PLASTIC OCEAN – THREATS AND OPTIONS FOR ACTION

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Dissertation submitted as partial requirement for the conferral of

Master in International Studies

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October 2019

ABSTRACT

ENG:

In the past years, the global problem of marine plastic pollution received more and more public attention. Various attempts have been made on regional, national and international level to address the issue. However, we are looking at a complex problem with various sources and pathways. Nonetheless, since most of the plastic ending up in the ocean originates from land-based activities, it seems clear that the problem has to be solved on land.

This work indicates that only a holistic approach can solve the issue of marine plastic pollution, involving various actors from industry, politics and communities. However, legal research reflects, that most of the existing agreements lack effective enforcement, measurable targets and control mechanisms, therefore an efficient implementation and enforcement of existing frameworks needs to be ensured. Furthermore, we need to change our consumer behavior and no longer treat plastic as throw-away product. NGOs can play an important role in providing information and raising awareness. Moreover, it is crucial to involve local communities in protecting the marine environment and make use of their specific local knowledge. In addition to that, it’s important to help developing countries with implementing waste management systems.

Keywords:

Durability of Plastic, Trash Vortex, Dead Zones, the Great Pacific Garbage Patch, Microplastic, Plastic Footprint, Initiatives and NGO's, Marine Plastic Pollution, Plastic Waste, Marine Litter

RESUMO

PT:

Nos últimos anos, o problema global da poluição por plásticos marinhos recebeu cada vez mais atenção do público. Várias tentativas foram feitas em nível regional, nacional e internacional para resolver o problema. No entanto, estamos olhando para um problema complexo com várias fontes e caminhos. No entanto, uma vez que a maior parte do plástico que acaba no oceano tem origem em atividades terrestres, parece claro que o problema tem de ser resolvido em terra.

Este trabalho indica que apenas uma abordagem holística pode resolver a questão da poluição marinha pelo plástico, envolvendo vários atores da indústria, da política e das comunidades. No entanto, a pesquisa jurídica reflete que a maioria dos acordos existentes carece de aplicação efetiva, metas mensuráveis e mecanismos de controle, portanto, uma implementação e aplicação eficientes dos quadros existentes precisa ser assegurada. Além disso, precisamos mudar nosso comportamento de consumidor e não mais tratar o plástico como um produto descartável. As ONG podem desempenhar um papel importante no fornecimento de informações e na sensibilização. Além disso, é crucial envolver as comunidades locais na protecção do ambiente marinho e utilizar os seus conhecimentos locais específicos. Além disso, é importante ajudar os países em desenvolvimento a implementar sistemas de gestão de resíduos.

Palavras-Chaves:

Durabilidade do Plástico, Vórtice do Lixo, Zonas Mortas, a Grande Mancha de Lixo do Pacífico, Microplástico, Pegada Plástica, Iniciativas e ONGs, Poluição de Plástico Marinho, Resíduos de Plástico, Lixo Marinho

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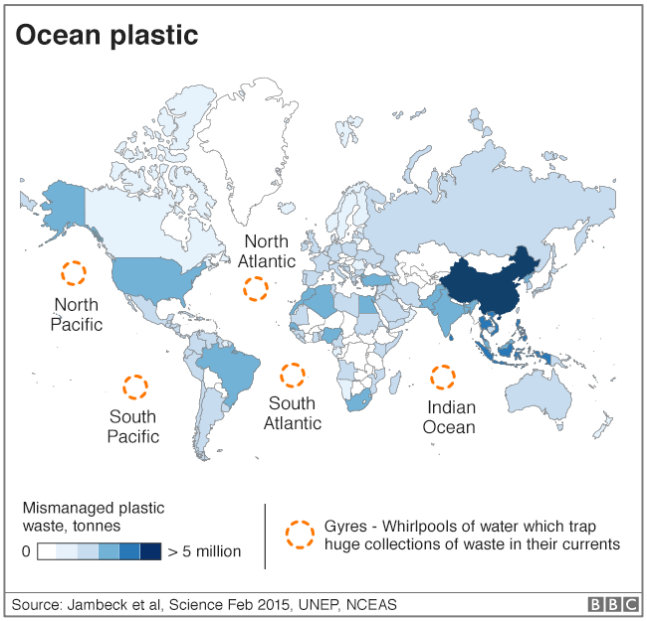
First Part: Introduction

"[W]ater and air, the two essential fluids on which all life depends, have become global garbage cans." (Cousteau 1985)

For a long time, oceans were a symbol of untouched expanse and an almost inexhaustible source of life. But these times are long gone. In the past decades, the ocean had to face many problems, starting with overfishing and pollution, the most obvious forms of which are devastating oil spills or the introduction of chemical waste. The impact of these incidents may be devastating, especially locally, but their total contribution to the pollution of the marine environment pales compared to the waste that enters the ocean through rivers, runoff and the air. The talk is about garbage, or more precisely plastic garbage. (cf. Sielen 2013)

Reports of marine plastic pollution first appeared in the scientific literature in the 1970s, yet more than 40 years later, there still exist no rigorous estimates of the amount and origins of plastic debris entering the marine environment (Jambeck et al. 2015). It is not about an individual PET bottle, but about huge, coherent garbage rugs, which sometimes even reach the size of Germany or Central Europe. In some marine regions epic gyres of floating waste have formed (cf. Fig. 1).

Figure 1. Ocean Plastic - the 5 Major Ocean Gyres



The most famous gyre is the Great Pacific Garbage Patch. which expands over hundreds of miles in the North Pacific Ocean. According to experts, it carries up to 100 million tons of plastic debris and keeps growing rapidly (cf. Lohmann 2014), which comes as no surprise, considering the fact that nearly 8 million tons of plastic find their way the ocean every year (ibid.). Without improved waste infrastructure, the total volume of plastic waste entering the ocean is estimated to rise by an order of magnitude by 2025. (ibid.)

Plastic waste in the ocean is of increasing concern because of its persistence and effects on the oceans, wildlife, and, potentially, humans. It is not completely clear yet, which long term consequences plastics (especially microplastics) in the ocean will have. However, the destruction of entire ecosystems is a huge threat to our very survival, since only the healthy functioning of these diverse systems makes life on earth possible. Disruption on this level will sooner or later come at a great cost for humans in terms of food, health, and quality of life. It also means that the unspoken promise of a better future passed from one generation to the next will be broken. (cf. Sielen 2013)

Nonetheless, in the past years awareness seems to have been growing slowly and steadily - at least in some parts of the world - and there are more attempts by national and international actors to address the issue of marine plastic pollution. These efforts have addressed various levels of governance and focused on the full range of response actions. Yet despite all these endeavors the problem has kept growing. The question is: why?

The aim of this work is to find out which answers scholars, international institutions, regional cooperation bodies as well as exemplary non-governmental organizations have proposed for the fight against marine plastic pollution.

First, the most relevant theoretical models on governing a common resource, from Garrett Hardins “Tragedy of the Commons” to Elinor Ostroms “Governing the Commons” are being presented in order to provide the necessary theoretical background. Then the main threats and problems linked to marine plastic pollution are clarified. In particular, reference is made to the durability of plastic, trash vortex, dead zones and microplastic. The goal here is to create a basic understanding of the problems; therefore, biochemical correlations are not explained in detail.

Next, an overview of existing initiatives and frameworks by different actors is provided. Possible reasons for the success as well as for the failure of these measures are identified.

Here, a special focus of this work will lay on their respective impact and the possible reasons why it might be limited.

To complete the picture, three exemplary non-governmental organizations and their work are briefly presented, namely The Ocean Cleanup, Fishing for litter, 4Oceans and Seas at Risk.

Since, marine plastic pollution is without a doubt a global problem, it seems extremely important to tackle this problem on a global scale. Therefore, the main focus of this works remains on global initiatives and international (binding and non-binding) frameworks.

On the basis of this analysis it shall be determined whether the existing frameworks are deemed sufficient or if a more holistic approach is needed, which also involves e.g. NGOs, local communities and the industry. In order to find an answer to this question, the strengths and weaknesses of existing regulations will be examined.

SECOND PART: THEORETICAL MODELS

A. The Tragedy of the Commons (1968)

In 1968, the American ecologist Garrett Hardin published in *Science* an article entitled "The Tragedy of the Commons" (Hardin 1968), in which he reflected upon both the nature of humankind and our interactions with the environment. He described the recurring fate of the pasture open to all. “[I]t is to be expected that each herdsman will try to keep as many cattle as possible on the commons. Such an arrangement may work reasonably satisfactorily for centuries because tribal wars, poaching, and disease keep the numbers of both man and beast well below the carrying capacity of the land. Finally, however, comes the day of reckoning, that is, the day when the long-desired goal of social stability becomes a reality. At this point, the inherent logic of the commons remorselessly generates tragedy.” (Hardin 1968: 1244).

However, the tragedy lies not in what one herdsman does but rather collectively, how they as a “class” follow the same behavioral pattern as “[E]ach and every herdsman sharing a common adds more and more animals to his herd. And therein is the tragedy. Each man is locked into a system that compels him to increase his herd without limit – in a world that is limited.” (Hardin 1968: 1244). Severe degradation of the common land follows and eventually resources are exhausted.

Hardin is proved right by countless examples, from overfishing of the oceans the atmosphere with greenhouse gases, because everyone wants to heat, cool, drive and fly without restrictions. As mentioned before, Hardin states that in circumstances where “[…] multiple individuals are acting independently with their own short-term, self-interest in mind, this selfishness leads to the destruction of the shared resource, which is ultimately against the long-term interest of all.” (Hardin 1968: 1245.).

But what does marine plastic pollution have to do with all of that? Since Hardin popularized the metaphor of the “Tragedy of the Commons” in 1968, showing the difficulties with managing the commons, the world’s oceans have been identified as a common pool resource (CPR), that is highly affected by degradation and over exploitation. Nowadays, marine litter has become as much a “commons” and a “tragedy” as is the ocean itself. Marine plastic pollution is an international and fundamentally transboundary problem. Plastics are not

contained by national borders. Once in the ocean, therefore, marine litter becomes an externality that no State (or group of States) is responsible for preventing, controlling or recovering. As such it is a classic example of an international cooperation problem, a "tragedy of plastic pollution", for which only a multifaced, global response can provide a meaningful solution.

Of course, there are states, politicians and companies who, out of sheer self-interest, want to maintain the status quo of a high plastic production and consumption. But what about the politicians who seriously want to advocate for long-term environmental protection, but then as individual states find themselves in the position to get the chestnuts out of the fire for all humanity, while others just lean back and rather save the money? It is doubtful that such politicians would be re-elected unless they effectively represent the vested interests of their electorate. Because when things get tough, the electorate tends to focus on its own short-term interests rather than those of the next generation - Hardin's tragedy of the commons. (cf. Milinski / Marotzke 2015: 103)

B. Governing the Commons (1990)

In 1990, Dr. Elinor Ostrom transformed the same field of research that Hardin created in 1968 with his tragedy of the commons. In her book "Governing the Commons: The Evolution of Institutions for Collective Action" published in 1990, Ostrom explores different efforts - successful and unsuccessful - of governing the commons. She tackles one of the most "[…] contentious questions of positive political economy, whether and how the exploration of common-pool-resources (CPR) can be organized in a way that avoids both excessive consumption and administrative costs." (Ostrom 1990: xi). As opposed to the "Tragedy of the Commons" argument, Ostrom claims that common pool problems are sometimes solved by voluntary organizations rather than by a repressive state (Ostrom 1990). Her aim is to illustrate the diversity of solutions that go beyond states and markets.

"The commons" are not a precisely defined term, and probably even less now, than it was when Hardin created the metaphor of the "Tragedy of the Commons" (Berge, Laerhoven 2011). However, by 1990, Ostrom popularized the concept of a "common-pool resource" which "[…] refers to a natural or man-made resource system that is sufficiently large as to make it costly (but not impossible) to exclude potential beneficiaries from obtaining benefits

from its use." (Ostrom 1990: 30). This concept is the key to understanding the circumstances under which resource governance regimes can possibly be expected to result in more sustainable forms of resource utilization. Of course, the main problem of common regimes is linked to the challenge of governing individual rational action in a system in which outcomes depend on the actions of all other consumers. Long story short: this is the "problem of collective action" (Berge, Laerhoven 2011: 161).

In order to determine successful Common Pool Resources management strategies, scientists have studied common property resources thoroughly from an institutional perspective. In 1985, a conference was sponsored in Annapolis, Maryland by the National Academy of Sciences to talk about common property management. This conference was a milestone for developing the theoretical foundation of the institutional design for the success of CPRs.

As a result, a strong international network of 2,000 scholars has been developed and committed to researching CPR issues in any area that may be applied. The International Association for the Study of Common Property (IASCP) was put together in 1989. Unquestionably, Elinor Ostrom can be seen as a leader of this intellectual movement.

Ostrom recognized that real-world commons organizations could be used to research how people resolved the circumstances that brought about the tragedy. In "Governing the Commons", her approach was therefore a meta-analysis of existing case studies. She highlighted systems of agricultural production like irrigation, forestry, fishing and animal husbandry systems. She then used her research as a base to propose eight design principles that she associated with sustainable resource governance: clearly defined boundaries, congruence between appropriation rules and local conditions, collective-choice arrangements, monitoring, graduated sanctions, conflict-resolution mechanisms, minimal recognition of rights to organize and nested enterprises. According to her "[W]hen individuals are presented with rules meeting these criteria, a safe advantageous and credible commitment can be made." (Ostrom 1990: 186).

However, the CPR management gets problematic, when an individual decides that he or she is entitled to the common resource even if not contributing to its sustainable management. This is also called the free rider problem, which is thoroughly analyzed by Manur Olson (1965) in his book "Logic of Collective Action". According to Ostrom "[O]lson challenged the presumption that the possibility of a benefit for a group, would be sufficient to generate

collective action to achieve that benefit." (Ostrom 1990: 6). Olson argued that if it isn't about a particularly small number of individuals, or if there is no coercion or any other special incentive to make individuals act in their common interest "[…] rational, self-interested individuals will not act to achieve their common or group interests" (Olson 1965: 2).

Ostrom also mentions the Prisoner's Dilemma (PD), which is closely related to the free rider problem and as which Hardin's model has often been formalized. It shows the paradox why two rational individuals might not cooperate, even if it is in their best interest to do so. Scholars are so fascinated by this paradox, that already in 1975, a staggering number of 2000 of articles has been written about it, often coming to the conclusion that the common pool resources will eventually collapse (Ostrom, 1990: 5). Usually two solutions are given to address prisoner dilemmas in CPR: the intervention of a centralized government or resource privatization.

In her work, however, Ostrom is offering an alternative. She suggests the development of durable cooperative institutions that are organized and governed by the resource users. According to her "[…] the capacity of individuals to extricate themselves from various types of dilemma situations varies from situation to situation" (Ostrom 1990: 14). She argues that in some cases, neither the state nor the market appear to be able to manage common natural resources successfully over the long term, whereas individuals from different communities who place their trust in institutions governed neither by the state nor the market have had better results managing certain resource systems over long periods of time (Ostrom, 1990).

