government's regulations and policies of the industry (such as plastic beads have been enacted or are considering bans).

3.4.2 Based on market mechanism and corporate responsibility

UNEP has identified market instruments such as taxes, fees, fees, fines and penalties that can be applied (UNEP, 2009). The basic principles behind these mechanisms include polluter pays, user pays and full cost recovery. Australia and the United States deposit programs, the application of market tools such as container cash recycling in Germany or net cash recycling in Korea can effectively reduce the phenomenon of littering and reduce marine litter from the source (Joanna & Britta, 2017). Corporate social responsibility will have an important impact on the r&d, sales and life cycle of plastic products. A research report has shown that many big companies will be sustainable packaging and plastic use as part of a corporate social responsibility, to avoid a negative brand image, are stepping up efforts to improve the packaging materials and packaging technology (Joanna & Britta,2017).

In 2011, the Plastics Industry Association issued the Declaration of the Global Plastics Associations for Solutions on Marine Litter, which has been signed by 60

industry associations in 34 countries (Marine Litter Solutions, 2014). The social responsibility of an enterprise may obtain social business licenses for enterprises, but through social licenses, communities and consumers can promote changes in enterprise policies and products.

CHAPTER 4

Analysis on the development trend of global Marine plastic waste management

4.1 Current situation of global MPP control

The universality of MPP and its impact on coastal economy, marine ecosystem and human health show that there is no simple solution. Although the global, regional, national and local level have adopted a series of management measures to solve the problem of MPP, unfortunately, so far, local, regional and global ocean plastic litter management have failed to effectively prevent the plastic into the ocean in terms of international agreements, and public awareness of plastic pollution compared with the seriousness of the problem of pollution is disproportionate. This is in marked contrast to internationally focused carbon emissions and other global pollutants such as chlorofluorocarbon (CFC) and persistent organic pollutants.

There are national, regional and global strategies aimed at preventing and mitigating plastic pollution, but there are no global commitments to match the pollution problem. Local policies and action (for example, banning the use of microbead and disposable plastic bags) all over the world, but only a handful of international documents focus on plastic pollution, including MARPOL convention, Honolulu

Strategy, and the UNEP new ocean "cleanseas" activities. While these international strategies recognize global pollution, they do not have binding commitments to meet the challenges.

MARPOL annex V is indeed an international agreement specifically on plastic pollution, and the ban on ships dumping plastic at sea is a great first step in the fight against MPP. However, since the entry into force of MARPOL convention, with the rapid growth of plastic production, its emissions have continued to rise, and Marine plastic pollution has become increasingly serious. Because annex V is limited to ocean emissions, 80 percent of plastic enters the ocean from land.

Soft law instruments are generally global statements, guidelines and other efforts that are not binding but persuasive. At the global level, soft law now dominates the response to marine litter and is an important part of the existing system. In addition, the sea of transboundary pollution is a global problem, whether it is on the high seas garbage clean-up project, or outside the sea areas under the jurisdiction of pollution liability, from perspective of governance and practice is complicated. There is still a gap in international law in slowing down and removing marine litter from areas outside their jurisdiction. Therefore, both the academic and management circles are advocating the establishment of new and legally binding international instruments to deal with MPL.

4.2 Some scholars suggest for the global MPL control

Some scholars pointed out that in formulating the international carbon emissions protocol field already has more than 25 years of experience and the latest

development of climate policy can provide global MPP control policy with the template. Since 1950, global carbon emissions and MPL have similar worsening trend, but policy against them has limitation (figure 4.1).

