OCEAN LEGACY

Plastic Pollution is a Threat to Global Security

Chloé Dubois

Written as part of the graduate degree completion requirements at Simon Fraser University

TABLE OF CONTENTS

INTRODUCTION

There are no proven formulas which provide one solution to ending the plastic pollution crisis. The issues surrounding plastic pollution are complex as intersecting issues such as poverty, human health, food security, global climate change, and environmental degradation are all captured in this matter. This paper investigates the potential detrimental human health effects and the environmental implications caused by plastic pollution as a serious risk to global security. This study will define global security in the context of plastic pollution and will examine how the 'real-world' threat of mismanaged plastic may risk human health and safety, as well as the integrity of the natural environment. The key arguments of this paper are that the widespread environmental and economic impacts, as well as human health risk potential from plastic pollution, warrant an urgent and comprehensive response realized only through classifying the issue as a threat to global security. Due to a lack of binding and harmonized global governance, a dedicated international legal framework is missing which could catalyze world-wide action to stop plastic pollution in our communities and environments. The methodology of this study is inductive and will draw upon a range of evidence which includes peer reviewed journal articles, policy papers, global treaty papers, and reports from expert organizations. This paper will demonstrate that the significant compounding effects of plastic pollution pose an existential threat to global security which warrants similar binding global emergency measures that have resulted in other similar environmentally focused threats.

This paper is structured into five sections, the first section focuses on defining global security in the context of plastic pollution. The second section examines some of the largest environmental degradation concerns and human health risk potential caused by plastic pollution. The third section investigates the role of plastic production in the carbon cycle and its relation to the global climate change crisis as a security threat. The fourth section investigates policy creation and the barriers to policy development which advance effective plastic pollution solutions. The last section concludes the findings of this paper's analysis, and answers questions regarding how the effects of plastic pollution qualify as an issue of global security. This paper highlights how plastic pollution warrants immediate harmonized binding action on a global scale to mitigate further pollution from occurring.

Plastic Pollution Basics

Over the last 60 years, the uses of plastic have grown exponentially. Plastic is inexpensive, lightweight, and durable in nature, allowing it to be applied in a broad array of applications, including packaging, automotive, household products, electronics, construction, and the marine industry (Paletta et al., 2019). Plastic polymer durability has enabled manufactured items to persist for thousands of years once disposed at their end-of-life. Once in the ocean, it is estimated that a plastic beverage container can last upwards of 450 years while fishing line upwards of 600 years before they disintegrate (The National Oceanic and Atmospheric Administration, 2018). It is estimated that more than 75% of all plastics that have been produced have become waste, while substantial quantities of plastic accumulate in landfills and natural ecosystems worldwide (WWF et al., 2020; Hopewell et al., 2009). Plastic manufacturing and trade are rapidly growing sectors, producing more than 450 million tonnes of plastic every year as of 2018 (WWF et al., 2020), generating more than $600 billion in revenue (Paletta et al., 2019; Wang et al., 2019; European Commission, 2018; Wright et al., 2017; World Watch Institute, 2015). If significant improvements are not made to plastic management systems worldwide, plastic in aquatic and landfill environments are estimated to increase to 12,000 million metric tonnes by 2050 (Geyer et al., 2017). Plastic pollution is now found in the deepest depth of the ocean surface (10,975 meters under) to mountain tops of more than 3,000 meters in altitude (BBC, 2019; Wetherbee et al., 2019). Emerging studies are beginning to investigate the human health risks associated to plastics found in the water cycle, human food chain and in human blood samples such as cytotoxicity, unwanted immune system response, hemolysis and respiratory difficulty (Fernando et al., 2020; Hwang et al., 2019; Wetherbee et al., 2019).

The effects of plastic pollution on human health remain a contentious issue in the scientific community. However, the study of these effects is rapidly becoming a growing field of study due to the increasing concern plastic pollution may have on human and environmental health with anticipated pollution projections. Despite the human health risk potential and environmental degradation concerns, the petrochemical industry has announced an investment of $204 billion USD to drive shale and gas development for virgin plastic production (Borelle et al., 2020). With the anticipated growth of plastic production and given current policy and infrastructure gaps, Borelle et al. (2020) predict that 90 million tonnes of plastic pollution could be released into aquatic ecosystems by the year 2030 without serious improvements to current plastic management systems. Wright el al. (2017) describes the accumulative pollution potential of plastic to reach 250 million tonnes by 2025. The WWF et al. (2020) remark that significant ecological, economic, and social harm will occur without immediate comprehensive and binding actions which would stop the flow of plastic pollution. The issues of plastic pollution are now ranked only second to climate change in global surveys as being the most pressing environmental issue of our time and is ranked first in Asia (WWF et al., 2020).

1.0 DEFINING GLOBAL SECURITY

Security, when studied in a global context, is a sub-discipline of International Relations (Hough, 2014). Historically, 'security' became attributed to the state by the end of the eighteenth century with a focus on military threats to state security (Hough, 2014; McSweeney, 1999). Human health and rights matters have traditionally been considered more domestic or 'low' policy issues but more recently have begun to be included as matters of global security. Issues surrounding environment, health, and rights have been taking precedence on the global agenda as disasters in other states are increasingly considered politically important even if people are not personally affected (Hough, 2014). McSweeney (1999) states that "…security must make sense at the basic level of the individual human being for it to make sense at the international level" (Pp.16). This statement highlights the realignment of the definition of security from one solely focused on the state to one refocused on the needs of the individual. The United Nations Development Program (1993) also began modernizing the understanding of global security from one of military focus to one of human development:

> "The concept of security must change – from an exclusive stress on national security to a much greater stress on people's security, from security through armaments to security through human development, from territorial to food, employment and environmental security." (Pp.2)

The realignment and widened definition of security would inherently encompass the environmental degradation and human health risk created from plastic pollution to the individual, and would become an infringement to human rights as the security of the individual would be compromised without coordinated global action. Contemporary international relation theorists now contend whether to maintain the traditional definition of security studies which focus on military threats to state or to expand the definition to include non-military threats. Some theorists go as far as to extend its definition to include both military and non-military threats to the state (Hough, 2014). The latter would form a contemporary definition of state security which would widen the focus of state security to encompass the political complexity and the prolific number of interactions between state actors that would more accurately reflect our current global system (Hough, 2014). Buzan et al. (1998) state that the following criteria qualify an issue as a matter of global security:

> "Threats and vulnerabilities can arise in many different areas, military and non-military, but to count as security issues they have to meet strictly defined criteria that distinguish them from the normal run of the merely political. They have to be staged as existential threats to a referent object by a securitizing actor who thereby generates endorsement of emergency measures beyond rules that would otherwise bind." (Buzan et al. 1998: 5)

Ullman (1983) also states that:

> "An action or sequence of events that (1) threatens drastically and over a relatively brief span of time to degrade the quality of life for the inhabitants of a state…." (Pp. 133).

It is by utilizing a contemporary definition of global security with qualifying criteria that non-military issues that meet these criteria can be considered legitimate threats to global security.

Some theorists argue that by broadening the definition of security beyond one of military focus, the definition becomes diluted, and all-encompassing. This ultimately weakens the analysis of military threats which can address global security (Wirtz, 2002; Walt, 1991). However, it is clear that "not all security risks are military in nature" (Hough 2014; Pp.14) and to define security in terms of "…state bodies whose aim it is to help secure their state and people in certain dimension[s] rather than the people whose security is at stake…" (Hough 2014; Pp.9) would be disconnected and illogical. When determining if an issue is a matter of global security, it must carry 'real-world' significance and must not be solely a theoretical question (Hough, 2014). The effects of plastic pollution on human and environmental health, although an emerging field of study, demonstrate 'real-world' risk which infringes on the health and safety of individuals. A lack of globally coordinated binding policy which would result in harmonized pragmatic action to prevent plastic pollution from occurring perpetuates a continual breach to global security. Hough (2004) reiterates:

> "If people, be they government ministers or private individuals, perceive an issue to threaten their lives in some way and respond politically to this, then that issue should be deemed to be a *security* issue." (Pp.9)

Plastic pollution compromises the integrity of the natural environment, decimates wildlife, contributes to global climate change and emerging research is demonstrating that there is serious potential risk to human health. However, more research is necessary to characterize the full impact to human health, as risks are still contentious among scientists (Wright et al., 2017). Catalyzing these causes of concern will be explored in the following chapters to demonstrate how plastic pollution not only qualifies as a threat to global security but warrants globally binding treaties which have been assigned to other environmental threats similar in magnitude and nature.