In her work, Ostrom specifically mentions small-scale communities, recently recognized by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) to play a crucial role in the management of biodiversity, especially when they are indigenous (IPBES 2019). Ostrom concentrated on communities with between 50-15,000 members, who rely on common pool resources for their economic welfare. By excluding non-renewable resources, abundant resources and circumstances that generate significant externalities, she further narrowed down the research criteria.

Both, Ostrom and Hardin are of the opinion that open-access resources that belonged to no one, such as the open sea, are vulnerable to over exploitation. However, Ostrom sees a difference when it comes to limited-access resources. She points out, that in some cases,

resources existed for centuries, which is where the concept of property rights comes into play. (Ostrom 1990)

Ostrom's philosophy of community-based resource management in between private property and state regulation was used by many legal scholars to develop new ways of looking on property rights. Especially in environmental law, "Governing the Commons" and Ostrom's design principles received a lot of attention in discussions about community forestry, as well as ecosystem and watershed management. However, it got problematic, whenever the scale of the system became too large, which is the case when talking about plastic pollution. Problems also emerged, when the group gaining benefits from a common resource varied from the one bearing the costs of preserving it, such as tourists benefitting from clean beaches and a healthy wildlife while local communities bear the cost (Henry, Dietz 2011). Therefore, it is important to ask to what degree Ostrom's design principles are applicable to governance problems at global scales, such as greenhouse gas emissions or marine pollution? A question that also concerns Adam Douglas Henry and Thomas Dietz (2011) in their book "Information, Networks and the Complexity of Trust in Commons Governance".

C. Information, Networks and the Complexity of Trust in Commons Governance (2011)

Following on Elinor Ostrom's works on CPR and commons governance, theoretical and empirical progress have been made to understand collective action and design institutional mechanisms to obtain a positive outcome. While the literature on commons has deepened the understanding of trust, most of the empirical work has been done in relatively simple contexts that do not reflect the complexity of the many global and institutionally complex dilemmas we face today. Adam Douglas Henry and Thomas Dietz (2011) set out in this paper to improve the understanding of trust in these more complex settings. They look particularly at two categories of variables: belief systems and networks and how they influence trust (A. Douglas, T. Dietz 2011)

Drawing on the knowledge brought by Ostrom's book "Governing the Commons", trust in commons is being defined as an important determinant of sustainable outcomes as it influences strategic interactions between individuals whose own initiatives are not necessarily

taking into account the collective action (Olson 1965). The authors acknowledge that most research on trust looks at trust in actions, which means that an individual puts herself at risk of an outcome determined by the actions of others (A. Douglas, T. Dietz 2011). However, when considering the different sustainable challenges that resource users are faced with, it is not limited to this form of trust and the research needs to expand into other aspects of trust to improve our understanding.

Information is crucial when it comes to decision-making in commons and trust in information is as important as trust in actions in supporting successful governance (A. Douglas, T. Dietz 2011). For example, marine plastic pollution in the ocean is widely recognized as a global common crisis. Everyone trusts this information, but little had been done to address the causes of this problem until fairly recently with national governments, the EU ban on single-use plastics, and NGOs advocacy, starting to build more trust on scientific evidence. According to Lackey (2006): "Many sustainability issues are mired in conflicts over scientific information that informs the presence (or absence) of a problem, the likely causes and severity of problems, and appropriate solutions" (Lackey 2006). Additionally, the authors argue that "In many cases, actors must acquire information not from primary sources (e.g. the scientific literature, formal policy analyses, or detailed analyses of the likely actions of other actors) but from other members of the action arena. With many individuals and organizations potentially providing information, and given the risks inherent in adopting misinformation, an actor has to assess how much to trust each source." (A. Douglas, T. Dietz 2011: 196)

Ecological policy issues may become further clouded by skepticism about the independence of scientists and scientific information (Lackey 2006). Belief systems play a significant role in influencing people's trust in information. Often considered as "biased assimilation", a belief system of a person or society is the set of beliefs that they have about what is right or wrong and what is true or false (J.L. Usó Domenech, J. Nescolarde-Selva 2016). In commons, people tend to believe or interpret information that supports their prior beliefs and mistrust information that disconfirms what they already believe to be true (A. Douglas, T. Dietz 2011). The authors found, based on The Advocacy Coalition Framework (ACF) argument, that biased assimilation causes policy actors to filter evidence through their existing beliefs. For example, in a fishery, the old generation of fishermen will argue that the state of resource unit on which they depend has either worsened or improved over their lifetime, whereas younger fishermen that were born with different conditions than that of their older counterparts will

have a different opinion on the resource's health. Beliefs on their environment would thus influence the trust in what they hold to be true regarding the resource unit. It would further impact the design of policies and of decision-making processes regarding the management of the fishery.

In their work, Douglas and Dietz attach some importance to networks in regards of trust and argue that these networks can "facilitate information sharing and will be critical for the social learning needed to move towards sustainability. "However, they warn against homophily and transitivity processes and the fact that they can move actors away from a global shared understanding of a problem, to push them towards a more segmented and polarized understanding that would prevent effective management of a common (A. Douglas, T. Dietz 2011)

D. Design Principles for Global Commons: Natural Resources and Emerging Technologies (2011)

Elinor Ostrom's institutional analysis and its focus on self-governance institutions have inspired more than one research in the study of common resources and design policy. In this work, Paul. C Stern (2011) looks at design principles for global resource commons and risks of emerging technologies. Drawing on Ostrom's work, the study shows the differences between common pool resources and global common resources, how they are affected by collective action and improve the understanding of these problems (Paul C. Stern 2011). The study concludes that although Ostrom's pioneering work in "Governing the Commons" is relevant to address commons that are very different from the ones studied in her book, the direct applications of the design principles to global commons and to technological risks is not entirely possible and require an extension for further applications. Additional information on different commons must be incorporated into the 1990 work in order to address them. A suggestion is made to expand the thinking beyond traditional mechanisms such as state intervention on the market, regulatory command and control or formal agreement between nations (Paul C. Stern 2011).

After the tragedy of the commons by G. Hardin (1968) and the realization of the threats to the natural environment posed by humans and their behavior in commons, Elinor Ostrom

developed an excellent set of design principles for governing the commons. These same principles are being used by the author to apply them to global common resources depletion. When degradation is global, through global and normalized behaviors, such as inappropriate disposal of worthless objects or pollution of natural resources, it becomes distant and more difficult to link it to them. This is why, amongst the differences between local and global commons, the geographic scale, the number of resource users, the regeneration of degraded resource, and the distribution of interests and power are not similar and thus governance cannot address them with the same policy mechanisms.

For example, Paul C. Stern identified the challenges in applying Ostrom's design principles to reducing the degradation of global resources and limiting technological risks (Fig.2) (Paul C. Stern 2011).

Figure 2: Application of Ostrom's design principles to reducing the degradation of global resources and limiting technological risks (Paul C. Stern 2011)

Table 2: Application of Ostrom's design principles to reducing the degradation of global resources and limiting technological risks

Ostrom's design principles	Applicable?	Challenges in application
Define boundaries for resources and appropriators	No	
Devise rules congruent with ecological conditions	Possibly	• identifying the relevant conditions • developing enforceable rules for global phenomena
Allow most users to participate in developing rules	Yes	• size of appropriating group • disconnect between winners and losers from resource use • difficulty of understanding science
Hold monitors accountable to users	Yes	• conflicts of interest between parties • establishing monitors' and scientists' independence from appropriators • need for global monitoring • uncertainty about what to monitor • greater difficulty establishing accountability across jurisdictions
Apply graduated sanctions	Yes	• authority to sanction limited because of disconnect of parties
Develop low-cost conflict resolution mechanisms	Yes	• disconnect between parties • lack of a common political system • intergenerational conflicts
Ensure that external authorities permit users to devise their rules	Yes	• need to prevent local actors from externalizing costs • need to affirmatively facilitate local governance • need to facilitate peer-to-peer learning
Establish nested layers of organization	Yes	• Same as above cell
Additional principles		
Invest in science	Yes	• scientific results are uncertain • incentives for interpreting uncertainty to favor one's interests • science may not be credible to users
Integrate scientific analysis with broadly based deliberation	Yes	• determining when and how best to engage the scientists with the interested and affected parties
Plan for institutional adaptation and change (iterative risk management)	Yes	• designing learning institutions • incorporating science into an updating process
Engage a variety of institutional types	Yes	• designing effective combinations of institutional types

These challenges require jointed global efforts and information sharing to implement globalized solutions, using the same technologies, within international frameworks, and with the same capacity. However, we see that on-the-ground realities are very different and what works in a country probably doesn't work in another. Beyond usual policy approaches, as Ostrom's work highlighted it with community's involvement, it is possible to steer away from inefficient decision-making processes and incorrect management.

For global commons, the author uses the case of climate change. He identifies climate change as a driver of degradation for many commons but recognizes that attribution of the degradation to climate change is difficult (Paul C. Stern 2011).

For emerging technologies, the authors look at five differences between technological risks and global commons. Risks are associated to large-scale application, with a possibility to alter physical and biological systems, it creates uncertainties depending on the kind of technology employed (e.g. nuclear hazard happens locally but can happen anywhere as the technology is global). Secondly, the irreversibility causes technology to have detrimental effects in case it becomes out of control. Again, uncertainties about new technologies are ever present as the effects can only be known when the deployment is complete. Governing technological risks requires institutions that involve those who are affected by the decisions taken. Finally, the benefits of highly risky technologies reaped are often concentrated among a few developers and major users, who usually bear a small portion of the risks. The most important aspect lays in risk governance when it comes to managing technologies and how conflicts are solved (Paul C. Stern 2011).

THIRD PART: PROBLEMS AND THREATS FOR THE OCEAN

A. The Slow Degradability of Plastic

Most plastics are designed with little consideration for their ultimate disposability or recyclability. This leads to worldwide concerns over the environmental consequences of such materials, when they enter the waste stream after their intended use. Plastics are known for specific characteristics. They are strong, very durable, energy-efficient, inexpensive, and easily processable and they have great barrier properties. However, it is exactly these characteristics of strength and indestructibility that cause huge problems for the marine environment. (cf. Andrady A.L. 2015)

The exact time required for plastic degradation in the ocean is mostly unknown. Experts estimate a time span of a few hundred years. According to Narayan various types of plastic "[c]an not be considered biodegradable in this environment, as the term 'biodegradable' would only apply to those that are broken down by bacterial action or oxidation into simpler molecules such as methane, carbon dioxide and water." (Narayan 2009). In fact, plastics are, for the most part, resistant to biological degradation because microorganisms do not have enzymes capable of degrading and utilizing most man-made polymers.

It is true that the so-called 'biodegradable' or 'oxy-degradable' plastics can be broken down in industrial composters with temperatures consistently above 58°C (Song et. al 2009), but the oceans are much colder, and therefore the process of degradation takes much longer. (cf. Kershaw et. al 2011)

Usually plastic items in the marine environment end up fragmenting into smaller equally shaped particles, a process which is enhanced by the action of wind and waves. Sunlight, specifically the UV radiation within, is another important factor for the fragmentation of specific plastics. However, many plastics contain anti-aging agents which are supposed to ensure the long-term use of the product and therefore additionally delay the degradation (Holm, Schulz, Athanasopulu 2013: 28). Naturally, plastics floating close to the ocean surface will therefore break down faster than those in the deep sea. Once a plastic object has sunk to the seabed, the degradation process is slowed down significantly due to the lack of UV penetration and much colder temperatures. "[…] it is intuitive that the ultimate sink for this debris, in whatever size, is the deep sea" (Jamieson et al. 2019: 2).

In general, the exposure of plastic debris to a variety of physical, chemical and biological processes in the marine environment leads – after a certain amount of time - to fragmentation and reduction of size. The potential chemical effects caused by little plastic particles, the so-called microplastic, in the ocean, will be further explained below.

However, also the physical effects of bigger debris, such as the entanglement of marine animals in drifting plastic or the ingestion of plastics mistaken for food can be fatal. So far, over 260 different species are documented to have been entangled in, or to have ingested, marine debris (Kershaw et al. 2011). Seabirds, sea turtles, fish and marine mammals are well known for the consumption of plastics mistaken for food. In the documentary "Albatross" by environmental activist and film maker Chris Jordan, you can see tens of thousands of Laysan albatross chicks lie dead on the ground, their bodies filled with indigestible plastic items. Jordan explained in an interview that "[L]ooking into the stomachs of those dead birds is like looking into a mirror. It's a perfect, macabre, kind of viscerally horrible reflection of our broken relationship with the natural world." (Jordan 2016).

Moreover, many of the affected species are on the IUCN red list of rare or endangered species, so there is also reason to worry from a conservation point of view (UNEP 2016). Larger pieces of debris can furthermore cause damage to sensitive habitats that are at risk like coral reefs. In addition to that, all sizes of plastics can provide a possible habitat for sessile organisms. This can have strong impacts, e.g. in the way jellyfish can extend their range. The "[…] rafting of species to a different region provides an additional mechanism for the introduction of non-indigenous species, most clearly demonstrated on the coast of North America as a consequence of the Japanese tsunami in 2011." (UNEP 2016).

B. Trash Vortex and Dead Zones

In the summer of 1997, the American skipper Charles J. Moore just completed a more than 4.000km sailing regatta from Los Angeles to Hawaii, where he and his crew landed on the winners' podium. On their way home, they decide on a course that is much shorter than the way there, but leads through an area in the Pacific, which is usually avoided by sailors. These regions are known for their high-pressure areas, their low rainfall and especially for their massive doldrums. However, more than 1.500km off the US West Coast, in the midst of the Pacific Ocean, they finally encounter a phenomenon that irritates them even more than the ongoing doldrums. At first, there are only individual pieces of plastic floating on the sea, but

they gradually become more and more. Eventually, the plastic parts above and below water are so numerous, that they build-up an almost infinite carpet of trash. A "[s]uperhighway of garbage" as Moore says later (Lohmann 2014). He describes the view as follows: "[Y]et as I gazed from the deck at the surface of what ought to have been a pristine ocean, I was confronted, as far as the eye could see, with the sight of plastic." (Moore 2003)

Moore is thought to be the first person to see the Great Pacific Garbage Patch (GPGP), which is most likely the largest contiguous garbage dump on earth. (cf. Lohmann 2014). Nowadays, it has long been proven that the Great Pacific Garbage Patch grows consistently and quickly (Ferrari et al. 2018). However, despite numerous expeditions into that area, the complete extent of the "world's largest rubbish dump" isn't known. Oceanographers estimate that between 700,000 and more than 15 million square kilometres of ocean surface are covered by it. This means that the Great Pacific Garbage Patch is at least twice as big as Germany.

The Great Pacific Garbage Patch cannot be seen from space, as it is often claimed (Parker 2018). A lot of people think about a "garbage patch" as an entire island of trash floating on the ocean's surface, but, as a matter of fact, these patches consist almost entirely of microplastics. Microplastics are sometimes so tiny, that they can't even be seen with the naked eye. Due to the microplastics, the Great Pacific Garbage Patch looks actually more like a cloudy soup, occasionally intermixed with larger waste, such as plastic bags, bottles or fishing gear.