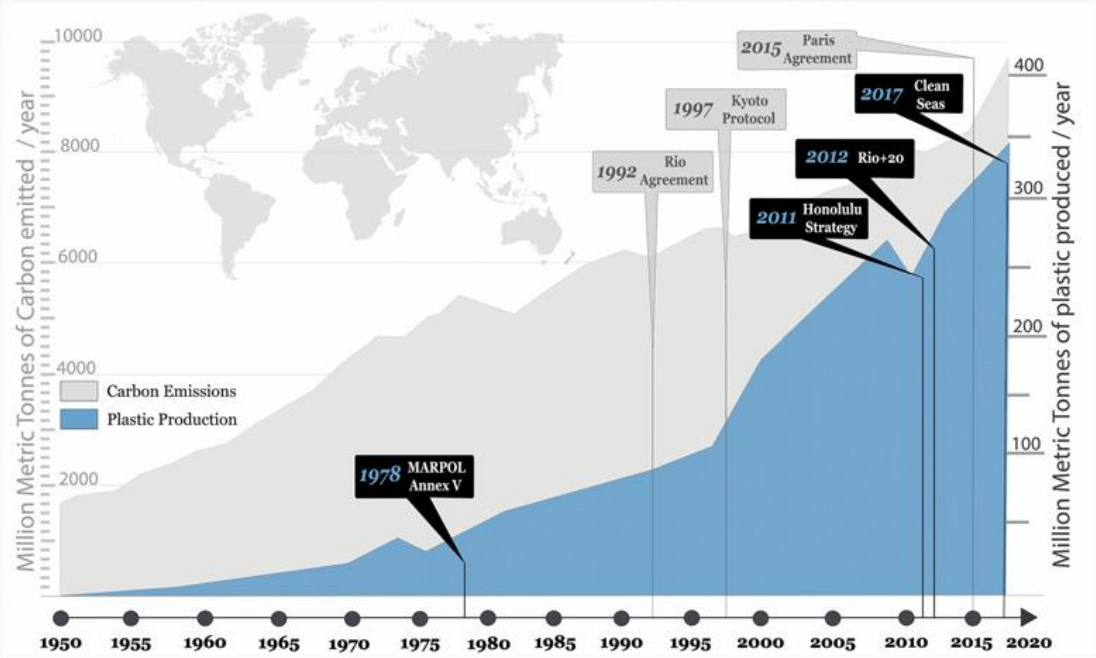

Figure 4.1: Compare global carbon emissions with plastic production

Source: Stephanie, B. B., Max, L., Alexander, B., Amy, L., Chelsea, M. R., Hillary, B., Jennifer, P., (2017). Why We Need an International Agreement on Marine Plastic Pollution. PNAS, Vol. 114, No.38, (2017), 9994-9997.

Experts suggest that the scale and pace of solutions to Marine plastic pollution problems must match the size and pace of emissions. At the Third Session of the United Nations Environment Assembly held in Nairobi, Kenya from December 4 to 6, 2017, Marine plastic waste is also a hot issue. The importance of MPL and microplastics in global environmental governance was highlighted at the previous two environmental session. Resolution 2/11 (UNEP/EA, 2016) on MPL and microplastics was adopted at the second environmental conference, of which the governments to evaluating the relevant international, regional and subregional management strategies and measures for MPL and microplastic, and considering the

relevant international, regional and sub-regional regulatory framework.

4.3 Methodology of Emissions Inventory

In accordance with the requirements of the resolution, the UNEP sets up expert advisory group. By analyzing the existing governance system, the expert group points out that there are three options for the international community: (a), maintain the status quo and continue the current efforts; (b), modify the existing governance framework to better handle MPL and microplastics; (c), establish a new international system of multi-tiered governance.The strong view of the expert advisory group is that the first approach is not the solution to the problem. The group also provided a possible timetable for the selection of programme 3 and recommended the establishment of Open Ended Working Group，(OEWG) or Intergovernmental Negotiation Committee (INC). Three to four years to complete negotiations on a new internationally legally binding instrument, the new agreement could come into force in four years.