2.0 THE EFFECTS OF PLASTIC POLLUTION TO GLOBAL SECURITY

2.1 THREAT TO HUMAN HEALTH

Once mismanaged plastics escape the waste stream, they often end up entering the natural environment polluting air, water and food systems. Plastics in the environment are exposed to harsh ultraviolet (UV) radiation, abrasion, wind and wave conditions which cause the materials to become brittle and degrade over time. When plastics degrade, they fragment into smaller and smaller pieces. Plastics greater than >0.5mm are classified as macro, plastics 0.1 μm−5 mm are classified as micro and plastics 0.001–0.1μm are classified as nanoplastics (Haegerbaeumer et al., 2019; Hwang et al, 2019; Wright et al., 2017). In addition to degradation caused fragmentation, microplastic particles are also commonly released as microfibers from clothing while doing laundry. They are intentionally manufactured in numerous applications, such as exfoliants (microbeads) in hygiene care products and are produced by tire wear (An et al., 2020; Eisentraut et al., 2018; Napper et al.; 2015; Browne et al., 2011). Manufactured nanoplastics are also commonly found in electronics, paint, and adhesive products (Koelmans, 2015). Plastics particles are directly transported around the environment through water and air pathways such as municipal effluent sources and air currents (Fendall et al., 2009). Due to the small nature of micro and nano-plastic particles, they commonly bypass wastewater treatment processes and containment systems (Stapleton, 2019), which result in plastic contamination in water, air and food. Microplastics are the most reported plastic pollution, with an estimated 5.25 trillion particles contaminating ocean surface waters globally (Buzan et al., 2018; Eriksen et al., 2014; Browne et al., 2011). These plastics have been found in oysters, shrimp and mussels which are often consumed by humans and other species (Hwang et al., 2019; Buzan et al., 2018).

Once plastic particles are in the water they act as small toxic sponges, absorbing and concentrating organochlorine pesticides, polychlorinated biphenyls (PCBs) and other Persistent Organic Pollutants (POPs) (Hwang et al., 2019; Wright et al., 2017; Saal and Hughes, 2005). They can also absorb heavy metals such as cadmium, nickel, lead, and zinc (Rochman et al., 2014; Holmes et al., 2012). Plastic particles can therefore be very contaminated with chemical concentrations several orders of magnitude greater than the plastic material itself (Haegerbaeumer et al., 2019). These toxic pollutants are registered on the Stockholm Convention for their potential adverse effects to human health (Wright et al., 2017; Vanden Bilcke 2002) and in 2004 a binding global treaty regulating and limiting the use of POPs entered into force with the United Nations Environment Programme (United Nations Environment Program, 2018). The treaty is supported by 184 parties designated to the convention, as well has been integrated into EU legislation and regulation (UN Environment Program, 2019). Persistent Organic Pollutants are considered a transboundary issue, similar in magnitude to plastic pollution and are considered a threat to global security warranting a global treaty.

Plastics may also contain chemical additives which are added to the materials during the manufacturing process. Additives can leach out of the plastic and can transfer into their surrounding environment (Hwang et al., 2019; Wright et al. 2017). Plastics containing these chemicals, POPs and metals then get consumed by wildlife including fish, shellfish, and other species which then can enter into the human food chain upon consumption (Hwang et al., 2019; Stapleton, 2019). Once consumed, toxins present in plastic particles can become absorbed in the human body and can bioaccumulate in fatty tissues (Stapleton, 2019). The bioaccumulation of these chemicals has been proven to be detrimental to human health, causing abnormalities in liver, skin, and nervous system function (Rochman et al., 2013). However, additional research is required to understand the full scope of adverse effects and impact to human health. Additional implications that adversely affect human health upon exposure via plastic ingestion and inhalation include possible correlations to endocrine disruptors, cytotoxicity, unwanted immune response, hemolysis, and respiratory difficulty (Fernando et al., 2020; Hwang et al, 2019; Wetherbee et al, 2019). Plastic pollution has also been found to carry pathogenic microorganisms and parasites such as Escherichia coli, Bacillus cereus, and Stenotrophomonas maltophilia which are detrimental to human health (Hwang et al, 2019).

2.1.1 ENTERING THE HUMAN BODY

Plastics enter the human body in two primary processes: inhalation and ingestion (Hwang et al, 2019; Wright et al., 2017). Three major concerns surrounding the uptake of these plastic particles include:
1) That fine nano-sized particles can translocate between cell membranes, the human placenta, and even the blood-brain barrier which have the potential to cause toxic effects to human cells including lung and gut injury (Hwang et al, 2019; Stapleton, 2019; Wright et al., 2017);

2) Chemical toxicity uptake and the bioaccumulation of toxins from PCB and POP leaching (Haegerbaeumer et al., 2019);

3) Pathogens and vectors can transport pathogenic bacteria, parasites and microorganisms into the human body (Stapleton, 2019).

It is agreed that further research is necessary and should be immediately established to determine the extent of these concerns and additional biological consequences associated with these exposures (Stapleton, 2019; Wright et al., 2017). There is great evidence which demonstrates that frequent human exposure to plastic pollution already occurs regularly. Plastics have now been found in table salt, beer, and sugar (Yang et al., 2015; Liebezeit et al., 2014; Liebezeit et al., 2013). Cox et al. (2019) estimate that depending on age and sex, humans are estimated to ingest 39,000 to 52,000 plastic particles a year and 74,000 and 121,000 when including exposure via inhalation. This number increases by another 90,000 particles when including people who meet their daily water in-take with bottled water and 4,000 particles for those who consume only tap water. Wright et al. (2017) quantify this consumption to approximately 40 mg a day per person.

2.1.1.1 RISK FROM INHALATION

Once inhaled microplastics meet lung tissues where they may translocate through blood diffusion, active cellular uptake, or direct cellular penetration (Wright eta., 2017). The inhalation of microparticles is correlated to cardiovascular disease and respiratory illness (Chen et al., 2016). Plastic inhalation can cause interstitial lung disease and dyspnea which induces coughing, breathlessness, increased phlegm production, wheezing, and reduced lung capacity (Hwang et al, 2019; Wright et al., 2017; Galloway, 2015; Kremer et al., 1994). However, the extent of health risk from exposure is still under investigation and not yet quantified. There is evidence that these particles trigger biological responses depending on the uptake and persistence of the particles (Wright et al., 2017). Plastic microfibers have also been observed in malignant lung tissue cells, exhibiting little deterioration, and supporting the notion that they are biopersistent causing acute and chronic inflammation. However, particle concentration and accumulation in the human body is still unclear as to what dose of pollutants they can supply. Longer fibers have been shown to be the most problematic for accumulation and fibers more than 0.3µm are the most carcinogenic. Site of deposition and potential chemical absorption from the particles surface can also contribute to toxicity (Wright et al., 2017). Figure 1.0 illustrates how plastic particles may become lodged in the human lung upon inhalation and how particles may pass through cells and translocate through the body, passing through the lung lining (Wright et al., 2017).

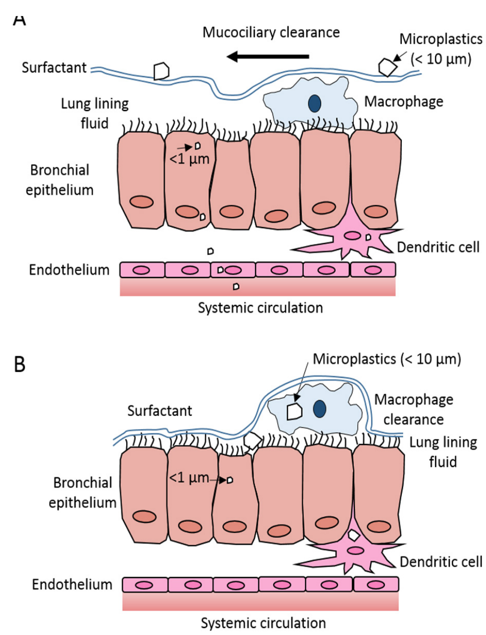

Figure 1.0

Image A depicts the clearance capacity of the lung, allowing microplastic between 0.1 and 10mm plastic particles to clear the lung. However, image B depicts particles which penetrate deeper lung tissue and can contact the epithelium, diffusing in the body causing translocation and active cellular uptake. Image taken from Wright et al., 2017.

In Rochman's (2013) study, animal testing was performed on rats which concluded that plastic particle inhalation can compromise immune system health and cause persistent inflammation. These studies suggest that the inhalation of plastic particles may result in damage at a cellular level, and could pose similar risk to the human body.

2.1.1.2 RISK FROM INGESTION

Approximately 3 billion people worldwide depend on seafood for about 20% of their protein intake (Aiking, 2011), however seafood and processed foods are the primary conduits for human plastic ingestion (Hwang et al., 2019; Rist et al., 2018). Plastic pollution is now found in 12 out of 25 of the top globally sea-fished species, jeopardizing the quality and health of the global food chain (WWF et al., 2020). Upon ingestion, plastic particles can enter the gastrointestinal tract (GIT) and translocate to the lymph node, liver, and spleen (Hwang et al., 2019; Wright et al., 2017). Evidence demonstrates that chemical leaching and absorption of contaminants can occur post-consumption of microplastics (Hwang et al., 2019) but does not reveal direct exposure to the plastic itself if seafood organisms contain plastic in their GIT upon consumption (Hwang et al., 2019; Wright et al., 2017).

Plastics which are inhaled may not remain in the lung due to their hydrophobicity, a molecular physical property which repels water. This may pass the plastic through the lung lining and into the gut. Mucus in the gut can enable microplastic particles to aggregate and increase the uptake of particles (Rabanel et al., 2012). Figure 2.0 illustrates how plastic particles may enter the GIT and pass through the gut lining resulting in translocation of particles to the liver, brain, and muscles (Wright et al., 2017). The third portion of the small intestine (Peyer's patches) in the GIT is where translocation and uptake of plastic particles occurs (Powell et al., 2010). This can transfer plastics to lymphoid tissues which play a key role in immune homeostasis (Powell et al., 2015). The presence of plastic particles in the immune system have been shown to cause a biological response, which creates histamines. This understanding is critically important as histamines act as a neurotransmitter in the body, regulating the immune system (Wright et al., 2017). Plastic presence has been demonstrated to imbalance histamine which has been correlated to allergies, and behavioural disorders such as depression, schizophrenia, anxiety as well as autism (Hwang et al., 2019).