It is largely unknown how much rubbish – almost exclusively plastic – actually floats around there. According to the researchers everything, between several million and a staggering 100 million tons, seems possible, (cf. Lohmann 2014)

In the last years, oceanographers managed to answer the question of why the marine garbage patch is located exactly at this point of the Pacific. A huge high-pressure area creates a gigantic ocean vortex – the North Pacific Gyre (cf. Fig. 1) – which is constantly fed by the circuit of rising warm subtropical air masses and sinking cooler air masses. Unlike on the coasts, where the ocean current is strongly influenced by the coast, the current in the open ocean is dependent on the air masses, which are directly above.

The area in the centre of the gyre is usually quite calm and stable. The circular motion of the gyre pulls litter into this stable centre, where it ends up being trapped. Marine researchers

assume that every plastic item entering the North Pacific will ultimately be caught up in the current of the vortex and end up in the huge Great Pacific Garbage Patch. US Oceanographer Curtis Ebbesmeyer once described how the gyres polluted centre “[m]oves around like a big animal without a leash. When it gets too close to an island, the garbage patch barfs, and you get a beach covered with these confetti of plastic.” For example, Henderson Island in the South Pacific Ocean is remote and uninhabited yet littered with 38 million pieces of plastic. (cf. Smith-Llera 2018)

The reason why no nation wants to take responsibility or provide funding for its cleaning, is that the Great Pacific Garbage Patch is far from the coastline of any country. In general, a state’s exclusive economic zone (EEZ), comprises an area which extends seaward to a distance of maximum 200 nautical miles from the baselines. In this area, the respective state has jurisdiction over natural resources, and often feels responsible for pollution only here. However, many organizations and individuals are trying to stop the patch from growing. But cleaning up marine debris is harder than it sounds. Often microplastics are of similar sizes as small sea animals, which means the animals as well would end up in nets meant to scoop up litter. And even if it was possible to design nets that only filter out waste, the pure extends of the oceans make this way of cleaning a Sisyphean task. According to the National Ocean and Atmospheric Administration’s Marine Debris Program it would take 67 ships a whole year to clean up less than one percent of the North Pacific Ocean (National Geographic 2019).

As we know today, there are more marine trash vortices; the Great Pacific Garbage Patch is only the biggest among them. Similar accumulations of plastic particles have shown up in the South Pacific Ocean, North Atlantic Ocean, South Atlantic Ocean and Indian Ocean (Kaiser 2018). In total five major ocean gyres have been detected, which trap huge amounts of waste in their currents (cf. Fig. 1). And even when sailing in smaller bodies of water, like the North Sea, garbage patches are now discovered (National Geographic 2019).

C. Microplastics

Increasing media coverage of the environmental impact of plastic waste has recently brought the term "microplastic" to the attention of the public. This recent attention has been caused particularly by reports on microplastic occurrence in food - such as drinking water, beer, honey and seafood (Giani et. al 2019).

According to the environmental scientist Dr. Kirsten Stöven "[M]icroplastic is weathered, mainly mineral oil based, synthetic polymer (<5mm) called as plastic." (Stöven et al 2015). However, its size is not uniformly defined. The plastic pollution of the environment starts with tiny particles in µm-size. Two types of microplastics can be differentiated, based on whether they were already introduced into the environment as microplastics (primary) or later fragmented to that size in the environment (secondary). (cf. Al-Jaibachi, Cuthbert, Callaghan 2018)

Primary microplastics are manufactured as microbeads, capsules, fibers or pellets. Microbeads are often used in cosmetics, personal care products and industrial scrubbers, while microfibers are used in textiles. For example, small plastic particles are deliberately added to shower gel or toothpaste in order to increase their cleaning effect. Such personal care products could contain up to 10% of microplastics in the form of plastic pellets. Cosmetic microplastic particles are inevitably released from domestic wastewater, where they are not captured by wastewater treatment systems. Rivers then carry the microplastics to the ocean and lakes, where they have been found in high concentrations. However, due to the public debate and a raising awareness, there are now efforts by the producers to remove microplastic additives from cosmetics and personal care products. (cf. ibid.)

Secondary microplastics are the result of larger pieces of plastic fragmenting into smaller pieces. The majority of plastic products is toxic and be due to their resistance to microbial degradation, they linger in the environment for immense time spans. The spectrum of particles released by the fragmentation of larger plastic products ranges from big fragments, visible to the naked eye, to particles in the micrometer range. (cf. Holm, Schulz, Athanasopulu 2013: 28)

Many marine animals can't tell the difference between their food and microplastics, so they end up eating them. The smaller the plastic particles, the greater the risk of ingestion and the greater the number of species that mistakenly consider the particles to be food. Once inside an animal, the plastic can transfer via the food chain into fish and other creatures and eventually become a potential health problem for humans.

Even though the majority of microplastic research has focused on the sea, plastic pollution is also a serious problem in freshwater, including rivers and lakes, as well as terrestrial ecosystems. A new study even shows that microplastics "[…] can be transferred

ontogenically from a feeding (larva) into a non-feeding (pupa) life stage and subsequently into the adult terrestrial life stage." (Al-Jaibachi, Cuthbert, Callaghan 2018). In this way, any flying insect that spends part of its life in water can become a carrier of plastic pollution and move the plastics into a new food chain. According to researchers Al-Jaibachi, Cuthbert and Callaghan this means that "[f]reshwater plastic pollution is a problem that has implications far beyond those of water quality and eventual marine pollution." (ibid.).

Higher environmental concentrations of microplastics increase the probability of organisms encountering and interacting with these substances. This will most likely lead to more ingestion of microplastics in the future. To date, there has been no attempt to fully understand the transfer of microplastics and associated contaminants for example from seafood to humans. The long-term impacts of microplastics on human health remain largely unknown as most studies have been limited to the ingestion by and the impact on marine life. (Carbery et al. 2018)

However, it is necessary to understand that microplastics stand at the end of a long chain of production, consumption and disposal. In order to fully appreciate the problem and to undertake targeted actions, it is necessary to identify and prioritize the sources and pathways of (micro)plastic pollution.

FOURTH PART: PLASTIC POLLUTION IN THE OCEANS: AN EVALUATION OF SOURCES

When the first synthetic plastic ever – bakelite – was introduced in 1907, no one knew that it marked the beginning of an industrial era. However, rapid growth in global plastic production was not realized until the 1950s (cf. R. Geyer, J. R. Jambeck, K. L. Law 2017).

There is no aspect in our everyday life that plastic products haven't entered – from packaging over transport vehicles to personal care products. Plastics are cheap, stable, flexible, long-lasting and can be molded into every form. It is one of most versatile products invented by mankind and offers an endless number of possible applications.

But all the advantages of plastic-use have come at a high cost. Huge quantities of plastics enter rivers and oceans with severe effects on biodiversity and associated economic activities.

Littering and waste mismanagement are often seen as the principal source of plastics entering the ocean. However, we are dealing with a very complex problem with various sources and pathways. The actual quantities involved still remain largely unknown. According to the UNEP Report 2016 "[R]eliable quantitative comparisons between the input loads of macro and microplastics, their sources, originating sectors and users are not possible at present, and this represents a significant knowledge gap." (UNEP 2016: xvii).

What we do know for a fact is that there are many different entry points for plastic litter into the marine environment. The following part of this work investigates the various sources of plastic and microplastic pollution from the production process to consumer behavior to plastic disposal. It is furthermore shortly evaluated from an economic point of view whether or not a complete substitution of plastics with alternative materials should be recommended.

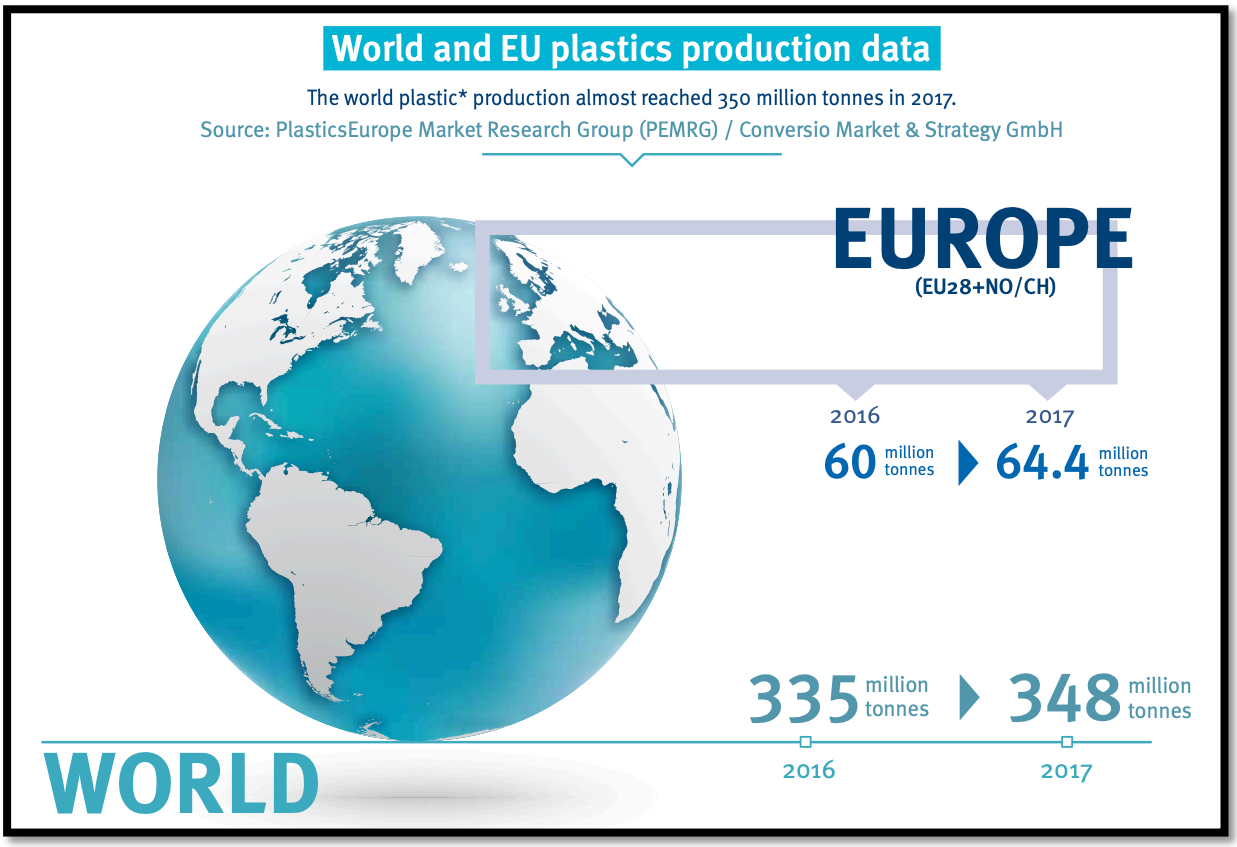
A. Plastic Production

I. Characteristics of Plastic

Plastic is any synthetic or semisynthetic organic polymer. Polymers are long molecules built around chains of carbon atoms, often with other components like hydrogen, oxygen, sulfur, or nitrogen filling in the spaces. The global plastic production today is estimated at 280 million

tons per year with packaging and consumer products making up approximately 75 % of this worldwide production. (cf. Holm, Schulz, Athanasopulu 2013: 27)

Figure 3.1. World and EU plastics production data (cf. PlasticsEurope 2018)



There are many reasons for this huge demand for plastic materials which is estimated to grow continuously in the years ahead. Plastics play a huge role in our daily lives and provide various benefits for human health and the environment. For example:

- Plastic packaging protects food and goods from getting rotten and / or contaminated, is thereby saving resources.
- The light weight of plastic packaging compared to other materials (e.g. glass, aluminum) saves petrol and lowers emissions.
- Plastic water distribution systems and storage containers/ tanks can provide clean water.
- Low-density plastic materials used to substitute metals or ceramics in cars and aircrafts, save fuel and reduce emissions.

- Plastic products for medical applications contribute to improved health (e.g. blood pouches, tubings, disposable syringes, prosthesis). (Hahladakis et al. 2018)

"[A]lthough there are countless polymers, plastics in general are lightweight with significant degrees of strength. Plastics can be molded, extruded, cast and blown into seemingly limitless shapes, films and foams." (American Chemistry Council 2019). They are cheap, stable, thermally and electrically insulating, flexible and durable. And all together these characteristics explain the huge success story of plastic materials during the last 60 years.

However, plastic items also have their downsides: what lasts long, also has a very slow degradability in the environment; what is cheap runs the risk of being disposed after a single use; what is lightweight is easily blown away by the wind and floats on the water surface for long distances.

II. Plastic Pellet Release during Plastic Production

The source of most thermoplastic articles and materials are so-called virgin plastic pellets (primary microplastics), which are commonly also known as preproduction pellets, beads or nurdles. The main production of these pellets takes place in polymeric production industries, and to a small extent in recycling facilities. After the production process, the pellets are usually transported to their final destination, which means the factory where the products are being finalized.

However, plastic pellets can get lost at every step of the production chain. Already in the 1970's there were scientific reports documenting the discovery of plastic beads in nature. Ever since, plastic pellets were discovered in samples of water and on coastlines all around the globe. They are even found on beaches that aren't in direct contact with polymer industries. Even though plastic pellets are just a little part of the global plastic pollution, the pathway resulting from their production shouldn't be neglected. (cf. Karlsson et al. 2018)

Researchers have long noted the link between the discovery of plastic pellets in nature and industrial outlets, so they called for preventive measures. In 2015, a study in the river Rhine showed that spherules made up 60% of the found particles, with a possible connection to production facilities along the river (ibid.).

Karlsson et al. (2018) carried out a study in Sweden to get a better understanding of the reasons for plastic pellets ending up in the environment. The researchers estimated that the overall release of beads from a production facility to the closer environment lies between 3 and 36 million pellets each year. They also documented pellet release close to subcontracted companies involved in transport, storage, cleaning and waste management. According to the researchers, "[T]he release is expected to be a consequence of inadequate precautions during production, loading, transport and handling of the material." (Karlsson et al. 2018: 58).

B. Plastic Consumption

I. The Release of Microplastics into the Environment

There are various occasions during the lifecycle of a plastic item, in which primary microplastics can be lost. However, plastic pellets "[…] are the only losses which occur during the production, transport or recycling stages of plastics. Most losses mainly occur during the use phase of products which contain plastic, such as driving a car or during their maintenance such as washing clothes." (Boucher, Friot 2017: 13). This remains in contrast to secondary microplastics which originate mainly from mismanaged waste.

Losses from personal care products are the only ones, which can be viewed as deliberate losses during the utilization (process) of plastic-containing products. They are deliberate since a product, that contains primary microplastics is intentionally poured into wastewater. This compares with the unintended losses that other sources create during the processing, distribution, usage, repair or reuse of plastic-containing products by abrasion, weathering or accidental spills. (cf. Boucher, Friot 2017: 14)

Synthetic textiles: Washing synthetic textiles produces primary microplastics by abrasion and fiber shedding in industrial laundries as well as private households. As a result, these fibers are then released into sewage water and eventually end up in the marine environment. According to Browne et al. "[E]xperiments sampling wastewater from domestic washing machines demonstrated that a single garment can produce >1900 fibers per wash." (2011).