At the third environmental conference, delegates discussed marine plastics and microplastics, though no consensus was reached on alternative options. But delegates fully realize the marine plastic exists in large number and in a rapid increase, affecting for marine biodiversity, ecosystem, animal welfare, fishery and ocean transportation, leisure and tourism, the local society and economy adverse effects will be increased, and the urgent need to reduce the microplastic and the number of nanometer plastics and its impact on the marine ecosystem, seafood and human health. Emphasizing that priority should be given to litter reduction through solid litter reduction and environmentally nonharmful litter management, which is of

particular importance in areas where is the largest source of MPL. The conference also stressed that in accordance with mutually agreed terms for technology transfer and assemble all resources is an important factor of governance MPL and microplastic, admitted in products and packaging plastic under the condition of increasing production and consumption in solving the problem of MPP challenges, and urged all countries and other stakeholders in the responsible use of plastic and effort to reduce unnecessary plastic use, and promote the research and application of harmless environmental alternatives.

The third environmental conference stressed the need to eliminate the long-term discharge of plastic waste and microplastics into the sea, and protect marine ecosystems and human activities that depend on them from marine litter and microplastics; urges all actors to strengthen action, to achieve "by 2025, to prevent and dramatically reduce all kinds of marine pollution, especially the land-based pollution, including marine litter pollution and nutrient pollution"; encourage all member states in accordance with the relevant environment of marine litter and the source of the microplastic and the number of existing best knowledge, give priority to formulate policies and measures in the appropriate level, in order to avoid the MPL and micro plastic into the marine environment;

4.4 China’s MPL management and challenges

China is a major producer and user of plastics. China’s MPL and microplastics have attracted much attention in the world. China accounts for 58 percent to 65 percent of the world’s floating litter in the north Pacific, according to a simulation of global

floating waste. With literature reports, through the use of the coastal state of population and waste production amount to estimate the amount of garbage into the sea, points out that the global 192 countries and regions, coastal China is one of the world's biggest source of plastic litter from land into the sea (Jambeck, Geyer, Wilcox, Siegler, Perryman, Andrady, Narayan & Law, 2015). A staggering 8 million tonnes of plastic end up in the world's oceans every year. And 10 rivers alone carry more than 90% of the plastic waste that ends up in the oceans, including China's Yangtze River, Yellow River, Huang He and Pearl River among them (Figure 4.2).