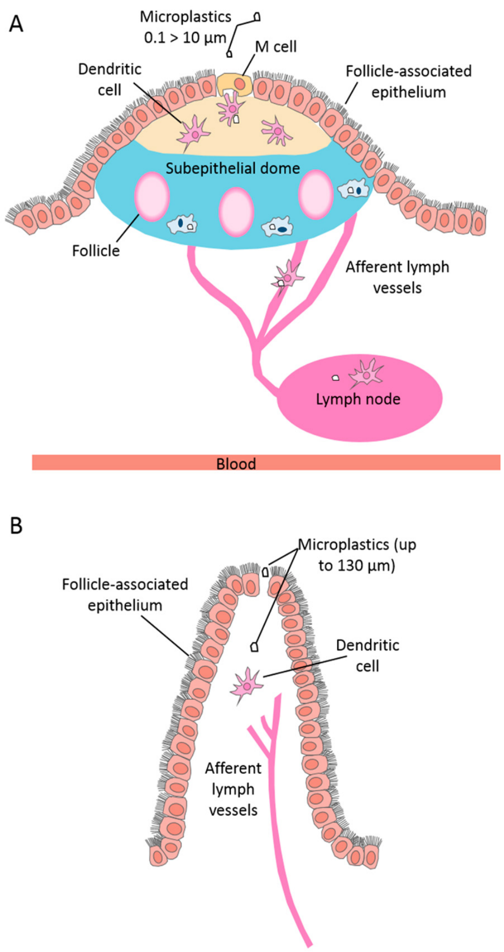

Figure 2.0

Both image A and B are both predicted pathways of microplastic uptake from the gastrointestinal tract (GIT). Microplastic uptake from the small intestines from the GIT by way of endocytosis. Cells transport plastics from small intestines to lymphoid tissues. Microplastics may be mechanically transported through junctions in the cell tissue layer which line the gut into the tissue below which can transport them to lymphatic vessels and veins. This can result in translocation of particles to the liver, brain, and muscles. Image taken from Wright et al., 2017.

Plastic particle size, shape, density, and solubility influence its cytotoxicity to human cells, making human health impacts variable (Wright et al., 2017). Understanding the risk of these particles becomes complex as particle parameters can change over time which can influence their biopersistence (Haegerbaeumer et al., 2019; Wright et al., 2017). Biopersistence of plastics have the potential to cause long term damage to immune system response, carcinogenesis, inflammation, intestinal fibrosis, tissue damage, and may transport pathogenic species into the body altering the microbial composition in the gut or lung (Haegerbaeumer et al., 2019; Hwang et al., 2019; Wright et al., 2017; Powell et al., 2010). Determining the full extent of plastic pollution on human health has been contentious among the scientific community. However, this investigation is critical due to prolific human exposure and the inherent security threat they pose as it may drastically degrade the quality of life over a brief period of time. Quality of life and its rapid degradation over a short period of time is a qualifying feature when determining if a non-military issue is a matter of global security (Ullman, 1989).

2.2 THREAT TO ENVIRONMENT AND SENSITIVE SPECIES

Plastic pollution in aquatic ecosystems is a major global environmental problem and is regarded as one of the most dangerous environmental issues worldwide (WWF et al., 2020; Hwang et al., 2019; Haegerbaeumer et al., 2019; Gregory, 2009). This pollution is so extensive that it is now considered a geological marker for the Anthropocene. The Anthropocene is a unit of measure used to describe the period on Earth where human activity is considered to have significant impacts to planetary climate and ecosystems (National Geographic, 2021; International Maritime Organization, 2006). Derraik (2002) estimates that combined human activities may be accelerating the natural rate of extinction by 1000 to 10,000 times greater. The ‘real-world’ effects of plastic pollution are widely documented, creating the existential threat needed to qualify Buzan et al.’s (1998) criteria and warrant a global security threat classification.

Borelle et al. (2020) estimate that 11% of all plastic waste generated in 2016 entered aquatic environments globally. This equates to approximately 19 to 23 million metric tonnes of plastic pollution currently impacting the health and safety of humans, wildlife, and ecological systems (Borelle et al., 2020). Geyer et al. (2017) estimate that as of 2015, 6300 million tonnes of plastic pollution have been produced and of that tonnage only 9% recycled, 12% incinerated and 79% have accrued in natural or landfill environments. Plastic pollution is known to entangle, starve, suffocate, and introduce invasive species that may affect endangered and sensitive species and generally debilitate wildlife (Gregory, 2009). Other major global issues induced by plastic pollution include shipping hazards, dangers to fisheries and other maritime activities as well as economic loss from property damage (Gregory, 2009). Anticipated accelerated rates of plastic pollution are projected; therefore, so is the magnitude of species loss and environmental degradation (Gregory, 2009).

2.2.1 SPECIES LOSS AND IMPACTS TO WILDLIFE

Hundreds of publications have been released over the last few decades which document the effects of plastic pollution on more than 700 species of marine wildlife (Gall & Thompson, 2015). Species include:

> "turtles, penguins, albatross, petrels and shearwaters, shorebirds, skuas, gulls and auks, coastal birds other than seabirds, baleen whales, toothed whales and dolphins, earless or true seals, sea lions and fur seals, manatees and dugong, sea otters, fish and crustaceans" (Gregory, 2009; Pp. 2; 2014)

Image 1.0 represents an albatross bird that has eaten and is deceased from plastic pollution. Plastic pollution has filled the stomach contents, resulting in starvation. 17 out of the 22 species of Albatross are critically endangered. Albatross often become entangled or starved by plastic pollution (ICUN, 2021). Photo copyright Chris Jordan. https://twitter.com/enrichatkaust/status/1000718958494994433

Wildlife, particularly marine animals, frequently consume plastics which have been proven to accumulate in their intestines, stomachs, and liver, often leading to a reduced quality of life, lowered reproductivity and death (Gregory, 2009; Laist, 1987). Unfortunately, many species which plastic pollution affects are considered sensitive or are critically endangered.

The North Atlantic right whale is critically endangered and is considered one of the most endangered whale species globally. Its leading cause of death is entanglement by plastic fishing gear and vessel strikes (Kraus et al.,2005). Another example of species loss due to plastic pollution can be found in Image 1.0. This image illustrates the death of an endangered albatross bird through plastic GIT accumulation resulting in starvation. This image represents a classic example of the amounts of plastic pollution being consumed by marine life around the world. There are 22 species of albatross and 17 of these species are critically endangered (ICUN, 2021). Butcher et al. (2021) estimate that 73% of the albatross species are on the brink of extinction and that 17.5% of Southern-hemisphere albatross deaths are caused by plastic pollution.

Loss of biodiversity is considered a threat to global peace security and development (Djoghlaf, 2021). The Convention on Biological Diversity (CBD) was enacted in 1993 and was supported by 168 signatures at the United Nations Conference on Environment and Development (Convention on Biological Diversity, 2021). Ecosystem integrity is essential to provide humanity with adequate natural resources which are necessary to socio-economic development and the survival of future generations. However, human activities are globally depleting biodiversity at an alarming rate (Convention on Biological Diversity, 2021). Plastics are no exception and are linked to approximately 500 oceanic dead zones around the world which cover approximately 245,000km² as well as cause the deaths of more than 100,000 marine mammals and more than one million seabirds annually (UNESCO, 2017). This impact is significant to habitat and species loss.

2.2.2 PLASTIC SHEETING

Plastic sheeting occurs when thick layers of plastic accumulate in marine or land-based environments which causes smothering and impacts the biota of soft sediment, reef environments and rocky substrata (Uneputty & Evans, 1997). Areas which contain thicker layers of plastic pollution are shown to disrupt habitat and benthic organisms by increasing levels of organic materials and contamination input of toxic substances (Haegerbaeumer et al., 2019; Uneputty & Evans, 1997). Benthic organisms are a critical component in the food chain, providing up to 90% of the biomass consumed by fish (Haegerbaeumer et al., 2019). The impacts of plastic sheeting are concerning as these organisms eat micro and nanoplastics and absorb the toxic contaminants either leached from or attached to the plastic particles. The consumption of contaminated benthic organisms provides the initial trophic level transfer necessary to introduce toxins to the aquatic food web. This frequently results in the bioaccumulation effect of harmful organochlorine pesticides and polychlorinated biphenyls (PCBs) in the human body upon seafood consumption (Haegerbaeumer et al., 2019). The effect of plastic particles on the health of benthic organisms is dependent upon the resin type of plastic, the type of organism and the concentration of toxin present on the particle (Haegerbaeumer et al., 2019). Other effects of plastic sheeting have resulted in increased levels of invasive species, flooding, algae mats, fly ash, and increased levels of sewage and bacteria shown to increase disease (WWF et al., 2020; Haegerbaeumer et al., 2019).