Significant quantities of fibers occur in open water and marine sediments in sampling studies. They are "[…] mostly made of polyester, polyethylene, acrylic or elastane." (Boucher, Friot 2017: 15).

Tyres: It is hard to find credible information when it comes to the transfer of microplastics from tyres to the marine environment. However, according to Boucher and Friot (2017) "[B]oth Norwegian and Swedish researchers have pointed out that a large fraction of particles found in the sea seem to originate from car tyres.".

When they are used, tyres get eroded. "[T]he Particles are formed from the outer parts of the tyre and consist of a matrix of synthetic polymers […] combined with natural rubber and many other additives." (Boucher, Friot 2017: 15).

Road Markings: Road markings are added when the road infrastructure of a country is established and maintained. Even though paint is globally the most used material, various types of markings such as paint, thermoplastic, preformed polymer tape and epoxy are available. In Europe, thermoplastics keep a common dominance. (cf. Boucher, Friot 2017)

Microplastics are released due to weathering or abrasion by vehicles. Upon entering the surface water and finally the oceans of the planet, the microplastics will either be dispersed by wind or washed away by rain.

Marine Coatings: To secure them, marine coatings are typically applied to all parts of ships. Such marine coatings include solid coatings, anticorrosive and antifouling paint coatings. "[S]everal types of plastics, including mostly polyurethane and epoxy coatings, are used for marine coatings." (Boucher, Friot 2017).

Microplastics loss can occur when commercial and leisure ships are constructed, operated, repaired or used. According to Boucher and Friot the main activities leading to releases are "[...] surface pre-treatment, coating, application and equipment cleaning" (ibid.).

Personal Care Products: Primary microplastics are often used in personal care products such as toothpaste, shampoo and scrubs. Some products have the same amount of plastic as ingredients as they are wrapped in (ibid.). In other words, up to a tenth of its product weight.

Typically, personal care products are rinsed off after use and are therefore directly introduced into wastewater streams. Sewage treatment plants have not been designed to filter microbeads from waste water. That's why after being washed down the drain, microbeads often slip through waste-water treatment plants and end up in the marine environment. They do not degrade over time and to make things worse, microbeads can act like tiny sponges, absorbing

other dangerous chemicals. As they ingest microbeads, these toxic chemicals are transported into marine organisms.

However, due to the public debate and a raising awareness, there are now efforts by the producers to phase out microbeads in cosmetics and personal care products in favor of natural alternatives. Also, more and more countries are considering a microbead-ban in personal care products. For instance, in 2018 a UK-wide ban on the use of plastic microbeads in the manufacturing of certain cosmetic and personal care products came into force. (cf. McGrath 2018)

City Dust: The term city dust includes nine sources that are mostly occurring in urban environments. According to the researchers Boucher and Friot it "[…] includes losses from the abrasion of objects (synthetic soles of footwear, synthetic cooking utensils), the abrasion of infrastructure (household dust, city dust, artificial turfs, harbors and marina, building coating) as well as from the blasting of abrasives and intentional pouring (detergents)." (Boucher, Friot 2017: 16). Because their individual contribution is minimal, they group these sources together.

The worldwide release of primary microplastics into the marine environment is an estimated amount of 1.5 Mtons/year. This number corresponds to an amount of plastic equal to every person tossing one plastic bag into the ocean each week. According to Boucher and Friot this suggests "[…] that between 15% and 31% of all the plastic in the world's oceans could originate from primary sources." (Boucher, Friot 2017: 19).

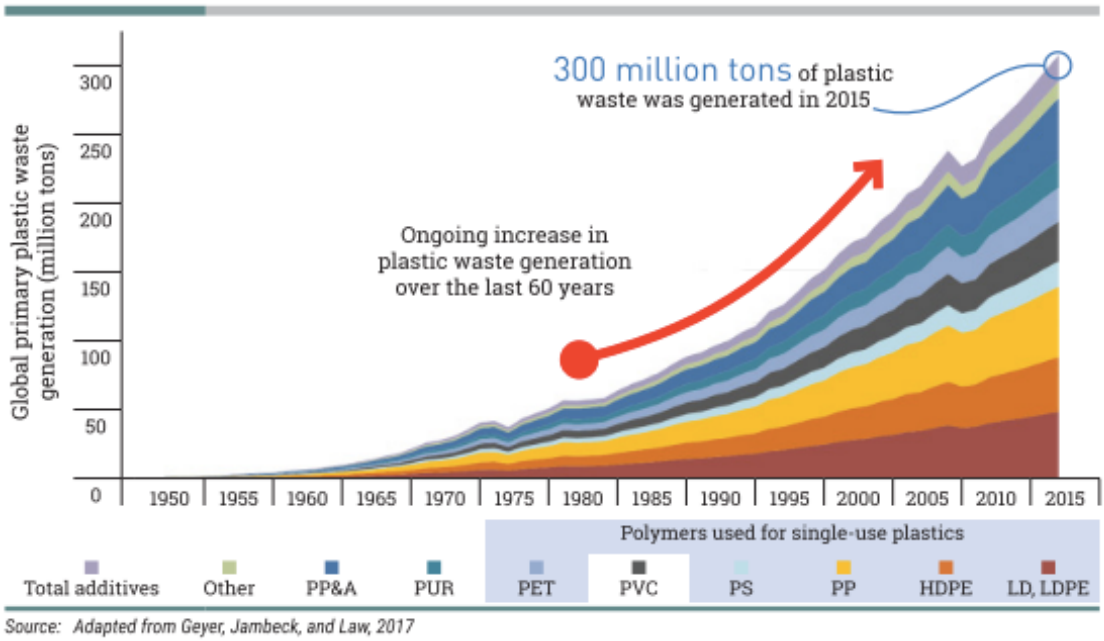
II. Single-Use Plastic

Most of the produced plastic is created to be thrown away after a single use. Therefore, packaging is the largest application of plastic, responsible for about half of the produced plastic waste in the world (UNEP 2018). Plastic packaging is omnipresent in our daily lives, appearing as food-wrappers, shopping bags, water bottles and take-away containers. Particularly, in business-to-consumer applications, it is used just once, and most of it is disposed in its production year.

However, our ability to manage the plastic waste we generate, is already overwhelmed. According to a report by the United Nations Environmental Programme (UNEP): "[O]nly fourteen per cent of the nine billion tons of plastics of plastic the world has ever produced has

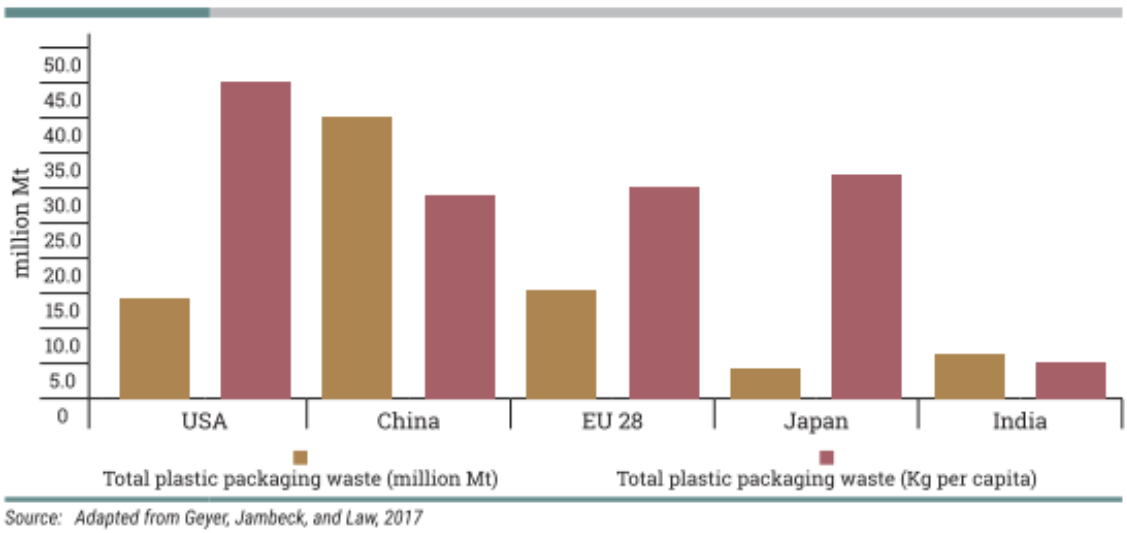
been recycled." (2018). Most end up in landfills, dumps, or surroundings. The majority of this waste is created in Asia, but America, Japan and the European Union produce the most package waste per capita in the world (cf. Fig. 3.1; 3.2).

Figure 3.2. Global primary plastics waste generation, 1950 - 2015



Source: *Adapted from Geyer, Jambeck, and Law, 2017*

Figure 2.3. Plastic packaging waste generation, 2014 (million Mt)



Source: *Adapted from Geyer, Jambeck, and Law, 2017*

13 Geyer, Jambeck, and Law, 2017.

14 China, Ministry of Commerce, 2017.
15 Due to a lack of robust data, it is difficult to determine the exact amount of plastic packaging waste generated in China.
16 "Primary plastics" are plastics produced from virgin materials.
17 The chart is based on an aggregation of datasets. For China, since no reliable data on plastic packaging is available, the overall packaging waste data (including plastic) is used in the graph.

The UNEP report (2018) also states that: "[T]he most common single-use plastics found in the environment are, in order of magnitude, plastics cigarette butts, plastic drinking bottles, plastic bottle caps, food wrappers, plastic grocery bags, plastic lids, straws and stirrers, other types of plastic bags, and foam take-away containers." (UNEP 2018). Here, it can be clearly seen how plastic is viewed as disposable material in our throwaway society rather than as a valuable resource to be put in harness.

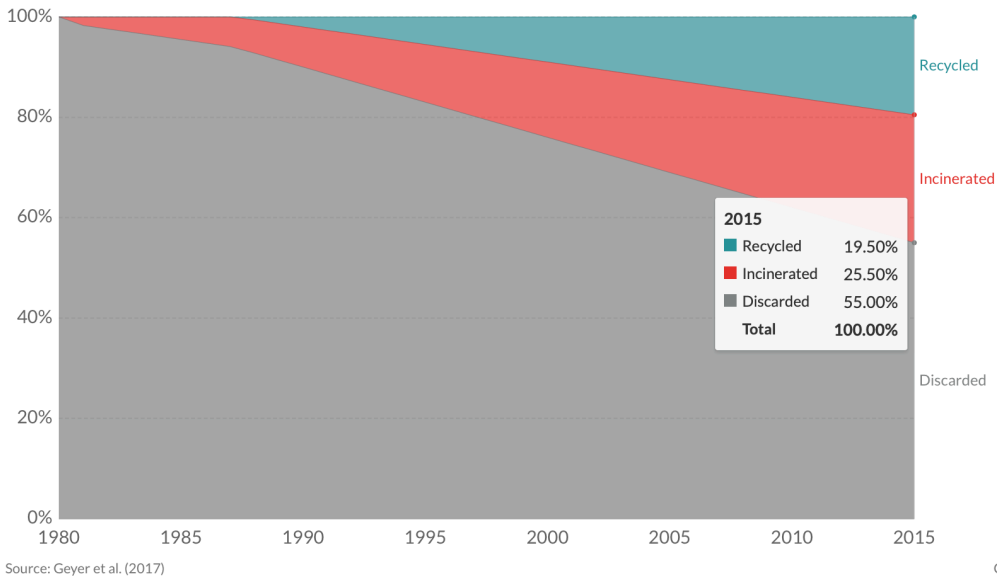
But it's not just the ignorance of the people that is responsible for the large presence of single-use plastic items in the environment. It is also a sign of malfunctioning and failing waste management systems.

C. Plastic Disposal

I. Waste Mismanagement

After being used, products are recycled, incinerated, landfilled, littered in uncontrolled sites, or thrown into the environment. Recent estimates show that a whopping 91 % of the ever-produced plastic waste ended up in landfills, dumps or the environment, whereas only 9 % has been recycled (cf. H. Ritchie 2018); (Fig. 3). Unless current consumption patterns and waste management practices are not dramatically improved, plastic waste in landfills and the surroundings will be about 12 billion tons by 2050 (UNEP 2018:).

Figure 4. Global plastic waste by disposal, 2017



According to economist Christopher Intagliata the economic success of plastics as well as the failure of plastics recycling rely mainly on two variables:"[t]he cost of the raw materials used to make virgin plastic, petroleum and natural gas, and the cost of recycling versus the cost of disposal, which fluctuates based on a city's proximity to recycling centers and the price to dump in local landfills." (Intagliata 2012). In other words, it is often simply cheaper to make a new bottle and dump the used ones instead of recycling them.

Sixteen of the top 20 countries contributing to marine plastic pollution are projected to be middle-income countries, whose economic growth outperforms the development of waste management infrastructure. Such multifactorial problems of waste management include scientific, ecological, economic, socio-cultural, social, legal frameworks and tourism, which in these emerging countries are not fully considered. According to a recent case study in Bolivia (a low-middle income country in South America), "[…] where public awareness services and municipal solid waste management services are lacking, people bury or burn their own waste or an informal recycling sector begins to operate in the area, as the only possible activity for poor households to receive income."(Ferronato et al. 2017: 185). The mentioned illegal plastics disposal activities, which often take the form of open burning, can release toxic gasses into the atmosphere (UNEP 2018).

At the moment, mismanaged plastic waste is disproportionally higher in Asian and African continents. However, the practice of waste trade between industrialized and developing countries could also be partly responsible for these enormous disproportions. Nonetheless, China – a nation that is held accountable for 56% of the worldwide imports of plastic waste destined for recycling - has banned the import of eight types of plastic scraps starting from 2018. As a reason, they said that hazardous waste was found to be mixed within the imported waste. As a consequence, many of the industrialized nations, that have traditionally relied on China as an importer of plastic waste, are now forced to identify new strategies for dealing with plastic trash and improving their local recycling industry (UNEP 2018: 6).

Even within developed regions, the rates of plastic recycling and re-use vary greatly. For example, according to recent estimates, in 2009 more than 84 % of used plastic was recycled – which means, recycled or reused for energy generation - in seven European countries as well as Norway and Switzerland. On the other hand, several European countries only recovered 25% or less. (cf. Kershaw et al. 2011) These differences indicate a large potential for improvement.

However, a growing number of national and local governments – both within and outside Europe - developed and implemented policies and economic measures over the past 10 years to minimize waste generation and increase plastic recycling. Africa, for instance, stands out as the region where the largest number of countries has imposed a total ban on plastic bag production and use (UNEP 2018). The goal in Europe is to build a circular economy where material and resources are kept as long as possible and where their disposal is the last choice. As outlined by the European Commission in a "European Strategy for Plastics in a Circular Economy" (2018-2030), this circular economy is supposed to be reached through government leadership, producer responsibility and consumer education and awareness. (cf. UNEP 2018)

In general, a lot of countries around the world have recognized that in order to minimize waste generation, they have to boost the status of solid waste collection services, enhance the recycling industry and ensure the safe waste disposal to controlled landfills (UNEP 2018).