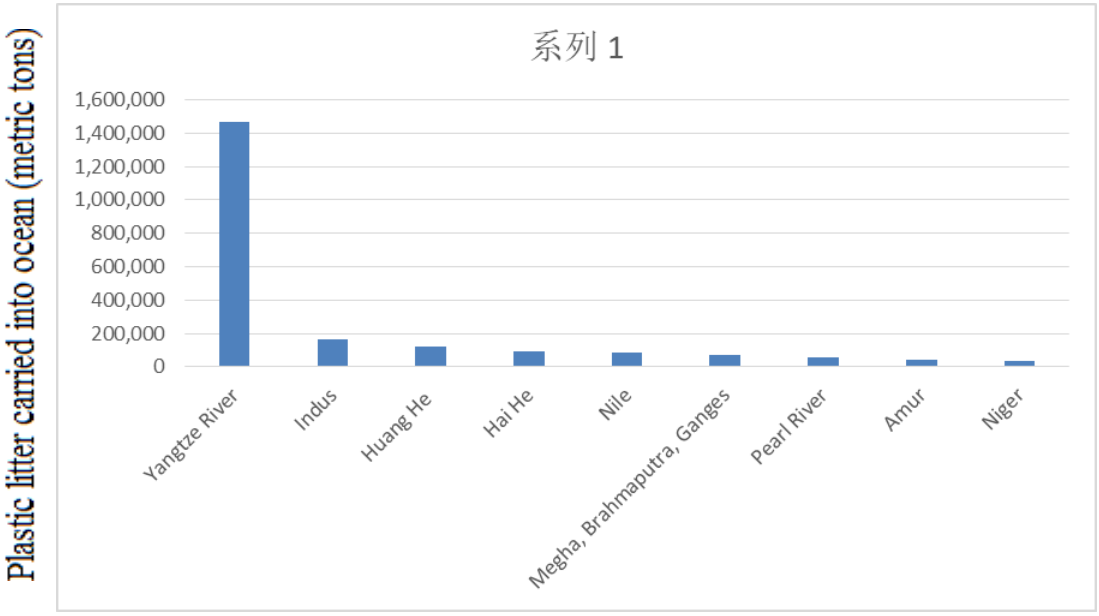

Figure 4.2 In a staggering 8 million tonnes of plastic end up in the world's oceans every year, The amount of plastic litter carrying by top 10 rivers into sea (in metric tons)

Source: www.unenvironment.org/interactive/beat-plastic-pollution/

The conclusions of the above literature have caused great concern on China's international public opinion. Since 2007, China has organized the national monitoring of marine garbage pollution and carried out pilot monitoring of microplastics in 2016. The results showed that the amount of plastic waste in China accounted for about 80% of the total amount, and microplastics were ubiquitous in

seawater, sediments and shellfish. Although the existing monitoring and research did not find the Chinese marine litter average density was significantly higher than that of other countries and regions, but local pollution problem is still serious. Coastal villages and towns, fishing ports and downstream cities of the river basin are particularly prominent in marine litter problem.

As the plastic litter in the marine environment gradually accumulate, its influences on the marine ecological environment, the existing monitoring cannot meet the demand of management and to respond effectively to the relevant international affairs. Specific performance includes:

(1), the amount of plastic into sea is unknown, the existing monitoring data is only supported on the current status of the marine plastic occurrence assessment, and unable to estimate rivers, sewage outlet, farming and fishing in the sea, marine exploration and development activities, etc. input the amount of plastic waste, lead to passive situation when dealing with the negative reports;

(2), the main source of marine plastic urgently needs to be found out, the existing monitoring by identifying the preliminary judgment of plastic components possible sources, but lack of survey data for various plastic products industry, unable to deeply grasp the various coastal and offshore activities of marine litter and the source of the microplastic, restricted the ocean plastic garbage and microplastic set of controls;

(3), marine plastic migration path is not clear. The marine plastic involved transboundary pollution. The existing monitoring stations are mainly distributed in coastal waters, and are enough to support the simulation and analysis of MPL migration path and diffusion range.

Although there is no specific legislation on marine litter in China, a number of laws

and regulations have been issued and enacted in China prevent and control marine litter, including Environmental Protection Law of People's Republic of China, Marine Environmental Protection Law of People's Republic of China, Water Pollution Prevention and Control Law of the People's Republic of China, Law on the Prevention and Control of Environmental Pollution by Solid Wastes of the People's Republic of China, The Regulations Concerning the Prevention and Cure of Pollution Damage of Marine Environment by Pollutants from Land, Regulations of the People's Republic of China on Control over Dumping of Waste in the Ocean,

In addition, China is one of the early countries to issue the "ban on free plastic bags ", and constantly strengthen the household garbage classification system. In recent years, China has successively promulgated environmental protection policies such as The Action Plan for Prevention and Treatment of Water Pollution and the River Chief System, and some coastal cities have also carried out the pilot work of the Bay Chief System. The above policy measures have played an important role in reducing land source solid waste pollution and controlling the inflow of plastic litter into the sea. But in general, from the management and policy aspects of MPL, there are the following problems:

(1), Because the management of China's MPL involves environmental protection, ocean, agriculture, residential construction, industry and other sectors, it lacks specialized policy arrangements and systems at the national level. In the actual management, there are many problems such as multiple management, unclear rights and responsibilities, insufficient investment, etc. The multi-party cooperation among state departments, local governments and the public has not yet been formed;

(2), the new international regulations on the prevention and control of MPP and their impact on the related industries such as plastics have not been well studied

and effective countermeasures and plans have not been formed.