Image 2.0 was taken along the Western coast of Panama by the Ocean Legacy Foundation in a suburb called Costa Del Este. The plastic pollution illustrated in Image 2.0 is over 5 feet tall in some areas and is an example of plastic sheeting which exhibits smothering effects to flora, fauna, and disruption to sediment soils. Smothering effects illustrated in this image have prevented plant and tree species from growing as well as removed sensitive mangrove habitat from returning wildlife.

Image 2.0 was taken by Ocean Legacy Foundation in 2017 in Costa Del Este, Panama. Shoreline-based plastic pollution concentrations change the physical properties of the environment, smoother plant and soil life, entangle wildlife and create unfavourable conditions for nesting wildlife such endangered turtle species. Conditions illustrated in this image also damage property, dimmish eco-tourism opportunities and create costly cleanup expenses.

2.3 THREAT TO SOIL HEALTH

Another effect of plastic pollution which must be considered is the impact to soil health. Soils provide one of the most important foundations needed for all terrestrial-based life on earth to survive, providing ecosystem services which humans depend upon and benefit from such as the resources to produce food through agriculture. However, studies are now discovering that the introduction of plastics into these systems can cause sudden environmental changes to soil structure, soil aggregation as well as soil microbial activities and function (De Souza Machado et al., 2020). These changes can consequently affect the biogeochemical and water cycles as well as plant and animal health (De Souza Machado et al., 2020). More research is needed to provide the full scope of effects that plastic pollution can cause to soil health and its possible effect on food security issues.

3.0 PLASTICS & GLOBAL CLIMATE CHANGE AS A SECURITY THREAT

Beyond the visible pollution and health risks, it is important to note that plastics are made from carbon and are closely linked with the carbon cycle, which is having a serious effect on our climate. Collectively, humans emit approximately 50 billion tonnes of carbon dioxide every year (Richie & Roser, 2020). Plastics, when studied across their lifecycle, are the fifth highest emitter of greenhouse gases (GHGs) and account for 3.8% of GHG emissions globally (Zheng & Suh, 2019). WWF et al. (2020) estimates that plastic will take up 10-13% of the world's carbon budget by 2050 while Wright (2019) and Zheng & Suh (2019) estimate upwards of 15%.

More than 99% of all plastics are made from petrochemicals that require large amounts of energy which emit significant amounts of GHGs during production, transportation, refining, product manufacturing and disposal stages (Zhu, 2021a; Wright, 2019; Ciel, 2017). It is estimated that 61% of the GHG emissions related to plastic are produced during the refining and transportation stage of plastic production. While 30% of related emissions are produced and emitted from the energy used during the product manufacturing stage (Wright, 2019). The remaining carbon footprint of plastics is produced during the end-of-life disposal. Plastics are commonly incinerated which can release toxic dioxins, mercury, furans and polychlorinated biphenyls into the atmosphere (Verma et al., 2016). These pollutants are proven to be damaging to human health (World Health Organization, 2016; Thompson, 2014). Geyer et al. (2017) estimate that 8300 million metric tonnes of virgin plastic have been produced and as of 2015, 6300 million metric tonnes of plastic pollution have been created. From that tonnage only 9% recycled, 12% incinerated and 79% accrued in natural or landfill environments. This is significant as Thompson (2014) estimates that more than 40% of the world's waste in landfill environments is burned in open-pit, uncontrolled conditions. This estimate is a substantial source of GHG gas emissions and small air-borne particulate matter, which can be a source of lung and neurological diseases. It is important to note that this estimate is also not accounted for in official GHG inventories. Due to the prolific and persistent nature of plastics, it is now becoming more widely accepted that plastics should be considered to have their own branch of the carbon cycle as these materials move between atmospheric, oceanic, and organism reservoirs (Zhu, 2021b). Plastic pollution must be incorporated into climate change action planning as they both are closely correlated.

Global climate change produced by the exploitation of fossil fuels is considered to be one of the greatest threats to humanity and is transforming the way we think about global security (Parry, 2021; Military Advisory Board, 2007). Global climate change causes resource scarcity, flooding, disease, famine, human displacement, and economic disruption on an unprecedented scale and is currently at the centre of the global security agenda (Parry, 2021). Therefore, scarce resource competition will be intensified, leading to outright global conflict and a breakdown of established codes of conduct which are the very tensions the UN Security Council manages daily (Parry, 2021). The Military Advisory Board (2007) states that climate change is "a threat multiplier for instability in some of the most volatile regions of the world" (Pp.6) and it is these concerns which resulted in the UN Security Council instigating an unprecedented debate in 2007 which reviewed matters of energy, security, and climate (Parry, 2021). The Paris Agreement created in 2015 at the Conference of Parties 21 (COP 21) in Paris was adopted by 196 parties. This treaty is internationally binding and came into force in 2016 to limit carbon emissions below 2º Celsius when compared to pre-industrial levels. This treaty was developed to address issues of climate change (United Nations, 2015).

Global climate change is no longer seen as just an environmental or economic concern but a matter of national security, warranting an internationally binding treaty. However, carbon-based plastics demonstrated to be closely correlated to a fluctuating climate in addition to causing resource depletion, large scale environmental degradation, human health risks, and further risk to endangered species has not gotten the same urgency or policy response.

> “Failing to recognize the intimate connections between these issues [climate change and plastic] not only makes tackling these issues inefficient but may also undermine efforts on both fronts.”
> (Zhu, 2021a)

Despite this correlation, plastic pollution has no binding international treaty and has not yet been addressed as a matter of global security by the UN Security Council. Borelle et al. (2017) remark in Figure 3.0 that although carbon emissions and plastic production seem to be increasing at a similar rate and scale of emission, the development of international policies to limit plastic emissions lags far behind the policy progress made to limit atmospheric carbon emissions.

The recognition of plastic pollution must be designated as a core security issue and an unprecedented threat that must be met with an internationally binding treaty for urgent action from the UN Security Council, just as was done for global climate change. Parry (2021) remarks that when the UN Security Council, charged with the preservation of international peace and security, debated global climate change, better results ensued as a more comprehensive understanding of all the implications including security imperatives were achieved. Plastic pollution warrants a similar response. WWF et al. (2020) state that two-thirds of United Nations member states have publicly expressed that they would be willing to consider the creation of a new global treaty to address plastic pollution. In addition, a quarter of United Nations member states have called for the negotiation of such a treaty (WWF et al. 2020). However, this convention to discuss a plastic pollution treaty has not yet occurred.

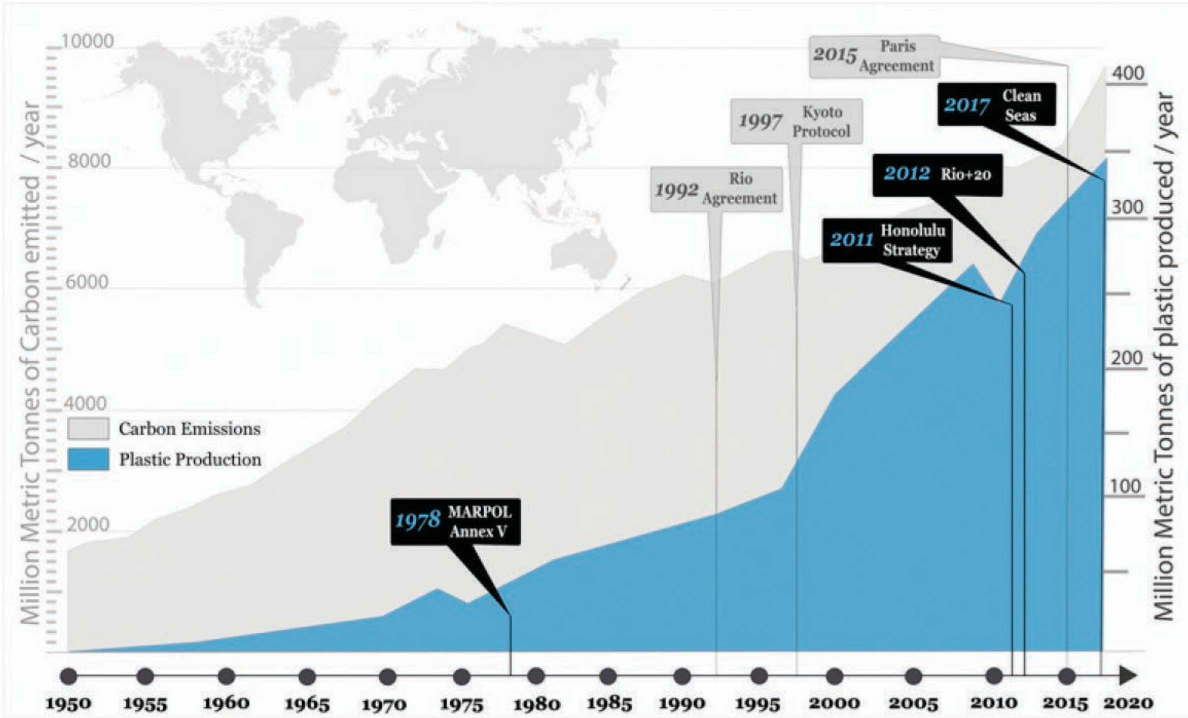

Figure 3.0 are the results of Geyer et al.'s (2017) comparative analysis which extrapolates global plastic production data and the international policy response to mitigate emissions with that of global carbon emissions. The study underlines the magnitude and scale of both issues comparable, however, highlights the lag in policy development identified to reduce and prevent plastic pollution emissions.