II. Environmental Costs of Mismanaged Waste

Improving the collection and disposal of waste is not only the key to lowering the amount of plastics ending up in the marine environment every year, but it will also reduce the associated environmental costs (ACC 2016).

Environmental costs are often hard to define. However, they are usually understood as "[C]osts connected with the actual or potential deterioration of natural assets due to economic activities.", in other words "[T]he production, transport and disposal of plastics and alternative materials create a range of environmental impacts, which impose costs borne by society."(ACC 2016: 32).

For example, the environmental costs of plastics under the business as usual scenario are dominated by greenhouse gas emissions (51%) and land and water pollutants (22%), as well as small contributions from air pollutants (12%), external waste management costs (11%) and damage to the oceans (3%). (cf. ACC 2016: 32)

The overall economic costs of marine litter are not easy to quantify. The degradation of our ecosystems, for example, includes both the effects of plastic debris on biodiversity in the oceans as well as on ecosystem services, such as food provision or tourism. The costs also have to be differentiated between direct costs (for beach cleanups or for impacting human

health), costs because of lower revenue (because of smaller fish populations or fewer tourists visiting polluted beaches) and welfare losses. (cf. Simon et al. 2018)

On the subject of beach or ocean cleanups, it needs to be stated that this is indeed a Sisyphean task without any realistic chance of ever being completed. It is out of question to try to remove all marine waste because plastic particles can be contained even in deep sea sediments and up to 13 million tons of plastic reach the oceans each year. Furthermore, it is really expensive. Only in Europe, the estimated costs of cleaning shores and beaches (not even the ocean itself) amount to € 630 million per year (UNEP 2018: 16).

The only truly effective strategy is to prevent plastic pollution from taking place. In other words, the origins of the problem need to be addressed. In order to achieve this goal, excellent waste collection systems are required, as well as the elimination of all direct impacts, like lost fishing gear, microplastics in cosmetics or car tyre abrasion. For the last point, Friends of the Earth and the Eunomia research group came up with a report in 2018 that is looking to raise awareness about car tyres pollution. Several solutions are available and would pave the way to making car tyres less of a threat to rivers and oceans. Testing and labeling, introducing a tyre levy, capturing tyre pollution from roads, increasing road cleaning, encouraging less driving, making tyres more resilient to wear and tear, finding alternative tyre materials are ways to address this type of pollution, according to the report (cf. S. Hann, C. Darrah, C. Sherrington, K. Blacklaws, I. Horton, A. Thompson 2018)

At first sight, it might seem cheaper to make a new bottle and dump the old one instead of recycling it, but only because the cost accounting is not complete. In the long run, it is estimated that the potential cost of removing all the plastics collected in the environment is higher than the cost of avoiding waste today by introducing effective waste collection and recycling systems (UNEP 2018).

D. Alternative Materials

Since various studies such as UNEP (2014) were drawing attention to the environmental costs of plastic use, including greenhouse gas emissions, pollution, land and water contaminants, water degradation and the marine litter production in the marine environment around the globe (UNEP 2014), many have called for the substitution of plastics with alternative materials that pose less environmental challenges.

However, the latest American Chemistry Council Report (2016) as well as studies by Franklin Associates (2013) and Denkstatt (2011), which modeled plastic substitution with alternative materials like paper, metal, aluminum or glass, indicate that not all non-plastic substitutes are environmentally beneficial. (cf. ACC 2016) From a sustainability perspective, they can come with higher costs and other externalities (Simon et al. 2018).

There is no doubt that in many of its applications, particularly in the consumer goods sector, plastic can potentially be replaced with alternatives. However, according to the ACC Report 2016 "[i]n most cases the substitution of plastics is not one for one – the different physical properties of plastic compared to its alternatives mean that a larger mass of alternative material is typically needed to achieve the same function as plastic." (ACC 2016: 14.). In fact, much replacement of alternative packaging materials was driven by the lower costs and weight of plastic (Simon et al. 2018).

Even the so-called biodegradable plastic is not necessarily an environmentally beneficial alternative to conventional plastic. Efficient waste management systems are as important for bio-degradable alternatives as for fossil-fuel-based plastics to minimize leakage and damage to the environment. Many biodegradable plastic materials only break down completely when for a longer period of time exposed to high temperatures (above 50°C). Such conditions are rarely met in the environment. Consequently, even bioplastics often do not automatically degrade in the environment and particularly not in the oceans. (cf. UNEP 2018: 14)

It is easy to dismiss plastics as cheap and nasty materials, that do nothing but polluting our planet, but the reality is different. As long as people want cars, toys, replacement body parts, medical adhesives, computers, water pipes, fiber-optic cables and countless other things – plastic is needed as well. The important part is to no longer treat plastic as a disposable material, but as a valuable resource and act accordingly.

FIFTH PART: ERASING OUR PLASTIC FOOTPRINT

There are many national, regional and even international strategies dealing with marine litter and plastic pollution; the question remains, however, whether or not they have a level of engagement that correlates with the global significance and accelerating growth of the problem (Borelle et al. 2017).

The global commitments especially against single use plastic show a general will to fight plastic pollution. Nonetheless, the large number of international frameworks also illustrates the present fragmentation in plastic governance. The problem of marine litter persists. This suggests that - despite numerous conventions and other frameworks – there is still a lack of efficient global, regional and national strategies to address the different origins of plastic waste. It furthermore points to "[..] deficiencies in the implementation and enforcement of existing regulations and standards, some of which may lack economic support." (UNEP 211: 28).

In the following, a distinction is made, at an international level, between legally binding agreements and non-legally binding agreements. The most relevant frameworks, resolutions, action plans and strategies are examined, and their strengths and weaknesses are pointed out.

A. Governance Frameworks of Relevance to Marine Litter

I. Hard Law: International Binding Conventions

So-called "hard law" agreements usually apply to specific jurisdictional areas of the marine environment, which are determined by the signatories. However, it is necessary to keep in mind that this distinction is not always apparent, as almost every single international convention is essentially a compromise containing both hard and soft law elements. The more binding provisions there are in a treaty, the longer it takes to negotiate, to finalize and to alter the document.

Thinking about Garett Hardin it is safe to say, that he would consider "hard law" the only possible solution of governing a common good. Since according to him "Freedom in a common brings ruin to all." (Hardin 1968: 1248), there must be strong rules for the whole community, so that individuals can't uncontrollably exploit the common good anymore.

Unfortunately, many hard law obligations within international binding frameworks are neither implemented nor enforced. Another weakness can be found in the fact that even though annexes to protocols are created to be legally binding, States can usually choose which annexes they want to be bound by; thus, the overall effectiveness is lost.

1. MARPOL Convention (1948)

The International Maritime Organization (IMO) United Nations specialized organization. It was created in 1948 to establish uniform international regulations of the maritime industry. Initially IMO focused on regulations addressing vessel safety, but huge pollution events led to the passage of MARPOL. (cf. Rakestraw 2012: 387)

In total, MARPOL contains six operational annexes, dealing with the prevention of oil pollution (Annex I), regulation of pollution by noxious liquid substances in bulk (Annex II), prevention of pollution by harmful substances carried by sea in packaged form (Annex III), prevention of wastewater from ships (IV), prevention of pollution by garbage from ships (Annex V), and prevention of air pollution by ships (Annex VI). For this work the discussion is limited to Annex V regarding discharges of garbage, but it is recognized that only by implementing a comprehensive regulatory, which includes all six Annexes the health of the ocean can be ensured.

MARPOL Annex V of the IMO MARPOL Convention includes regulations for the prevention of garbage pollution from ships. It forbids the garbage discharge from "[…] all vessels of any type whatsoever operating in the marine environment, from merchant ships to fixed or floating platforms to non-commercial ships like pleasure craft and yachts." (MARPOL Annex V: 2012).

Even though the Annex is optional, it received a sufficient number of ratifications and entered into force on the 31st of December 1988. Until today, more than 150 countries have signed up to MARPOL Annex V. Member nations are not just bound by simply signing the convention. As with other international conventions, the member states must implement domestic legislation to comply with MARPOL's mandate. (cf. Rakestraw 2012: 388)

MARPOL is an international agreement that focuses on marine pollution and it's been a very important step. However, critics claim that "[…], since MARPOL entered into force in 1988, the oceans have not benefited from reductions of plastic pollution. Instead emissions have accelerated at a pace commensurate with plastic production." (Borelle et al. 2017: 9995). There are various reasons for this. First of all, Annex V is limited to marine emissions, while 80% of plastic originates from land-based activities.

Secondly, it is very challenging to regulate marine debris at an international level. The seemingly endless sea and the lack of state jurisdiction beyond 200 nautical miles (EEZ) off the coast make it very difficult to successfully implement waste disposal laws. According to researcher Andrew Rakestraw "[T]he current regulatory system essentially leaves compliance with international standards up to the good will of the captain of the ship." (Rakestraw 2012: 384). He criticizes that "[E]nforcement and compliance are delegated to individual states and regulated by the International Maritime Organization (IMO). Although the IMO has enacted many rules, violators are not incentivized to comply, and largely feel free to discharge without fear of being caught." (ibid.).

As long as there is no effective regulatory scheme to address garbage dumping, ships will continue to discharge largely unchecked. The key regulatory problems regarding MARPOL Annex V are the lack of a reliable source of information for non-compliant flag states and vessels, lack of uniform port reception facilities, lack of enforcement by flag states, and lack of enforcement by port states. In other words, there is a lack of enforcement of the MARIPOL convention worldwide as well as a lack of effective controls worldwide.

Therefore, "[I]MO must incentivize compliance and enforcement, while recognizing the objections that will erupt if IMO is viewed as an impediment to the free flow of goods across the seas." (Rakestraw 2012: 409). This means, due to the enormity of the ocean, direct enforcement of international environmental agreements is impracticable. So, incentives to discharge trash at port reception facilities need to be provided. This is not yet realized, because port state operators do not consistently enforce international regulations.

According to Rakestraw "[I]MO does not have a process for effectively dealing with non-compliance issues, therefore IMO needs to spur dialogues and agreements between port states." (Rakestraw 2012: 396). In detail, to improve the enforcement of MARPOL Annex V "[I]MO should create a centralized information clearinghouse for port state inspections, place

pressure on states under which ships are registered (flag states) to disseminate educational information to sailors, and encourage member states to publish garbage dumping fees to work against the current race-to-the-bottom effect among port operators." (Rakestraw 2012: 385).

MARPOL Annex V should be seen as a global common denominator, which offers an absolute minimum guidance. However, minimum guidelines are often internationally treated as the maximum standards to be applied. Regional legislation must go beyond these minimum guidelines in order to efficiently tackle marine pollution.

2. London Convention and Protocol (1975)

The "Convention on the Prevention of Marine Pollution by Dumping Wastes and Other Matter", known as the London Convention (LC), entered into force in 1975 and offers an international mechanism for the protection of the ocean from the discharge of waste at sea. The LC is the only framework solely concerned with this way of disposal, namely the dumping of waste into the ocean. Written in 1972, the agreement was "[…] a significant step forward in the international management of our ocean resources." (Lentz 1987: 362). It is consistent with the overarching 1982 UN Convention on the Law of the Sea (UNCLOS). 87 states are currently parties to the Convention.

In 1996, the London Protocol was agreed to improve, modernize and eventually replace the London Convention. The London Protocol came into force in 2006 and the Protocol currently has 46 parties. (cf. Verlaan 2011)

The Convention works by categorizing wastes to a black or grey list. Dumping is forbidden in the case of black-list waste, while dumping is allowed in the case if a special permit is issued by a designated authority, and it has to be subject to strict controls. (cf. UNEP 2016)

Under the Protocol, this approach has been modified, banning all dumping unless expressly allowed. This is also referred to as the "reverse list" approach. The London Convention and Protocol forbid the discharge of durable plastic and other synthetic materials, such as netting and ropes, at sea (LC Annex I, Paragraph 2 and LP Annex 1). Exporting waste for dumping and incineration at sea is also forbidden. States are obliged to ensure that waste is disposed of in compliance with the London Convention and Protocol, equivalent regional agreements or UNCLOS (Article 210).

However, the London Convention neglects land-based plastics origins, which are believed to be responsible for most aquatic waste. It only regulates land-based waste loaded onto ships for the purposes of disposal at sea. And again, it is possible to find examples for the various exceptions and opt-out provisions in existing international treaties. For instance, the London Convention does not regulate ship-generated waste and expressly permits disposal "incidental to or derived from the normal operation of ships". (cf. Gold et al. 2013: 9)

The London Convention and MARPOL are both addressing marine pollution caused by operational discharges of residues and disposal of garbage into the ocean. The difference between them is that the London Convention, even though it primarily addresses the prevention of marine pollution, also considers the "practical availability of alternative land-based methods of treatment, disposal or elimination, or of treatment to render the matter less harmful for dumping at sea" (LC Annex III, Section C.4). As a result, the London Convention is also dealing with various waste management issues.

MARPOL on the other hand, solely focuses on issues in relation to the marine environment and deals with maritime authorities. Even though, both Conventions have a very different approach, it is interesting to see, that problems are caused both by the very broad scope of the London Convention as well as the very focused and therefore limited mandate of MARPOL. Both Conventions are administered by the International Maritime Organization (IMO).

3. UNCLOS: The United Nations Convention on the Law of the Sea (1982)

UNCLOS, which entered into force in 1994, has 167 members, including the EU. It establishes the overarching framework that must be applied in all ocean operations. Many of the Convention's clauses constitute customary international law, which also makes it binding on non-Convention states. (UNEP 2016: 8).

Part XII of UNCLOS addresses the "Protection and preservation of the marine environment" and aims to prevent garbage dumping at sea. In the convention, dumping is defined as "[…] any deliberate disposal of wastes or other matter" (Simon et al. 2018: 20), this does not specifically include plastic waste, but it is considered to include it implicitly.

In Article 207 (1), UNCLOS addresses pollution originating from land-based sources and claims that "[S]tates shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment from land-based sources.". Article 207 (4) adds that "[…] states

shall endeavor to establish global and regional rules, standards, and recommended practices and procedures to prevent, reduce and control pollution of the marine environment from land-based sources".