In order to further prevent and control China's MPL and actively respond to changes in the international ocean governance, the following suggestions are made:

(1), research should be carried out in line with international standards of marine litter and plastic monitoring technique, strengthen marine plastic monitoring work, work for China's marine plastic governance and respond to provide scientific data to support.

(2), thorough development of China offshore Marine garbage and plastic source, transport flux and its ecological environmental impact study and improve the micro mechanism of plastic pollution and ecological risk of cognitive science, Marine garbage pollution comprehensive prevention and control in China and participate in global Marine waste management to provide scientific support.

(3), To strengthen the international development trend of the prevention and control of marine plastic track, anticipation and research, to form effective strategies and measures, to study and put forward marine pollution prevention plan of action and the management goal, gradually build system for the prevention and control of marine in China.

(4), we will actively promote international cooperation, deeply participate in international governance, and show China's achievements in MPP monitoring, prevention and control;

(5), Education needs to be promoted to raise public awareness of marine litter and microplastics pollution. Strengthen the volunteer team, and carry out a wide range of volunteer activities such as cleaning up beach litter and marine litter.

CHAPTER 5

Summary and conclusion

MPP has become one of the serious problems facing mankind. MPL exists in every corner of the ocean and has had a very bad impact on marine life and human health. In recent years, microplastic has attracted wide attention, and its effects on marine biology and human beings are still being studied. Through the analysis of the distribution and harm of the existing MPL, this paper emphasizes its seriousness and tries to arouse people's attention on MPP, so as to control the pollution from the source.

Although the international community and some countries (UNEP, IMO, PlasticEurope, etc) have noticed the seriousness of plastic waste and formulated some strategies and laws and regulations, the pollution of plastic waste is still not well controlled. Addressing this issue requires everyone's participation, from the source to the clean-up.

First of all, relative government, public welfare organizations and education institutes must have a clear knowledge of the hazards of plastic waste. People's minds and habits need to be changed to minimize the use of plastic. Developing countries, in particular, should not destroy the future of the planet because of temporary economic

benefits.

Second, we should introduce legally binding laws and regulations. Many of the existing instruments at the strategic level are not legally binding, and most remain between governments, some organizations and academia. As a result, many people don't know the seriousness of MPP and how to control it. So countries should reach a consensus on this issue and sign some legally binding international and domestic laws, in order to achieve minimal use of plastic.

The disposal and recycling of plastic waste are also very important. Land-based plastic litter is largely caused by improper disposal, such as littering on the beach, improper landfill of garbage which is washed away by rain and into the sea. Sea-based plastic litter is nearly the same. Although MARPOL annex 5 forbids the disposal of plastic waste into the sea, the phenomenon still exists. Therefore, the supervision of plastic waste disposal should be strengthened.

Nowadays, plastic has become a necessity of life and permeates every aspect of life. To control the use of plastics, we must actively look for greener alternatives and encourage people to use them instead of plastics.

How to clean up the existing plastic litter in the ocean is also a hot topic in recent years. There are many ideas for cleaning up and utilization of MPL. Many governments and organizations have actively carried out clean-up operations, such as cleaning up beach garbage. Cleaning up plastic waste in the ocean is bound to cost a lot of money. The source of funding becomes a big problem, and it still requires the joint efforts of countries, organizations and individuals.

To address MPL, governance should be given more priority than regulation. Because the problem with plastic waste is so big, there are so many gaps in regulation, from the high seas to the habits of everyone. Therefore, efforts should be made to improve public awareness and morality in order to restrict the use of plastics and reduce plastic waste.

Finally, China, as a major producer, consumer of plastic and source of MPL, has great responsibilities in the management of MPL. But China has done little. After nearly a decade of "ban of plastic bags", little has been achieved. There is also very little publicity about the hazards of MPL. Therefore, the above opinions on the management of MPL are particularly important for China.

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