4.0 PLASTIC & ENVIRONMENTAL DEGRADATION AS A SECURITY THREAT

The health and integrity of the natural environment are becoming recognized as matters of international security as these issues are increasingly becoming politicized. Broadening the definition of security to include the risk of plastic pollution, given its impact to environmental degradation, transboundary nature, and human health risk would apply additional pressure to globally push for an international convention to take place. This convention could strategically engage UN member states in harmonized cross-border action which could lead to a binding treaty to address the scale, urgency, and coordinated efforts required to stem the tide of plastic pollution. Comparable actions and treaties for other environmental issues similar in scale and magnitude have been taken such as the Paris Agreement for global climate change, the Stockholm Convention for POPs and PCB pollution, the Convention on Biological Diversity for species loss, the Montreal Protocol for ozone depletion and the Port State Measures for Illegal, Unreported and Unregulated (IUU) fishing. Hough (2004) explains that:

> "Environmental degradation in distant countries may destabilize regional balances of power and trigger military conflict that the onlooking government may be drawn into or be affected by in some capacity. Hence, with widening [the definition of security], the logic of national interest and prioritizing high politics is not really challenged. It is more of a refinement of the way in which external threats are calculated and a case of allowing 'low politics' to rise to prominence in the absence of major 'high politics' threats. Military defence is still being prioritized and security being defined as a very specific noun rather than as an adjective" (Pp16).

By encompassing environmental degradation due to plastic pollution into a broader definition of security, more localized and comprehensive analysis can take place to address and assess the flow of plastics across state borders. In addition, it can evaluate plastic capture and processing capacities as well as develop a deeper understanding of the local health risks and existing damage caused by plastic pollution. These types of analysis and data are missing on a world-wide scale and for many states, this information is just beginning to emerge. This data is critical when developing comprehensive and effective regional solutions which can address the complexity of plastic pollution issues. It is estimated that if significant improvements are not made to global plastic management systems, plastic in aquatic environments will triple by the year 2040. This will mean more plastic pollution than fish in the ocean by the year 2050 (Independent, 2020). Plastic pollution is a global threat to human wellbeing and security as the livelihoods of more than three billion people depend on the health of the oceans and its coastal biodiversity (United Nations Sustainable Development, 2021).

Plastic pollution can limit, alter, damage, and ultimately deplete the ecosystem services and natural resources available to humans which are used to enhance health, provide livelihood, food, and water as well as recreational activities. Ullman (1983) argues that resource depletion is an issue of global security needed to be brought alongside other military threats. Environmental issues such as ozone depletion were first discussed by Mathews in 1989 as being matters of global security (Mathews, 1989). The Montreal Protocol on Substances that Deplete the Ozone Layer was enacted in 1987 as a legally binding treaty. This protocol required countries to gradually eliminate the use of Chlorofluorocarbons (CFCs) and reduce overall concentrations by 50% (United States Environmental Protection Agency, 2020). This protocol is considered a noteworthy example of a large-scale environmental issue becoming designated as a threat to global security. Creating binding global policies which result in action-based solutions to solve problems which are considered a global threat to security are possible and need to be mandated for similar issues such as plastic pollution. WWF et al. (2020) examine how this treaty catalyzed a vital tool in mitigating ozone depletion. The issue of ozone depletion draws similarities to the issue of plastic pollution. This study's analysis concludes that the Montreal Protocol can serve as an effective model for a similar UN treaty targeting the elimination of plastic pollution.

Homer-Dixon (1993) correlates environmental degradation and resource depletion with violence and social disorder. Environmental changes to soil, water, and a stable climate have been correlated to widespread social disorder and violence (Homer-Dixon, 1993). Changes to soil, water, and climate as well as risk to human health have all been well documented from the wide-spread effects of plastic pollution (Shen et al., 2020; De Souza Machado et al., 2020; Hwang et al., 2019; Borrelle et al., 2017). It is alarming that the devastating effects of plastic pollution have not yet been classified as a risk to global security which would warrant the internationally binding action needed to solve these issues. Table 1.0 provides a comparative analysis, taking the key criteria which qualify global issues as matters of global security and compares these criteria with similar environmental issues. Plastic pollution meets all the same criteria which should qualify the issue as being a matter of global security, warranting similar binding global treaties; however, it currently has no such global accord.

Table 1.0 Comparative Analysis of Security Threat Criteria with Prominent Environmental Cases to Global Security and Their Global Treaty Response (Table created by author)

Similar Cases of Global Security Threats

Qualifying Criteria for a Security Threat	Climate Change	Persistent Organic Pollutants (POPs)	Biodiversity and Species Loss	Illegal, Unreported and Unregulated (IUU) Fishing	Ozone Depletion	Plastic Pollution
Threat to preservation of international peace	✓	✓	✓	✓	✓	✓
Transboundary Threat	✓	✓	✓	✓	✓	✓
Political action has been taken	✓	✓	✓	✓	✓	✓
Resulted in "real-world" consequences	✓	✓	✓	✓	✓	✓
Drastically threatens or degrades the quality of life of state inhabitants over a brief timespan	✓	✓	✓	✓	✓	✓
Globally binding treaty exists	✓	✓	✓	✓	✓	✗

The fact that plastic pollution currently does not have a globally binding agreement to govern the management of plastic materials is a matter of great importance. The effects of plastic pollution are interconnected with many of the existing issues already classified as threats to global security. Many of these related threats carry legally binding global treaties as illustrated in Table 1.0 which clearly demonstrates many other environmental crises which qualify as threats to global security including the threat of plastic pollution. Mismanaged plastic materials carry invasive species, contribute to global climate, contribute to biodiversity loss, transport POPs, can cause Abandoned, Lost or Otherwise Discarded Fishing Gear (ALDFG) during IUU fishing activities and is suspect in cases of human health degradation. Table 2.0 highlights how plastic pollution contributes to other leading global threats to security. This table disseminates the global effects of plastic pollution, details the impacts of the effect, explains what risks they pose to global security, and shows the corresponding reference material within this study.

Table 2.0 The Effects of Plastic Pollution and its Relation to Existing Threats to Global Security Issues (Table created by author)

Effects of Plastic Pollution	Considered a threat to global Security	Impact	Risk	Corresponding References (paper reference number)
Invasive Species	✓	Plastics are transboundary and can carry living organisms as well as seeds from one location to another, introducing invasive species worldwide	Threat to livelihoods, food insecurity and environmental degradation	10
Global Climate Change	✓	Plastics are made from carbon and require significant energy to produce. Plastic emits significant carbon sources throughout its lifecycle. Anticipated to grow upwards of 15% of the carbon budget by 2050	A changing climate causes human displacement, food insecurity, biodiversity loss, water scarcity, economic loss,	13
Biodiversity and Species Loss	✓	Plastics kill and significantly injure critically endangered and non-endangered species, reducing planetary biodiversity. Plastic pollution also dramatically alters the natural environment, resulting in habitat loss	Risk to social-economic development	11
Persistent Organic Pollutants	✓	Plastics absorb and concentrate organochlorine pesticides, polychlorinated biphenyls (PCBs) and other persistent organic pollutants (POPs).	Contaminant food sources and create food insecurity as well as create health risks	7
Illegal, Unreported and Unregulated (IUU) Fishing	✓	Industrial fishing is a major contributor of plastic pollution. It is estimated that roughly half of the plastic in the ocean ALDFG	Food insecurity, species loss	15
Degradation of the quality of life for human health	✓	The human health effects of plastic pollution remain contentious. However, there is emerging evidence which discloses human risk via inhalation and ingestion exposure	Degradation of human health and wellbeing * Research still emerging and additional investigation required	6

5.0 PLASTIC POLLUTION POLICY RESPONSE

Plastic pollution is from both land and marine-based sources and is widely accepted as a transboundary issue (Gomez-Villarrubia et al., 2018; Gregory, 2009). When land-based mismanaged plastics escape solid waste management systems or lack thereof, these materials leak into aquatic environments. Once plastic is free to move around aquatic ecosystems waves, wind, and currents begin to move materials into the five major gyres on the planet (WWF et al., 2020; Gomez-Villarrubia et al., 2018). More than 50% of the ocean's surface area rests beyond state jurisdiction, causing a lack of global governance when designing policies that can limit plastic emissions. This results in little clean-up activity and scarce enforcement of best practice plastic management strategies (Borrelle et al. 2017; Stahel, 2016).

Plastic pollution has been designated as a long-standing international issue which affects all nations (Gregory, 2009; Kibria, 2017). It is transboundary in nature and can impact food security, human health, biodiversity, and ecosystem services (Shen et al., 2020; De Souza Machado et al., 2020; De la-Torre, 2019; Borrelle et al. 2017; Gomez-Villarrubia et al., 2018). It is generally accepted that more than 80% of oceanic plastic pollution is from mismanaged land based sources (Jambeck et al., 2015). Therefore, mitigative binding global policy could be developed to prevent land based plastic pollutants from escaping the waste stream and entering in the natural environment.