In addition to that, Article 210 (1) stipulates that "[S]tates shall adopt laws and regulations to prevent, reduce and control pollution of the marine environment by dumping", Article 210 (4) points out that this is not solely a domestic issue, but that states "[…] shall endeavor to establish global and regional rules, standards and recommended practices and procedures to prevent, reduce and control such pollution.". (cf. Simon et al. 2018: 20)

In general, UNCLOS is a very broad instrument and covers numerous pollution sources. However, even though UNCLOS acknowledges the existence of land-based sources, it simply requests that countries address the problem through domestic means. According to critics the Convention lacks more precise instruments and rules and leaves the legislation of how marine pollution shall be prevented to its member states (Simon et al. 2018: 21). Since its use of language is rather imprecise, it is argued that monitoring of compliance is difficult. (cf. ibid.) For example, UNCLOS, only requires that nations "shall endeavor" to use "the best practical means" to reduce ocean pollution in accordance with their capabilities. A mandate that is obviously hard to define and enforce. In fact, it is difficult to know what the phrases "best practical means" or "all appropriate measures" demand of countries with differing legal systems, environmental circumstances and capacities. Another problem is the various exceptions and opt-out provisions. For example, UNCLOS does not punish ships for the "incidental" loss of otherwise prohibited waste. Again, it is difficult to prove whether or not marine litter is the result of an incidental loss or an intentional disposal.

However, UNCLOS as the general legal framework within all activities in the marine environment must be carried out has a symbiotic relationship with international environmental law adopted within the IMO, such as MARPOL or the London Convention. It is also termed as "an umbrella convention", since many of its provisions are so general, that they can only be implemented through specific operative regulations in other international agreements. A fact that can be noted when examining several provisions in UNCLOS, which e.g. demand that States "implement" certain rules which are developed by a "competent international organization" (e.g. IMO). UNCLOS is therefore clearly an international attempt to regulate all aspects related to the maritime environment and establish guidelines for a further harmonious development of international rules and standards.

II. Soft Law: Non-binding Frameworks, Resolutions, Action Plans and Strategies on the International Level

There are various examples of 'soft' mechanisms that can directly or indirectly help reduce the presence and effect of litter in the marine environment. 'Soft' Law is not a formal term, but rather a description, which academics use to describe the nature of international law. In fact, 'soft law' signifies laws that do not have any legally binding obligations upon party states, often appearing as declarations, resolutions and regional strategic plans.

"Soft law" would most likely be Elinor Ostrom's approach of choice. From her point of view, there are more solutions to the "Tragedy of the Commons" than Hardin has suggested. For an agreement to be reached, both a credible self-commitment on the part of the parties involved and the establishment of effective control possibilities are necessary. According to her, this self-commitment of a community or a national state can be as efficient as a legally binding framework (hard law).

Since so-called "soft-laws" are easier to negotiate, they are often used in preference to legislation. The downside is that there is a lack of legal enforcement or penalties, although social and public pressure can also be a powerful tool.

1. The UNEP Global Programme of Action (GPA) for the Protection of the Marine Environment from Land-based Activities (1995)

The UN Environment's Global Programme for Action for the Protection of the Marine Environment from Land-Based Activities (GPA) has been in force since 1995. It was adopted at an intergovernmental meeting in Washington, D, C., and United States of America by 108 governments and the European Commission. It is the only worldwide intergovernmental mechanism that tackles specifically the connectivity between terrestrial, freshwater, coastal and marine ecosystems (UNEP 2016).

While many countries and activists have been in favor of seeking a legally binding global agreement, the GPA follows a "soft law" approach. The main objective of the GPA is to advise states on how to deal with land-based activities that impact the marine environment. It hereby seeks to cover all three levels – national, regional and global. It mentions nine origins of marine degradation, one of which is debris, which includes plastic waste, though plastic

waste is also listed in the source category “sewage” (UNEP 1995). However, the GPA does not foresee a compliance mechanism and also doesn’t provide adequate funding to achieve the goals in developing countries (Simon et al. 2018).

National

In chapter 2 the GPA demands states to develop national programs of action (NPA) within the time span of a few years. The GPA also suggests these NPAs to follow six basic parameters: “[…] 1) identifying and assessing problems; 2) establishing priorities for action; 3) setting management objectives for priority problems; 4) selecting management strategies and measures; 5) including criteria for evaluating the effectiveness of management interventions; and 6) ensuring program support elements, such as financing, human resources and legal enforcement mechanisms“ (VanderZwaag, Powers 2008: 427-428). Chapter 5 of the GPA also advises further urges states to set specific goals and take different steps according to nine types of origin such as sewage, reesidual organic pollutants, radioactive substances, heavy metals, oils, nutriments, sediments, debris and structural changes and habitat destruction.

Regional

Chapter 2 aims to improve local collaboration to protect the marine environment from land-based activities. States are required to enhance existing regional conventions and programs and to negotiate new regional conventions and programs (VanderZwaag, Powers 2008). The development of regional programs of action, using the six-part format for NPAs, in Chapter 5 of the GPA identifies possible targets and actions to be taken within regional programs of action, such as improving regional information exchange and guidance on environmentally sound sewage treatment. (cf. ibid.) The development of Regional Seas Conventions and Action Plans is further discussed in a later part of this work.

International

Chapter 4 of the GPA seeks to address on the problem of mobilizing international financial resources to support the development and implementation of national and regional programs of action. It states that, generally, states are generally expected to fund their national and regional initiatives from their own public and private sectors. Nevertheless, the chapter further acknowledges that there will be a need for substantial new and increased funding for countries that need assistance (cf. ibid.)

The GPA has to tackle issues common to many fields of environmental governance, such as inequality, lack of public education and awareness, insufficient individual and political will to take marine pollution and environmental degradation seriously, over-consumption and materialistic thoughts, limited financial and human resources, fragmented legal and administrative arrangements and last but not last a lack of efficient compliance and enforcement. (cf. VanderZwaag, Powers 2008: 437)

Due to critics the shortcomings of the GPA are in particular a "[…] limited national participation and implementation, limited national reporting, limited coverage of pollutant source categories, limited financing, limits of a non-legally binding approach, and limits in international environmental governance" (VanderZwaag, Powers 2008: 438).

Notwithstanding success in developing and adopting NPAs, there is still a long way to go. The participation by countries has not been universal. More than 60 NPAs are designed, developed and adopted worldwide, according to the UNEP / GPA Coordination Office, but many countries have not yet officially accepted the NPA process (UNEP Report 2018).

2. The Honolulu Strategy – A Global Framework for Prevention and Management of Marine Debris (2011)

The Honolulu Strategy was developed at the Fifth International Marine Debris Conference, which was organized by the National Oceanic and Atmospheric Administration (NOAA) as well as UNEP. With the signing of the Honolulu Commitment to tackle marine litter by the representatives of 64 governments and the European Commission in 2011, participants were asked to take part in the development and implementation of the Honolulu Strategy.

The result – "A Global Framework for Prevention and Management of Marine Debris" – is a collaborative framework that seeks to link and promote coordination and partnerships between various marine debris projects by exchanging learned lessons and best practices on a voluntary basis. (cf. Simon et al. 2018)

The Honolulu Strategy focuses on land- and sea-based sources of marine litter and contains a monitoring tool, which tries to take a more holistic view on the progress achieved by different projects. The Strategy contains three overarching goals:

1. To reduce the amount and impact of land-based sources of marine debris in the oceans
2. To reduce the amount and impact of sea-based sources in the oceans
3. To reduce the amount and impact of accumulated marine debris on shorelines, in benthic habitats and in pelagic waters

There are specific provisions for the tracking and reviewing the success of the various projects in operation, as well as a variety of possible actions and approaches that different parties can take. The Strategy does not, however, provide any measurable targets or deadlines, which hinders proper chances of effectiveness. However, it recognizes its own flaws as it is stated in the acknowledgements that target-setting, Integrated Solid Waste Management (ISWM) and Extended Producer Responsibility (EPR) could not be integrated into the strategy, even though the authors view them as extremely important. Therefore, "[…] the Honolulu Strategy should be viewed as a companion document to other global, regional and national processes to address the issue. (Honolulu Strategy 2011: Acknowledgements) Some of the mentioned missing aspects (e.g. EPR) were taken up again in later frameworks such as the EU Single Use Plastic Ban.

3. Agenda 2030 and the UN Sustainable Development Goals (2016)

"Any collective attempt to address the complex problem of marine litter can only be successful if it takes into account regional and international frameworks, intended to improve marine environmental protection, which are either in place or currently under development." (UNEP 2016: 5).

Therefore, the UN Agenda for Sustainable Development offers an overarching framework for contextualizing other global, regional, national and local initiatives. The UN General Assembly adopted the resolution 70/1, "Transforming our World: the 2030 Agenda for Sustainable Development" on the 25th of September 2015 at a landmark UN summit. It embodies an action plan that includes 17 Sustainable Development Goals and 169 targets. (cf. ibid.) The 17 Sustainable Development Goals (SDG) of the 2030 Agenda for Sustainable Development officially entered into force on 1 January 2016.

In the preamble of the resolution is stated that "|A]ll countries and stakeholders, acting in collaborative partnership, will implement this plan. We are resolved to free the human race from the tyranny of poverty and want to heal and secure our planet. We are determined to take

the bold and transformative steps which are urgently needed to shift the world on to a sustainable and resilient path. As we embark on this collective journey, we pledge that no one will be left behind." as well as "[…] The goals and targets will stimulate action over the next 15 years in areas of critical importance for humanity and the planet." (SDG Report 2018: 9).

The goals 11, 12 and 14 appear to be particularly applicable to marine plastic pollution, although all 17 goals are concerned in one way or another:

- Goal 11: Make Cities and Human Settlements Inclusive, Safe, Resilient and Sustainable
- Goal 12: Ensure Sustainable Consumption and Production Patterns
- Goal 14: Conserve and Sustainably Use the Oceans, Seas and Marine Resources for Sustainable Development

Sets of more specific targets are placed under each of these more common priorities. Eleven objectives under Goals 11, 12 and 14 are of particular relevance to combating marine pollution with those of most relevance highlighted in italic letters:

SDG Targets Related to Marine Litter

6.3 "*By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous material, halving the proportion of untreated wastewater"* (SDG 2015: 18)

11.6 "*By 2030, reduce the adverse per capita environmental impact of cities*, including by paying special attention to air quality and *municipal and other waste management.*" (SDG 2015: 22)

12.1 "Implement the 10-year framework of programmes on sustainable consumption and production, all countries taking action, with developed countries taking the lead, taking into account the development and capabilities of developing countries." (SDG 2015: 23)

12.2 "By 2030, achieve the sustainable management and efficient use of natural resources" (SDG 2015: 23)

12.4 "*By 2020, achieve the environmentally sound management of chemicals all wastes throughout their life cycle,* in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and environment" (SDG 2015: 23)

12.5 "*By 2030, substantially reduce waste generation through prevention, reduction, recycling and reuse"* (SDG 2015: 23)

12.b "Develop and implement tools to monitor sustainable development impacts for sustainable tourism that creates jobs and promotes" (SDG 2015: 23)

14.1 "*By 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris* and nutrient pollution" (SDG 2015: 24)

14.2 "*By 2020, sustainably manage and protect marine and coastal ecosystem* to avoid significant adverse impacts, including by strengthening their resilience and *take action for their restoration* in order to achieve healthy and productive oceans" (SDG 2015: 24)

14.7 "By 2030, increase the economic benefits to Small Island developing States and least developed countries from the sustainable use of marine resources, including through sustainable management of fisheries, aquaculture and tourism" (SDG 2015: 24)

14.a "Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing States and least developed countries" (SDG 2015: 24)

14.c "*Enhance the conservation and sustainable use of oceans and their resources by implementing international law as reflected in UNCLOS, which provides the legal framework for the conservation and sustainable use of oceans and their resources,* as recalled in paragraph 158 of The future we want" (SDG 2015: 25)

15.5 "*Take urgent and significant action to reduce the degradation of natural habitats, halt the loss of biodiversity and, by 2020, protect and prevent the extinction of threatened species."* (UNEP 2016: 7) (SDG 2015: 25)

While many NGOs support the existence of a particular SDG on Oceans (SDG 14), they tend to encourage recognition of the socio-economic and cultural implications of marine environment protection and the interconnection between SDG 14 and the other SDGs. Especially concerning the wide range of ecosystem services that human beings take from the seas. (cf. OceanCare 2017)

Some researchers such as Roland Cormier and Michael Elliott criticize that the SDG targets "[…] are more like goals reflecting the aspirations in the UN resolution." (Cormier, Elliott 2017: 28). In their work, they identify a lack of specific indicators and standards in the targets of the SDGs:"[T|echnically, we do not think that these are targets as they do not provide the specificity needed to be measurable and subsequently will be difficult to implement in an operational context." (Cormier, Elliott: 2017: 30). Therefore, the identified goals should be reviewed, and clear objectives defined, "[…] before we can go on to develop national regulatory frameworks and implement them within the complexity of our national statutory bodies, governance structure and institutional capacities." (ibid.). Despite the critics from the authors, some measurable indicators have been published with tracking reports from the UN, as highlighted in a document on the progress towards the Sustainable Development Goals (SG Report 2019). The researchers are of the opinion that the oceans management should be treated like a corporation by implementing a risk-based framework with evidence-based science linked to maritime policy.

However, even if targets can be measured, according to the researchers, some are not necessarily achievable and realistic. "[…] this is because the SDG targets themselves are primarily strategic and aspirational goals." (Cormier, Elliott 2017: 32). Countries will have to develop management objectives and operational outcomes to specify and design operational measures and controls. Because "[V]isions, goals, objectives and even outcomes are simply an expression of aspirations, directions, intent and expected results – they alone cannot act on the sources and causes of the risk." (Cormier, Elliott 2017: 33).

It needs to be stated though, that the novelty of the SDGs - if they are being compared with their predecessors - is their aim to cover all aspects of sustainable development. According to

David Le Blanc, they can therefore be seen as a network of targets, that connects all the different goals (Le Blanc 2015). With the adoption of the SDGs, discussions on the power of goal-setting and trust as a governance tool have gained momentum in the academic world. Especially, since national status reports – the so called Voluntary National Reviews (VNRs) - are not mandatory. Nonetheless, 142 countries have already presented their VNRs.

However, it is questionable how accurate the presented data really is, since the Sustainable 2019 Development Report 2019 stated that "[M]ost countries do not regularly collect data for more than half of the global indicators." (SG Report 2019: 3). And despite considerable efforts over the past four years, the progress in addressing these data gaps has been limited. Therefore, the report highlights the importance of investments in data to fully implement the 2030 Agenda.

Despite all the criticism and all the obstacles, there is reason to hope. It seems like, the 2030 Agenda and the SDG Goals through their holistic view have already caused advances in some areas, e.g. coastal water quality. Still all countries have room to improve their water quality at the coast, but an analysis of trends from 2012 to 2018 shows, that 104 of 220 coastal regions improved their coastal water quality during this time span. So overall, "[L]and-based pollutant and marine debris threaten coastal habits, but improvements in water quality are achievable" (SG Report 2019: 50).

4. G7 and G20 Action Plans to Combat Marine Litter (2015, 2017, 2018)

In 2015, during the German G7 Presidency as well as 2018, during the Canadian G7 Presidency, action plans regarding the problem of marine litter were adopted. Under the German Presidency, the G7 agreed on the Action Plan to Combat Marine Litter. This action plan acknowledges the GPA and the Global Partnership on Marine Litter (GPML), which is a multi-stakeholder partnership, as applicable tools, and includes nine overarching principles and a range of policy measures to address land-based sources, including the promotion of "relevant instruments and incentives to reduce the use of disposable single-use and other items, which impact the marine environment" (Simon et al. 2018: 24). In addition to that, it contains sections on removal actions, actions to address sea-based sources, education, research and outreach.

In 2018, under the Canadian Presidency of the G7, five out of seven nations – Japan and the US not included - agreed on the Charlevoix Blueprint for Healthy, Oceans, Seas and Resilient

Coastal Communities, which contains an Ocean Plastics Charter in the annex. The charter is voluntary and entails pledges on environmental design and production, collection systems and infrastructure, green lifestyles and education, research and innovation, and action on the coast and shoreline. The Charter states that it is needed to "[…] significantly reduce the use of micro-beads and single-use plastic bags and where appropriate phase them out". (cf. ibid.)

Even though most elements of the Charter are qualitative and therefore hard to measure, it contains a few quantitative goals as well, e.g. the pledge to work with industry "[…] towards a 100% reusable, recyclable, or, where viable alternatives do not exist, recoverable plastics by 2030" as well as "[…] to recycle and reuse at least 55% of plastic packaging by 2030 and recover 100% of all plastics by 2040" (ibid.).

In 2017, marine plastics were introduced to the G20 under the German Presidency and a "G20 Action Plan on Marine Litter" was adopted. It requires the effort to take measures needed to avoid and remove all types of marine waste, including single-use plastics and micro-plastics. The Plan aims to prevent and substantially reduce marine litter and its impacts by 2025 in support of the 2030 Agenda for Sustainable Development. The G20 Action Plan outlines a set of seven high level principles:

1. "Promote the socio-economic benefits of establishing policies to prevent marine litter" (G20 2017: 2)
2. "Promote waste prevention and resource efficiency" (G20 2017: 3)
3. "Promote sustainable waste management" (G20 2017: 3)
4. "Promote effective wastewater treatment and storm water management" (G20 2017: 4)
5. "Raise awareness, promote education and research" (G20 2017: 4)
6. "Support removal and remediation activity" (G20 2017: 4)
7. "Strengthen the engagement of stakeholders" (G20 2017: 5)

It is possible to see, that further attention has been paid to marine pollution, including waste prevention and sustainable waste management as well as wastewater treatment. However, it still needs to be stated that both, the G7 and G20 Action Plan, as well as the Ocean Plastic Charter, are on a purely voluntary basis. The obvious drawback with these initiatives is also that they do not include all States. In fact, the Oceans Plastics Charter didn't even include all the G7 States. In addition, neither the G7 nor the G20 Action Plan contains any quantified goals, which makes it almost impossible to measure their impact.

B. Regional Cooperation

Compared to international agreements, regional agreements are less broad and often tend to specifically target issues of marine litter with less ambiguity by really taking the economic and ecological situation of the respective region into account. It is important to recognize, that regional conventions have the same legal weight as global-scope international convents, the only distinction, of course, is the scope of their application.

In regard to regional initiatives and agreements, scholar Elinor Ostrom states in her work "Governing the Commons: The Evolution of Institutions for Collective Action", that functioning solutions to the commons problem in local commons are often based on the management of the resource by the concerned individuals within the framework of an appropriate institution based on the self-organization of the participants (Ostrom 1990). According to her, such agreements at local level are often more successful than central state control, because local knowledge can be used.

In fact, regional cooperation is an integral part of successfully addressing the issue of marine plastic pollution. In most cases, regional programs are implemented by Member States through action plans, which entail a comprehensive environmental management strategy for the program and the operational legal framework. However, it is important to note here, that when speaking of local arrangements, Ostrom was thinking of a much smaller scope than e.g. the European Union or the whole Arctic.

I. Regional Seas Conventions and Action Plans

The United Nations Environment Programme (UNEP) promoted national and regional efforts to address land-based marine pollution and activities through its Regional Seas Programme (VanderZwaag, Powers 2008: 426). The program currently covers 18 regional sea arrangements around the world and some regions have even implemented specific protocols or annexes on land-based marine pollution and activities. (cf. VanderZwaag, Powers 2008: 427)

The UNEP Regional Seas Programme (1974) is made up of regional action plans, each underpinned by a regional convention. (cf. Gold et al. 2013: 10) In the implementation of the UNEP Global Programme of Action for the Protection of the Marine Environment from

Land-based Activities (GPA) and the Regional Seas Conventions (RSC), together with the Action Plans adopted by them, play a fundamental role.

To date, more than 143 nations are participating in the program, within the 18 regional seas programs covering: the Arctic, Antarctic, Eastern Africa, Mediterranean Seas, the Pacific, North-East Pacific, North-West Pacific, North-East Atlantic, South-East Pacific, Western Africa and others. (cf. Gold et al. 2013: 10)

However, when UNEP evaluated the Regional Sea Action Plans (RSAP), it was discovered, that these smaller-scale agreements failed to effectively tackle the marine plastic pollution crisis and were largely ineffective. Main reasons for this might be inadequate funding, poor enforcement, a lack of proper infrastructure and the lack of domestic legislation in most RSAP nations. (cf. Goldberg 2012: 331) Often marine litter is regulated under the large category "solid waste", which isn't adequate in neither implementation nor enforcement (ibid.). But, as pointed out in an earlier part of this work, there are academic scholars such as Elinor Ostrom, who are convinced, that local or regional initiatives by smaller communities can actually have an immense impact on global challenges and should therefore not be underestimated.

II. European Union

1. European Strategy for Plastics in a Circular Economy

In January 2018, the European Strategy for Plastics in a Circular Economy was adopted. It seeks to transform the design, use, production and recycling of plastics in the EU. According to the European Commission "[B]etter designs of plastic products, higher plastic waste recycling rates, more and better quality recycling will help boosting the market for recycled plastics." (European Strategy 2018: 1). By working towards achieving these aims, the strategy "[…] will also help achieve the priority set by this Commission for an Energy Union with a modern, low-carbon, resource and energy-efficient economy and will make a tangible contribution to reaching the 2030 Sustainable Development Goals and the Paris Agreement." (ibid.).

The European Strategy for Plastics in a Circular Economy points back the EU Action Plan for a Circular Economy (EU Action Plan 2015), which was adopted in December 2015. There,

plastics were already identified as a key priority with the Commission committing to "prepare a strategy addressing the challenges posed by plastics throughout the value chain and taking into account their entire life-cycle" (ibid.). The Commission announced in 2017, that it would concentrate on the production and use of plastics and seek to ensure that all plastic packaging can be reused by 2030.

According to a press release by the European Commission, the goal of the European Union's strategy is to:

- Make recycling profitable for business: New packaging regulations shall be introduced to boost the recyclability of plastics used on the market and at the same time increase demand for recycled plastics. This should also add value to a more competitive, robust plastics industry.
- Curb plastic waste: In 2018, propose new EU-wide rules concerning single-use plastics and take action to limit the use of microplastics in products, and tag biodegradable and compostable plastics.
- Prevent littering at sea: New rules on port reception facilities shall address the pollution of the marine environment, ensuring that ship-generated waste or waster gathered at sea is not left behind. Measures for decreasing the administrative burden on ports, vessels and competent authorities are also included.
- Drive investment and innovation: Guidelines on how to reduce plastic waste at origin shall be provided for national authorities and European businesses. Innovation funding will be expanded by an estimated €100 million to finance the innovation of smarter and more recyclable plastic products, make recycling processes more effective, and track and remove hazardous substances and contaminants from recycled plastics.
- Spur change across the world: Another part of the strategy, is the development of international standards and the continuous support of other countries.

(European Commission Press 2018)

As a consequence of this strategy not only a ban on single-use plastic has been proposed but also a directive on port facilities for ship waste distribution (Port Reception Facility Proposal 2018). Furthermore, the Commission has also initiated the work on revising the Packaging and Packaging Waste Directive and providing guidance on separate collection and sorting of waste to be published in 2019. So even though, the strategy itself is no legally binding

framework, it has been the starting point for some proposals that either look set to become European law in the near future or already have been adopted, as noted below.

2. Ban on Single-Use-Plastic

In May 2018 the European Commission proposed new EU-wide rules on the use of 10 single-use plastic products and missing or discarded fishing gear. The ban primarily seeks to affect products that are the most common on European shores and are estimated to account for more than 70 percent of marine litter. On 31 October 2018 the Council reached its position. Negotiations with the European Parliament began on 6 November 2018 and concluded on 19 December 2018 in a provisional agreement, confirmed on 18 January 2019 by EU ambassadors of the member states.

Finally, in May 2019 the EU officially approved then new directive (EU) 2019/904 on the reduction of the impact of certain plastic products on the environment, shortly referred to as Single-use Plastic Directive (Single-use Plastic Directive 2019).

The goal of the directive is to prevent and combat plastic waste in the marine environment. This goal shall be reached by phasing out needless single-use plastics, providing economic incentives to reduce consumption and transition to re-usable systems, and setting high collection rates and extended schemes for producer responsibility.

It's main objective as stated in Article 1 of the Directive is therefore "[…] to prevent and reduce the impact of certain plastic products on the environment, and on human health, as well as to promote the transition to a circular economy with innovative and sustainable business models, products and materials, thus also contributing to the efficient functioning of the internal market." (ibid.).

The following products will be banned in the EU by 2021:

- Single-use plastic cutlery (forks, knives, spoons, and chopsticks)
- Single-use plastic plates
- Plastic straws
- Cotton bud sticks made of plastic
- Plastic balloon sticks
- Oxo-degradable plastics and food containers and expanded polystyrene cups

(Single Use Plastic Directive 2019)

In addition, Member States should take the needed steps to achieve a meaningful statistical reduction in the consumption of the following products:

- Food containers made of plastic, such as fast food boxes, with or without a cover
- Plastic cups for beverages, as well as their covers and lids

Furthermore, it is pointed out in Article 6.5 of the Directive that plastic bottles in the Member States will have to consist of at least 25% of recycled material by 2025, calculated as an average for the Member State. In 2030 all PET bottles will have to contain at least 30% of recycled content. Member States furthermore have to ensure a 90% collection target for plastic bottles by 2029. (ibid.)

Article 7 of the Directive deals with marking requirements: Wet wipes will have to carry a label on their packaging, reminding the user about the presence of plastic in the wet wipe and the harm done to the environment if it is not dumped into the bin. (ibid.)

In Article 8, the directive strengthens an extended producer responsibility scheme (EPR), especially for tobacco. This means that producers will have to cover the cost of (public) cigarette stubs disposal schemes, as well as the necessary infrastructure, meaning adequate waste receptacles in common litter hotspots. (ibid.)

It is highlighted that "[T]obacco product filters containing plastics are the second most found single-use plastic items on beaches in the Union." (Single Use Plastic Directive 2019: 1), therefore "[…] innovation and product development are expected to provide viable alternatives to filters containing plastic and need to be accelerated." (ibid.) It also stated, that cigarettes and other tobacco filters that contain plastics have to carry a label on their packaging, also informing the smoker of the harm done to the environment if the cigarette butts are not solely thrown in the bin.

A European wide single use plastic ban is an extraordinary political action that could indeed make a difference in the end, since legally binding laws on this topic are very rare. Even though many national governments seem to want to tackle marine pollution, it often happens, that powerful voices are able manage to undermine measures, that could otherwise be successful and efficient. For instance, in December 2017, a UN resolution was discussed with

the goal to prevent any plastic from reaching the world's waterways. Starting off as being legally enforceable, protests by the U.S. made it non-obligatory and therefore much less effective.

However, the Directive recognizes its own flaws. It is being admitted that "[M]icroplastics do not fall directly within the scope of this Directive, yet they contribute to marine litter and the Union should therefore adopt a comprehensive approach to that problem. The Union should encourage all producers to strictly limit microplastics in their formulations." (ibid.). And indeed, it needs to be criticized that microplastics are not included in the Directive, since they play an important role in marine pollution. It is also questionable, if being "encouraged" by the European Union will really lead many producers to limit microplastics in their formulations.

Time will tell how much of an impact the new directive will really have. While it is undeniably an important first step in combating plastic pollution, its success relies on the application of EU member states' national governments. Since the directive has been published in the Official Journal of the European Union (OJ) in June 2019, the legislative has now entered the transposition phase. This means that Member States will have two years to transpose the new rules into their national legislation.

Many people, like journalist Larissa Copello de Souza, see the Directive as a great possibility for EU-wide change. She is of the opinion that "[…] reducing overall plastic use and consumption, especially single-use plastics, could be a game changer in Europe: it has the potential to create new markets, and local jobs, stimulate innovation and provide opportunities for alternative business models, while preserving the natural resources upon which we all depend." (Copello de Souza 2019: 1).

However, the directive includes some loose criteria, such as the vague requirement to reach an "ambitious and sustained reduction" of food containers and cups for beverages by 2026. Especially without precise targets in the Directive, it is difficult to evaluate compliance. "[T]herefore, Member States must set national targets and immediately collect data according to the given baseline 2022." (Copello de Souza 2019: 1). Here, countries can even go a step further and e.g. enforce trade limits on food containers and cups for single use. Nevertheless, Copello the Souza states, that there must be no exceptions for bio-based or compostable

products, as it is not a matter of replacing one single-use commodity with another, but of encouraging recycled alternatives. (cf. ibid.)

In regard to extended producer responsibility (EPR) schemes, it needs to be stated that measures can be improved. The Directive allows to implement EPR measures, which are agreed upon between industry and officials, but sets a far too long "by 2024" deadline for introducing these schemes. This deadline does not reflect the time pressure our world is facing when addressing the plastic single-use issue. However, it is of great importance that national governments "[…] ensure full transparency and monitoring of EPR schemes" (Copello de Souza 2019: 1), particularly those developed under arrangements with the industry.

At the end of the day, including ambitious measures in the law does not change anything if they are not effectively enforced and constantly tracked. Thus, it is of great importance for countries to ensure effective of all the established measures established under their national compliance legislation. They also need to maintain monitoring systems to that the actual impact of the regulations can be measured. (cf. ibid.)

3. Outlook – "The European Green Deal"

The former Vice-President of the EU Commission Frans Timmermans said back in 2018 „[I]f we don't change the way we produce and use plastics, there will be more plastics than fish in our oceans by 2050. We must stop plastics getting into our water, our food and even our bodies. The only long-term solution is to reduce plastic waste by recycling and reusing more. This is a challenge that citizens, industry and governments must tackle together. With the EU Plastics Strategy we are also driving a new more circular business model. We need to invest in innovative new technologies that keep our citizens and our environment safe whilst keeping our industry competitive." (EC Press 2018: 1)

Timmermans now holds a powerful position in the new Commission, under the President-designate Ursula von der Leyen. He will have a dual role as an Executive Vice-President responsible for the European Green Deal and also hold the climate action portfolio. In her mission letter to Timmermans, von der Leyen has already made specific asks of him. She clearly states, that his priority will be the fight against climate change and therefore the ecological transition, nonetheless he is also requested to "[…] coordinate our work on the circular economy, as well as on the 'Farm to Fork' strategy for sustainable food. This will

cover every step in the food chain from production to consumption, looking at consumer information, food safety, animal and plant health, fisheries and the agri-food sector." (ML 1 von der Leyen 2019: 5) Furthermore, von der Leyen demands Frans Timmermans to protect Europe's biodiversity. He will have to ensure that "[…] we mainstream biodiversity priorities across all policy areas, notable trade, industry agriculture and maritime affairs." (cf. ibid.) So even though plastic pollution is not explicitly mentioned, it can be assumed that Timmermans will include this topic on his agenda.