Around the world, states are designing and implementing political measures at national and subnational levels which could limit the concentrations of plastic pollution leaking from the waste system. In 2015, the United Nations General Assembly created and agreed upon a set of Sustainable Development Goals (SDGs) which includes SDG #14: Conserve and sustainably use the oceans, seas and marine resources for sustainable development (United Nations Department of Economic and Social Affairs, 2021). This goal states that "by 2025, [member states should] prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution" (Duke Nicholas Institute, 2020). To date, more than 310 policies have been created or are being proposed in 137 countries (Duke Nicholas Institute, 2020). These policies regulate the use of single-use plastics and tackle broader issues associated with plastic pollution and its life cycle (WWF et al., 2020). The Business Case for a United Nations Treaty on Plastic Pollution authored by WWF et al. (2020) states that regulation to address plastic pollution has double in the last five years by 109% and that plastic packaging waste has been ranked a top priority issue for the Largest Fast-Moving Consumer Goods (FMCG) companies in the world.

Despite this growth, there is little policy continuity between states. Not all states and businesses using plastic are participating in voluntary commitments and many of the voluntary commitments such as the New Plastics Economy Global Commitment are not binding or legally enforceable (Ellen McArthur Foundation, 2017). Although these voluntary commitments are beginning to standardize common reporting and definitions, and are important in the development of pragmatic solutions, they lack the scale needed to create systematic change and are under-supported (WWF et al., 2020). The magnitude and scale of plastic pollution is clearly a threat to global security which has catalyzed political response. However, the heterogeneity of policies created globally, nationally, and even sub-nationally are incredibly challenging to navigate; resulting in a regulatory patchwork which undermines their effectiveness through implementation and enforcement. To resolve the issue of plastic pollution, a global response through the creation of a dedicated legal framework such as a treaty is needed. A treaty could harmonize efforts and address the scale and complex nature of this issue.

5.1 CREATING A GLOBALLY BINDING TREATY

The WWF et al. (2020) report recommends that this treaty should objectively focus on creating a specific date whereby plastic leakage into the ocean is eliminated as well as include:

> "1. Harmonized regulatory standards and common definitions across markets
>
> 2. Clear national targets and action plans that aggregate to deliver on the treaty's overarching objective
>
> 3. Common reporting metrics and methodologies across the plastic value chain
>
> 4. Coordinated investment approaches to support infrastructure development in key markets and innovation"
>
> (WWF et al. 2020; Pp. 2)

Creating a global treaty which would standardize definitions and harmonize the current disjointed patchwork of emerging policy would create more effective policies (WWF et al., 2020). An example of a successful global treaty that was signed by 97 countries is the Agreement on Port State Measures (PSMA) issued by the Food and Agriculture Organization of the United Nations in 2016. This is the first binding international agreement which addresses IUU fishing, outlined in Table 3.0. This treaty was created to block and eliminate IUU fishing by preventing the vessels engaging in this illegal activity port access to land their catches. This significantly reduces the capacity for these vessels to operate and blocks illegal fishery products from reaching markets (Food and Agriculture Organization of the United Nations, 2021). This treaty is an example of an internationally binding agreement which was created to address serious environmental degradation, and resource depletion which posed risks to the health, safety, and wellbeing of the international community. Given the high human exposure rates and the potential toxicity associated with plastic pollution, it is crucial that mitigative binding policies such as the PSMA be created which can prevent plastic pollution from occurring. By preventing this pollution, the potential to significantly reduce exposure can occur.

WWF et al. (2020) estimate that of the top 20 plastic polluters who are responsible for 83% of mismanaged plastic waste worldwide, only one polluter has plastic policies in place which regulates more than 50% of the plastic items currently polluting aquatic and shoreline environments. Additionally, seven states from the top 20 polluters lack even an official plastic policy document (WWF et al., 2020). Plastic pollution is internationally recognized as a global crisis, yet an international legal instrument specifically designed to address the urgency and scale of the associated issues and risk is non-existent.
Table 3.0 was adapted from WWF et al.'s (2020) comparative analysis of environmental issues and their characteristics which explore environmental challenges with their resulting global treaties. The study's resulting table outlines multiple global issues comparable to the impacts of plastic pollution however highlights the lack of a globally binding treaty for plastic pollution. Table 3.0 adapts and combines WWF et al. (2020) table and Geyer et al.'s (2017) figure which compares policy developments between eliminating plastic and carbon emissions, again highlighting the magnitude of the issue of plastic pollution but the limited policy response. These datasets are then applied in Table 3.0 to the broadened definition of global security and specify additional policies, voluntary initiatives, and agreements.

Table 3.0 Environmental Threats to Global Security and their related policy (Table created by author with adaptations from WWF et al., 2020 and Geyer et al., 2017)

Issue	Environmental Degradation	Threat to Global Security	Negative Transboundary Impacts	Global Binding Agreement	Initiative/ Policy/ Voluntary Commitment	Depositary	Year
Plastic Pollution	✓	✓	✓	✗	MARPOOL Annex V Voluntary Prevents pollution by garbage from ships	International Maritime Organization	1978
					Honolulu Strategy Voluntary	UN Environment Program	2011
					Rio 20 Voluntary	UN Sustainable Development	2012
					Clean Seas Voluntary	UN Environment Program	2017
					New Plastics Economy Global Commitment Voluntary	Ellen McArthur Foundation & United Nations Environment Programme	2019
Global Climate Change	✓	✓	✓	✓	Rio Agreement	UN Climate Change	1992
					Kyoto Protocol Binding emission reduction targets	UN Climate Change	1997
					Paris Agreement Binding	United Nations Climate Change	2015
Ozone Depletion	✓	✓	✓	✓	Montreal Protocol on Substances that Deplete the Ozone Layer Binding	Secretary General of the United Nations	1987
Biodiversity Decline	✓	✓	✓	✓	The Convention on Biological Diversity (CBD) Binding	United Nations Conference on Environment and Development	1993

Persistent Organic Pollutants	✓	✓	✓	✓	The Stockholm Convention Binding	UN Environment Program	2001
Illegal, Unreported & Unregulated (IUU) Fishing	✓	✓	✓	✓	Agreement on Port State Measures (PSMA) Binding	Food and Agriculture Organization of the United Nation	2016

The result from this comparative table indicate that plastic pollution carries similar attributes and defining parameters as most other major environmental issues that are considered threats to global security. All global initiatives for plastic pollution are listed as voluntary actions whereas all other security threats contain globally binding treaties. This analysis also highlights that the issue of pollutive solid waste at sea has been recognized as a major environmental issue since 1978 upon the creation of the Marpool Annex with consistent voluntary policy development until 2019. This is striking as all other issues similar in magnitude highlighted in this table have binding global treaties which were enacted as far back as 1987 with the development of the Montreal protocol. This table indicates that plastic pollution is the oldest standing issue to be addressed through policy development yet is still the only issue listed to not receive a globally binding treaty. Binding global actions to combat significant environmental issues seen as threats to security is regularly taken. However, this is not yet the case for plastic pollution despite being similar in scale, magnitude, and impact. Plastic pollution warrants a binding global treaty to limit emissions and curb detrimental effects.

5.2 BARRIERS TO POLICY DEVELOPMENT

The effectiveness of a policy can only be understood if there are mechanisms in place to measure and track the policy's progress once implemented. This requires adequate data, yet only 39% of states currently publicly report their waste data. Plastic data is globally collected using wide ranging definitions and calculation methods that create inconsistent and missing data results. These results obscure accurately captured plastic emissions data worldwide (WWF et al., 2020). Incomplete, unavailable sources of data are a major barrier when developing comprehensive evidence-based policies which can address the complexity of plastic pollution. Without data, policy makers are often left with conflicting base-line information founded on best-guess estimates which make developing policies that address the gaps in infrastructure capacity and harmonizing regulations extremely difficult (WWF et al. 2020). Insufficient data also results in difficulties assessing the full value and impacts of plastics throughout its lifecycle and across markets. Insufficient data makes it challenging to track what impact the policy or management effort has had on the plastic pollution issue (WWF et al. 2020).

Understanding current plastic waste recovery rates worldwide is imperative to identifying what capacity the globe has in collecting, processing, and redistributing this plastic (Greenpeace, 2020). Geyer et al.'s (2017) estimates that only 9% of plastics are captured globally which may also be a clear indication that there is a major lack of plastic processing infrastructure. This lack of capacity to capture and process plastics is a major additional barrier to making plastic capture and diversion policies possible. A lack of financial resources and infrastructure investment has resulted in poor waste management (WWF et al. 2020).

6.0 CONCLUSION

Although military threats continue to be ever-present, it is clear that they are not the only threat to global security. Creating systematic mechanisms achieved through binding policy which limit plastic pollution must be seen as a political duty and not an act of charity or volunteerism to truly be resolved. For plastic pollution to be solved and taken seriously on the international stage, it must be defined as a global threat to security and must be included on the agenda of national security just as other comparable major environmental issues. Plastic pollution meets the same criteria and, in many cases, feeds existing threats to security such as climate change and biodiversity loss which are already considered major threats to human survival. Deeping the definition of security to include threats to human health, environmental degradation, economic loss, climate change, and plastic pollution warrants serious consideration.

Global governance which can enforce binding emergency measures such as a global treaty in the face of threats to global security will not only be able to create swift and effective action but will end plastic mismanagement. Such actions have the potential to save thousands of critically endangered species, habitat loss, reduce human health risks and economic loss, conserve soil health, protect food security, and reduce sources of carbon currently affecting global climate change. Plastic pollution will continue to grow and jeopardize the security of our human communities and natural ecosystems without urgent, comprehensive global action which continues to undermine world peace and sustainable development.