And Timmermans will not fight alone. Ursula von der Leyen put the youngest ever Commissioner-designate in charge of managing some of the biggest threats to future generations, such as environment protection and ocean conservation. Lithuanian minister Virginijus Sinkevičius gained support by the MEPs after his hearing on 3 October 2019. In Sinkevičius mission letter the plastic strategy is finally explicitly mentioned. Von der Leyen tells him to work on a new Circular Economy Action plan to ensure sustainable resource use and "[A]s part of this, you will lead efforts towards plastic free ocean. I want you to address the issue of microplastics and ensure that the existing legislation on plastics is implemented." (ML 2 von der Leyen 2019: 5). Sinkevičius stated in his hearing, that he wants to raise the profile of circularity and make sure it is not only a word but also an action. He also highlighted the importance of not only reducing waste but eliminating waste completely. Furthermore, he explicitly promised to focus on the full implementation of the plastic strategy. However, he claimed that it shouldn't stop there and that the next step should be to address the problem of microplastics.

In regard to these committed announcements, there is reason to hope that the Single-use Plastic Directive will be implemented correctly and that there will be an actual enforcement and continuous monitoring of the measures. Raising public awareness helps putting further pressure on the decisionmakers in Brussels and forces them to deal with the problem of plastic pollution.

C. Initiatives of Non-Governmental Organizations

There are several nonprofit organizations (NGOs) working to bring attention, visibility and change to the amount of plastic waste in our oceans. The approaches reach from more preventive actions like reducing waste to cleanup efforts like removing plastic debris from beaches or even attempts to clean the oceans. In the following section a few exemplary

initiatives are being briefly presented, to give an impression of what is currently being done by non-governmental actors.

As is has been stated by Ostrom it doesn't always need a government to initiate change. Environmental NGOs have the potential to play a significant role in helping to tackle e.g. marine pollution. Due to their knowledge and experience they are often asked for advice by policymakers who are developing environmental laws. They serve as the "voice of the ocean", lobbying for the interests of the marine environment. The increasing interest in marine issues within the civil society is also creating a higher demand for more independent research and communication. NGOs have the potential to play a very significant role in leading and promoting these kinds of initiatives. Furthermore, NGOs are able to provide an independent (non-political) view, which is often crucial for individuals to build trust in the issues and to help enact behavioral changes in communities.

Since trust - according to Adam Douglas Henry and Thomas Dietz – is "[...] an important determinant of sustainability outcomes because it influences strategic interaction between actors whose individual incentives are not necessarily alignment with that of the collective" (Henry, Dietz 2011: 189), the important role that NGOs can play becomes clear. If they transfer the feeling that they provide reliable information, they can help to gain the trust of the communities in certain actions. Trust in actions ultimately increases the willingness of the community (and the individual) to self-commit to a sustainable use of a common resource. However, "[…] when the action taken has the potential for benefiting others, as it does in actions to protect a common pool resource, then altruism (the degree to which an individual takes account of the well-being of others) also matters." (Henry, Dietz 2011: 193).

I. The Ocean Cleanup

In 2013, the Ocean Cleanup has been founded by Boyan Slat in Delft (Netherlands), when he was just 18 years old. The non-profit organization develops technologies to clean the world's oceans of plastic. On their website, they claim that "[B]y deploying a fleet of systems, The Ocean Cleanup has estimated to be able to remove 50% of the Great Pacific Garbage Patch in just five years' time." (The Ocean Cleanup). The collected and concentrated plastic is then supposed to be brought back to shore for recycling and sold to B2C companies, which helps funding the cleanup expansion to the other four gyres.

On 8 September 2018, the first cleanup system towed from San Francisco Bay to the Great Pacific Garbage Patch. After four months System 001 returned to short, and a redesign took place. System 001/B was then deployed in June 2019. (cf. ibid.)

Despite some setbacks, with the initiative announcing in December 2018 that the first System 001/A could not hold the collected plastic, some progress has been made. As of October 2nd, 2019, the System 001/B is successfully capturing and collecting plastic debris in the Great Pacific Garbage Patch. (TOCU 2019) However, there have been problems from the beginning. In December, the initiative announced that the plant could not hold the collected plastic. In addition, the effect of the project is questioned by some critics. According to marine researcher Mark Lenz, the best effect of the project is attention. Otherwise, The Ocean Cleanup only works on the symptoms. “We have to solve the waste problem on land,” said Lenz. (cf. ZEIT 2019)

II. Fishing for Litter

KIMO’s Fishing For Litter is an initiative that tries to reduce marine litter by getting the fishing industry on board.. According to the initiative, the project is “[…] designed to reduce the amount of marine litter in our seas by physically removing it and to highlight the importance of good waste management amongst the fleet.” (Fishing for Litter). Ships, that are participating receive bags to collect waste caught in their nets while they are fishing. All the fishermen who participate in the project are volunteers.

The Fishing for Litter initiative was originally started by the North Sea Directorate of the Dutch Government in cooperation with the Dutch Fisheries Association in March 2000. (cf. ibid.)

Fishing for Litter has been recognized by more and more policy makers as a useful tool in combating marine litter. E.g. the European Marine Strategy Framework Directive requires member states to ensure that "[P]roperties and quantities of marine litter do not cause harm to the coastal and marine environments" and notes that, "[F]ishing for Litter offers a tried and tested tool that can be used to both remove litter from the sea and raise awareness of the issue". (cf. ibid.)

III. 4Oceans

On the website it says “[W]e’re here to clean the ocean and the coastlines while working to stop the inflow of plastic by changing consumption habits.” (4Ocean). While being on a surf trip in Bali, Alex Shulze (United States) and Andrew Cooper (United States) got aware of hordes of floating trash in the water. They came up with an idea that contains a good dose of free market capitalism. So, in order to fund the cleanup efforts, they created the 4Ocean Bracelet. The bracelets are made with recycled materials, every bracelet purchased “[…] funds the removal of one pound of trash from the ocean and coastlines. To date, the initiative has more than 300 employees and cleared the oceans of almost 4.2 million pounds of trash. (cf. Washington Post 2019)

What is remarkable, is that the ocean-cleaning is done entirely by private citizens and by private money earned via sales. Or as it was stated by the Washington Post: “[H]ow refreshing. Two guys, driven to act on behalf of the betterment of others, using the free market and personal creativity to solve a societal problem – and providing jobs and service opportunities for hundreds of others in the process.” (Washington Post 2019).

IV. Seas At Risk

Seas At Risk (SAR) is an umbrella organization of environmental NGOs from all over Europe that advocates for ambitious policies for marine protection at EU-level and international level. Their work expands across a wide range of issues regarding marine protected areas, fisheries, marine litter, shipping and the climate crisis as well as other issues (deep sea mining, aquaculture, and ocean governance). Unlike the abovementioned NGOs, their focus lies with the pressure on EU institutions, national governments to make sustainable, environmental-friendly laws. Regarding marine litter, and especially single-use plastics, SAR is using legislative leverages to support the reduction in consumption of single-use plastics and thus significantly reduce marine plastic pollution.

Basing their actions on scientific evidence and public consultation, SAR engages in lobbying activities. In a 2017 report, the NGO highlighted the legislative tools and opportunities that the EU has when it comes to tackling plastic pollution on a European scale. It particularly emphasizes the implementation of the Extended Producer Responsibilities (EPR), the environmental policy whereby a producer’s responsibility for a product extends to the whole of that product’s life cycle, including its disposal (Seas At Risk 2017).

Located in the center of the European Union in Brussels, their team of policy officers works together with their growing membership of environmental NGOs, representing millions of European citizens that care about the oceans state.

SIXTH PART: CONCLUSION AND RECOMMENDATIONS

A. Conclusion

"Since its invention some 100 years ago, plastic has become an integral part of our daily lives, but every year, some eight million tons of it end up in the ocean, and there it can be lethal." (Sir David Attenborough 2017)

Over the past years, various actions have been taken to tackle marine plastic pollution. These efforts have addressed various levels of governance, e.g. local, national, regional or international and focused on the complete range of response options, such as prevention, mitigation, control or recovery. On top of that all sorts of different actors – individuals, communities, businesses and governments - have been involved. The initiatives reach from Government declarations and global partnerships, to regional conventions with legally binding protocols. However, despite all these endeavors the problem has kept growing. The question is: why?

As this work has shown, there is not one single reason, but we are looking at a complex problem with various sources and pathways. Therefore, a holistic approach is needed in order to efficiently tackle marine pollution.

Of course, one obvious reason for our inability to effectively combat marine litter is the increase of the total global production and consumption over the past decades. An increase of plastic production like this, inevitably leads to the generation of more plastic waste. This might not have been such an obstacle for the marine environment if all the plastic debris had been flawlessly collected and safely managed. Sadly, that hasn't been the case neither in the past, nor is it the case today. States attempts to prevent the leakage of plastic waste into the natural environment have not kept pace with the increasing global production.

Another key factor why the problem has kept growing is that most States lack systems, structures and capacity to effectively collect and manage plastic waste. Especially in Asia, many States do not have the funding to build an infrastructure required for effective waste collection and also for many of these States, this has not been a key priority.

Furthermore, there is a very limited use of effective market-based solutions for minimizing waste or for incentivizing collection. Actors of the industry as well as businesses have not been properly tasked or required to put effective return schemes or recycling systems in place. On top of that, they never had to thoroughly pay for the pollution caused by their products, or in other ways a producer responsibility scheme has not been implemented. Or as Sir David Attenborough puts it: "[W]e should be grateful for all the useful things plastic can do, but the people who provide the plastic should also have some degree of responsibility about how it's disposed. We can make a demand on the people who put plastic into our lives: to make plastic easier to recycle and not to use it gratuitously. Our children will have to pay a much higher price unless we change out behavior now." (Attenborough 2018)

The third key reason is cultural. There is a huge difference between states, when it comes to social codes and norms concerning littering waste treatment and above all awareness of the problem. In most countries, plastic is still treated as a disposable material, and not as a valuable resource, and people are acting accordingly which leads e.g. to the life span of a single-use plastic bag of about 15min. It is a process of "normalization" that sets in, whereby plastic waste gradually accumulates in people's surroundings. After a period of time, when plastic debris has been on streets, beaches or in forests long enough, it becomes normal and therefore has limited potential to drive political actions.

It is possible to overcome all of these challenges. In fact, the majority could even be solved on a national scope. However, the problem reached such proportions, that it is unlikely that donor States would be willing to foot the bill for all humanity, unless the receiving States were to make some serious commitments in return.

So, in order to reach infrastructure upgrades, while at the same time getting the pollution numbers down a sophisticated, a global approach is required. Preventing the leakage of plastic waste into the oceans requires attention to the entire value chain, from production over consumption to recycling.

Last but not least, a fourth key reason for the lack of effective initiatives, is that the lion's share of the problem quite literally drifts away, either because it is directly discharged into the ocean, or because it gradually makes its way there. Once the plastic debris enters the oceans,

Governments often are no longer held accountable for it, and here the marine litter becomes an international cooperation problem.

There is no real incentive for each individual State to keep plastic waste from reaching the ocean, in particular if other States are not doing the same. However, if none of the States take actions, eventually the collective of States will lose. This "Tragedy of the Commons Dilemma" is also the main reason, why Garett Hardin claims that it's most effective to deal with international environmental problems in the form of legally binding treaties. According to him, too much "[f]reedom in commons brings ruin to all", which means once a resource is fully available to all people, everyone tries to generate as much benefit as possible for themselves. (cf. Hardin 1968) A logic consequence would be the creation of international, legally binding laws in order to effectively control and regulate access to the public good, e.g. the marine environment.

However, for a long-time no such legally binding global agreement has been developed for the issue of marine plastic pollution. Existing "soft-laws" are non-binding; therefore often lack legal enforcement and sanctions, although social and public pressure can be a powerful tool. Since they are easier to negotiate, they are often used in preference to legislation. Initiatives like the G7 Ocean Plastic Charter do not include all States, which is another obvious drawback.

The legally binding frameworks that do exist are an important step towards a plastic free ocean. Unfortunately, many hard law obligations within international binding frameworks are neither implemented nor enforced. Often, there are no proper systems in place for monitoring progress. Another weakness can be found in the fact that even though annexes to protocols are created legally binding, States can usually choose which annexes they want to be bound by; thus, the overall effectiveness is lost.

However, according to Elinor Ostrom there are more ways to solve the "Tragedy of the Commons" than suggested by Hardin. In her opinion, there are a multitude of collective forms of use that have to be taken into account. She explicitly highlights the importance of regional agreements, which need to be based on credible self-commitment of the local communities as well as the establishment of effective control measures. In her view, such arrangements are

often more successful than centralized state control, because specific knowledge of the local conditions can be used.

Furthermore, local, but also international NGO's play an important role in fighting marine pollution, since they can serve as the "ocean's voice" and provide reliable (non-political) information, which is often crucial for individuals to build trust in actions. According to Adam Douglas Henry and Thomas Dietz, trust is a crucial determinant of sustainability outcomes, which explains why the tasks of NGOs such as raising awareness, providing information and lobbying for the marine environment are extremely important.

At the end of this work it needs to be stated, that public awareness actually is increasing. Marine plastic pollution has become an important topic in political debates and the global attention is a vehicle for political mobilization. For example, the EU-Single Use Plastic Ban – if effectively implemented by the Member States – can set new global standards and serve as an example, since it is the first legally binding framework on such a big regional scope.

After all the key to unlocking the "common dilemma" for marine litter can only be a holistic approach, that does not only include legislative measures (e.g. Plastic Circular Economy, Single-Use Plastic Bans etc.) but also triggers a change on how we consume plastic as a society. Marine environmental pollution has to be solved on land. If our waste enters the high sea, it is already too late. Therefore, we do not only need effective waste management systems, but we have to start at a much earlier point: waste consumption and reduction. Here, we need commitments on every level: individual, local, and regional and of course also global. Looking at the continuously growing Great Pacific Garbage Patch, it is clear that existing global frameworks can only provide a minimum guidance, but actions taken by society, industry and politics have to go much further.

B. Recommendations for Future Research

This work has only investigated the most popular and relevant theoretical models, international frameworks and regional cooperations in regard to marine plastic pollution. No attempt has been made to cover the whole extent of literature covering the topic or to analyze

every framework that addresses the issue of plastic pollution in the ocean. Therefore, further research is recommended to:

- provide a complete overview of the existing literature and theoretical models
- analyze the entire history of international legislation concerning marine plastic pollution up to this date
- assess national legislations, especially in the countries, that are known to be the largest producers of plastic waste, such as e.g. Japan (Case Studies)

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