WORKS CITED

Aiking, H., 2011. Future protein supply. Trends Food Sci. Technol. 22: 112–120.

An, L., Liu, Q., Deng, Y., Wu, W., Gao, Y., Ling, W., 2020. Sources of Microplastics in the Environment. In: He D., Lou, Y. (eds) Microplastics in Terrestrial Environments. The Handbook of Environmental Chemistry. Springer, Cham. 95.

Borrelle, S., Rochman, C., Liboiron, M., Bond, A., Lusher, A., Bradshaw, H., Provencher, J., 2017. Why we need an international agreement on marine plastic pollution.
PNAS. 114(38): 9994–9997.

Browne, M. A., Crump, P., Niven, S. J., Teuten, E., Tonkin, A., Galloway, T., Thompson, R., 2011. Accumulation of microplastic on shorelines worldwide: sources and sinks. Environ. Sci. Technol. 45(21): 9175−9179.

Butcher, R., Hardesty, B., Roman, L., 2021. Plastic in the ocean kills more threatened albatrosses than we thought. Accessed on March 11, 2021.
https://theconversation.com/plastic-in-the-ocean-kills-more-threatened-albatrosses-than-we-thought-154925.

Buzan, B., Waever, O., De Wilde, J., 1998. Security. A New Framework for Analysis, Boulder, USA & London: Lynne Rienner.

Ciel., 2017. Fueling Plastics: Fossils, Plastics, & Petrochemical Feedstocks. The Production of Plastic and Petrochemical Feedstocks. Center for International Environmental Law. Accessed on March 5, 2021. https://www.ciel.org/wp-content/uploads/2017/09/Fueling-Plastics-Fossils-Plastics-Petrochemical-Feedstocks.pdf.

Cox, K., Covernton, G., Davies, H., Dower, J., Juanes, F., Dudas, S., 2019. Human Consumption of Microplastics. Environmental Science and Technology. 53: 7068−7074.

Convention on Biological Diversity., 2021. History of the Convention. Accessed on March 11th, 2021. https://www.cbd.int/history/.

Derraik, J. G. B., 2002. The pollution of the marine environment by plastic debris: a review.
Mar. Pollut. Bull. 44: 842 –852.

De Souza Machado, A.A., Horton, A.A., Davis, T. and Maaß, S., 2020. Microplastics and their effects on soil function as a life-supporting System. Microplastics in Terrestrial Environments: Emerging Contaminants and Major Challenges. Pp.199-222.

Djoghlaf, A., 2021. Climate Change and Biodiversity Loss. The Great New Threats to Peace Security and Development. Accessed on March 11th, 2021. https://www.climate-policy-watcher.org/sustainable-development-2/climate-change-and-biodiversity-loss-the-great-new-threats-to-peace-security-and-development.html.

Duke Nicholas Institute., 2020. Plastics Policy Inventory. Accessed on February 20th, 2021. https://nicholasinstitute.duke.edu/plastics-policy-inventory.

Eisentraut, P., Dümichen, E., Ruhl, A., Jekel, M., Albrecht, M., Gehde, M., Braun, U., 2018. Two Birds with One Stone—Fast and Simultaneous Analysis of Microplastics: Microparticles Derived from Thermoplastics and Tire Wear. Environmental Science & Technology Letters. 5(10): 608-613.

Ellen McArthur Foundation., 2017. Global Commitment. Accessed on February 20th, 2021. https://www.ellenmacarthurfoundation.org/our-work/activities/new-plastics-economy/global-commitment.

Eriksen, M., Lebreton, L.C.M., Carson, H.S., Thiel, M., Moore, C.J., Borerro, J. C., Galgani, F., Ryan, P. J., Reisser, J., 2014. Plastic pollution in the World's oceans: more than 5 trillion plastic pieces weighing over 250,000 tons afloat at sea. PloS One. 9(12): e111913.

Fendall, L. S., Sewell, M. A., 2009. Contributing to marine pollution by washing your face: Microplastics in facial cleansers. Marine Pollution Bulletin. 58(8): 1225−1228.

Food and Agriculture Organization of the United Nations., 2021. Agreement on Port State Measures (PSMA). Accessed on February 20th, 2021. http://www.fao.org/port-state-measures/background/en/.

Kibria, G., 2017. Plastic Waste, Plastic Pollution- A Threat to All Nations. Project Report. Accessed on February 20th, 2021. https://www.researchgate.net/profile/Golam-Kibria/publication/319391174_Plastic_Waste_Plastic_Pollution-_A_Threat_to_All_Nations/links/59a97f86458515d09cd001cb/Plastic-Waste-Plastic-Pollution-A-Threat-to-All-Nations.pdf.

Kraus, S., Brown, B., Caswell, H., Clark, C., Fujiwara, M., Hamilton, P.K., Kenney, R.D., Knowlton, A., Landry, S., Mayo, C., McLellan, W.A., Moore, M., Nowacek, D., Pabst, D., Read, A.J., Rolland, R.M., 2005. North Atlantic Right Whales in Crisis. Science. 309(5734): 561-562.

Galloway, T.S., 2015. Micro-and Nano-Plastics and Human Health. Marine Anthropogenic Litter. Springer, Cham, pp. 343–366.

Geyer, R., Jambeck, J., Lavender, K., 2017. Production, use, and fate of all plastics ever made. Law Sci. Adv. 3: 1-5.

Gomez-Villarrubia, P., Cornell, S.E., Fabres, J., 2018. Marine plastic pollution as a planetary boundary threat- the drifting piece in the sustainability puzzle. Marine Policy. 96: 213-220.
Gregory, M.R., 2009. Environmental implications of plastic debris in marine settings—entanglement, ingestion, smothering, hangers-on, hitch-hiking and alien invasions. Philos Trans R Soc Lond B Biol Sci. 364(1526): 2013-2025.

Haegerbaeumer, A., Mueller M-T., Fueser H., and Traunspurger, W., 2019. Impacts of Micro- and Nano-Sized Plastic Particles on Benthic Invertebrates: A Literature Review and Gap Analysis. Front. Environ. Sci. 7:17.

Hopewell, J., Dvorak, R., Kosior, E., 2009. Plastics recycling: challenges and opportunities. Phil. Trans. R. Soc. B. 364: 2115–2126.

Homer-Dixon, T., 1993. Environmental Scarcity and Global Security. Headline Series No. 300 Foreign Policy Association, New York, N.Y. Pp 1-84. https://files.eric.ed.gov/fulltext/ED384561.pdf.

Holmes, L. A., Turner, A., Thompson, R. C., 2012. Adsorption of trace metals to plastic resin pellets in the marine environment. Environ. Pollution. 160 (1): 42−48.

Hough, P., 2014. Understanding Global Security. Chapter 1: Security and Securitization. Taylor and Francis. Pp.1-20.

Hwang, J., Choi, D., Han, S., Choi, K., Hong, J., 2019. An assessment of the toxicity of polypropylene microplastics in human derived cells. Science of the Total Environment. 684: 657-669.

International Union for Conservation of Nature (ICUN)., 2021. Red List: Albatross. Accessed on February 21, 2021. https://www.iucnredlist.org/search?query=Albatross&searchType=species.

Independent., 2020. Environment: Ocean plastic could triple by 2040 and out number fish by 2050, study says. Accessed on October 10th, 2020. https://www.independent.co.uk/environment/ocean-plastic-fish-climate-crisis-sea-study-a9635241.html.

International Maritime Organization, 2006. Protocol to the convention on the prevention of marine pollution by dumping of wastes and other matter, 1972. Accessed on February 22, 2021. https://wwwcdn.imo.org/localresources/en/OurWork/Environment/Documents/PROTOCOLAmended2006.pdf.

Jambeck, J., Geyer, R., Wilcox, Siegler, T., Perryman, M., Andrady, A., Narayan, R., Law, K., 2015. Plastic waste inputs from land into the ocean. Science. 347(6223): 768- 771.

Koelmans, A., 2015. Nanoplastics in the aquatic environment. Critical Review. In Marine Anthropogenic Litter; Bergmann, M., Gutow, L., Klages, M. (Eds). Springer International Publishing. Pp. 325− 340.

Kremer, A.M., Pal, T., Boleij, J. S., Schouten, J. P., Rijcken, B., 1994. Airway hyper-responsiveness and the prevalence of work-related symptoms in workers exposed to irritants. Am. J. Ind. Med. 26(5): 655−669.

Laist, D., 1987. Overview of the biological effects of lost and discarded plastic debris in the marine environment. Mar. Pollut. Bull. 18: 319 –326.

Liebezeit, G., Liebezeit, E., 2013. Non-pollen particulates in honey and sugar. Food Addit. Contam., Part A. 30(12): 2136−2140.

Liebezeit, G.; Liebezeit, E., 2014. Synthetic particles as contaminants in German beers. Food Addit. Contam., Part A. 31(9): 1574−1578.

Mathews, J., 1989. Redefining Security. Foreign Affairs. 68(2): 162–177.

McSweeney, B., 1999. Security, Identity and Interests. A Sociology of International Relations, Cambridge: Cambridge University Press.

Military Advisory Board., 2007. National Security and the Treat of Climate Change. Accessed on March 5th, 2021. https://www.cna.org/I_files/pdf/national%20security%20and%20the%20threat%20of%20climate%20change.pdf.

Napper, I. E., Bakir, A., Rowland, S. J., Thompson, R. C., 2015. Characterisation, quantity and sorptive properties of microplastics extracted from cosmetics. Mar. Pollut. Bull. 99(1−2): 178−185.

National Geographic., 2021. Anthropocene. Accessed on February 22, 2021. https://www.nationalgeographic.org/encyclopedia/27nthropocene/

Paletta, A., Filho, W., Balogun, A., Foschi, E., Bonoli, A., 2019. Barriers and challenges to plastics valorisation in the context of a circular economy: Case studies from Italy. Journal of Cleaner Production 241: 118149.

Parry, J., 2021. United Nations: UN Chronicles. The Greatest Threat To Global Security: Climate Change Is Not Merely An Environmental Problem**.** Accessed on March 5th, 2021. https://www.un.org/en/chronicle/article/greatest-threat-global-security-climate-change-not-merely-environmental-problem**.**

Powell, J., Faria, N., Thomas-McKay, E.; Pele, L. C., 2010. Origin and fate of dietary nanoparticles and microparticles in the gastrointestinal tract. J. Autoimmun. 34(3): 226−233.

Powell, J., Thomas-McKay, E., Thoree, V., Robertson, J., Hewitt, R. E., Skepper, J. N., Brown, B., Hernandez-Garrido, J. C., Midgley, P. A., Gomez-Morilla, I., Grime, G. W., Kirkby, K. J., Mabbott, N., Donaldson, D., Williams, I. R., Rios, D., Girardin, S., Haas, C. T., Bruggraber, S. F. A., Laman, J. D., Tanriver, Y., Lombardi, G., Lechler, R., Thompson, R. P. H., Pele, L. C., 2015. An endogenous nanomineral chaperones luminal antigen and peptidoglycan to intestinal immune cells. Nat. Nanotechnol. 10(4): 361−369.

Rabanel, J. M., Aoun, V., Elkin, I., Mokhtar, M., Hildgen, P., 2012. Drug-Loaded Nanocarriers: Passive targeting and crossing of biological barriers. Curr. Med. Chem. 19(19): 3070−3102.

Richie, H., Roser, M., 2020. Greenhouse Gas Emissions. Accessed on March 5th, 2021. https://ourworldindata.org/greenhouse-gas-emissions

Rist, S., Almroth, B.C., Hartmann, N.B., Karlsson, T.M., 2018. A critical perspective on early communications concerning human health aspects of microplastics. Sci. Total Environ. 626, 720–726.

Rochman, C.M., 2013. Plastics and priority pollutants: a multiple stressor in aquatic habitats. ACS Publ. 47(6): 2439–2440.

Rochman, C. M., Hentschel, B. T., Teh, S. J., 2014. Long-term sorption of metals is similar among plastic types: implications for plastic debris in aquatic environments. PLoS One. 9(1): e85433.

Rochman, C.M., Hoh, E., Hentschel, B.T., Kaye, S., 2013. Long term field measurement of sorption of organic contamination to five types of plastic pellets: Implications for plastic marine debris. Environmental Science and Technology. 47(3): 1646-1654.

Ruge, C.A., Kirch, J., Lehr, C., 2013. Pulmonary drug delivery: From generating aerosols to overcoming biological barrier-therapeutic possibilities and technological challenges. Lancet. Respi. Med. 1(5): 402-4013.

Saal, F.S.V., Hughes, C., 2005. An extensive new literature concerning low-dose effects of Bisphenol A shows the need for a new risk assessment. Environmental Health Perspectives. 113(8): 926-933.

Shen, M., Ming, H., Biao, C., Guangming, S., Zhang, Z.Y., 2020. (Micro)plastic crisis: Un-ignorable contribution to global greenhouse gas emissions and climate change. Journal of Cleaner Production. 254(120138): 1-13.

Stapleton, P.A., 2019. Toxicological considerations of nano-sized plastics. AIMS Environ Sci. 6(5): 367-378.

The National Oceanic and Atmospheric Administration., 2018. Marine Debris is Everyone's Problem. Accessed on March 4th, 2021. https://www.whoi.edu/fileserver.do?id=107364&pt=2&p=88817.

Thompson, A., 2014. Burning Trash Bad for Humans and Global Warming. Accessed on March 5th, 2021. https://www.scientificamerican.com/article/burning-trash-bad-for-humans-and-global-warming/.

Ullman, R., 1989. Redefining Security. International Security. 8(1): 129-153.

UNESCO., 2017. Facts and figures on marine pollution. Accessed on March 11th, 2021. http://www.unesco.org/new/en/natural-sciences/ioc-oceans/focus-areas/rio-20-ocean/blueprint-for-the-future-we-want/marine-pollution/facts-and-figures-on-marine-pollution/.

United Nations., 2015. Paris Agreement. Accessed on March 6th, 2021. https://unfccc.int/sites/default/files/english_paris_agreement.pdf

United Nations Environment Programme., 2018. Stockholm Convention Texts and Annexes: Revised in 2017 on Persistent Organic Pollutants (POPs). Secretariat of the Stockholm Convention (SSC). Pp. 1-78.

United Nations Environment Programme., 2019. Stockholm Convention: Text of the Convention. Accessed on March 9th, 2021. http://www.pops.int/TheConvention/Overview/TextoftheConvention/tabid/2232/Default.aspx

United Nations Sustainable Development., 2021. Goal 14: Conserve and sustainably use the oceans, seas and marine resources. Accessed on February 20th, 2021. https://www.un.org/sustainabledevelopment/oceans/.

United Nations Department of Economic and Social Affairs., 2021. Goal 14: Conserve and sustainably use the oceans, seas and marine resources. Accessed on February 20th, 2021. https://sdgs.un.org/goals/goal14.

United Nations Development Program., 1993. Human Development Report. Published for the United Nations Development Program. New York, Oxford University Press. Pp. 2.

United States Environmental Protection Agency., 2020. International Treaties and Cooperation about the Protection of the Stratospheric Ozone Layer. Accessed on February 20th, 2021. https://www.epa.gov/ozone-layer-protection/international-treaties-and-cooperation-about-protection-stratospheric-ozone.

Vanden Bilcke, C., 2002. The Stockholm Convention on Persistent Organic Pollutants. Review of European Community & International Environmental Law. 11(3): 328−342.

Verma, R., Vinoda, K.S., Papireddy, M., Gowda, A.N.S., 2016. Toxic Pollutants from Plastic Waste- A Review. Procedia Environmental Sciences. 35: 701-708.

Walt, S., 1991. The Renaissance of Security Studies. International Studies Quarterly. 35(2): 211-239.

Wang, W., Themelis, N., Sun, K., Bourtsalas, A., Huang, Q., Zhang, Y., Wu, Z., 2019. Current influence of China's ban on plastic waste imports. Waste Disposal & Sustainable Energy. 1:67–78.

Wetherbee, G., Baldwin, A., Ranville, J., 2019. It is raining plastic.: U.S. Geological Survey Open-File Report 2019–1048. Accessed November 25th, 2020. https://doi.org/10.3133/ofr20191048.

World Wildlife Fund (WWF), Ellen McArthur Foundation, Boston Consulting Group., 2020. The business case for a UN treaty on plastic pollution. Accessed February 20th, 2021. https://f.hubspotusercontent20.net/hubfs/4783129/Plastics/UN%20treaty%20plastic%20poll%20report%20a4_single_pages_v15-web-prerelease-3mb.pdf.

Wirtz, J., 2002. A New Agenda for Security and Strategy? In J Baylis, J. Wirtz E. Cohen and C. Gray (eds) Strategy in the Contemporary World. An Introduction to Strategic Studies, Oxford: University Press: 309-327.

World Health Organization., 2016. Dioxins and their effects on human health. Accessed on March 5, 2021. https://www.who.int/news-room/fact-sheets/detail/dioxins-and-their-effects-on-human-health.

Wright, S. and Kelly, F., 2017. Plastic and Human Health: A Micro Issue? Environmental, Science and Technology. 51: 6634−6647.

Wright, L., 2019. Plastic warms the planet twice as much as aviation – here's how to make it climate-friendly. Accessed on February 20th, 2021. https://theconversation.com/plastic-warms-the-planet-twice-as-much-as-aviation-heres-how-to-make-it-climate-friendly-116376.

Yang, D., Shi, H., Li, L., Li, J., Jabeen, K., Kolandhasamy, P., 2015. Microplastic pollution in table salts from China. Environ. Sci. Technol. 49(22): 13622−13627.

Zheng, J., Suh, S., 2019. Strategies to reduce the global carbon footprint of plastics. Nat. Clim. Chang. 9: 374–378.

Zhu, X., 2021a. Plastic is part of the carbon cycle and needs to be included in climate calculations. Accessed February 28th, 2021. https://theconversation.com/plastic-is-part-of-the-carbon-cycle-and-needs-to-be-included-in-climate-calculations-154730.

Zhu, X. 2021b. The Plastic Cycle – An Unknown Branch of the Carbon Cycle. Frontiers in Marine Science. 7: 1227.