



Governing Outer Space as a Global Commons: Examining 'Tragedy' in Orbital Medium

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Name: Besir Suleyman OZ

Number: OZXBES001

Supervisors: Professor Elrena Van der Spuy

Associate Professor Cathleen Powell

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Abstract

The purpose of this research is to examine the outer space governance regime and to identify key governance deficits which are arguably the main reason for the far-reaching proliferation of space debris in the outer space commons. To this end, the research initially inspects two of the existing global commons – the maritime and polar regions – their governing regimes, and the regulatory, legal, and political challenges encountered in each. The discussion on the connection between global governance deficits and the environmental tragedies within these domains aims to establish the conceptual foundation of this study. Based on this foundation, the research discusses legislative and regulatory dimensions of outer space governance and international responses to the challenges facing the outer space commons. It concludes with the examination of the space debris problem and potential policy responses to address this global environmental tragedy. In this regard, in the light of Ostrom’s design principles, an international treaty on space environment protection, a financial programme in managing the cost of debris removal programmes and maintenance of spatial resources, and an international space agency to coordinate these fields and provide substantial cooperation between space actors, are offered as fundamental steps to prevent the tragedy in outer space – the common heritage of mankind. Therefore, this research intends to contribute to the understanding of the space debris problem and its consequences for global welfare.

List of Abbreviations

| | |
|---------------|--|
| ADR | Active debris removal |
| AMAP | Arctic Monitoring and Assessment Programme |
| ASAT | Anti-satellite |
| ATS | Antarctic Treaty System |
| ATCM | Antarctic Treaty Consultative Meetings |
| CCAMLR | Commission for the Conservation of Antarctic Marine Living Resources |
| CD | Conference on Disarmament |
| CHM | Common heritage of mankind |
| CLCS | Commission on the Limits of the Continental Shelf |
| COPUOS | Committee on the Peaceful Uses of Outer Space |
| COSPAR | Committee on Space Research |
| CPLA | Committee, Policy and Legal Affairs Section |
| EEZ | Exclusive Economic Zone |
| ESA | European Space Agency |
| ESPI | European Space Policy Institute |
| EU | European Union |
| FAO | UN Food and Agriculture Organisation |
| GNSS | Global navigation satellite systems |
| GSO | Geosynchronous Orbit |
| IADC | Inter-Agency Space Debris Coordination Committee |
| IAATO | International Association of Antarctic Tour Operators |
| ICG | International Committee on Global Navigation Satellite System |
| IMO | International Maritime Organisation |
| ISA | International Space Agency |
| ISA | International Seabed Authority |
| ISS | International Space Station |
| ITU | International Telecommunication Union |
| LEO | Low Earth orbit |
| MEO | Medium Earth orbit |

| | |
|-----------------|--|
| NASA | National Aeronautics and Space Administration |
| NOAA | National Oceanic and Atmospheric Administration |
| OLA | UN Office of Legal Affairs |
| OSPAR | Convention for the Protection of the Marine Environment of the North-East Atlantic |
| OST | Outer Space Treaty |
| UN | United Nations |
| UNCLOS | United Nations Convention on the Law of the Sea |
| UNEP | UN Environmental Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| UNSPIDER | United Nations Platform for Space-based Information for Disaster Management and Emergency Response |
| UNOOSA | United Nations Office for Outer Space Affairs |
| US | United States |

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1. Introduction

1.1. Background

As the globe becomes more interdependent, the governance of the global commons is of great importance for achieving sustainable and secure development. In addition, deepening financial, political, and cultural globalisation has boosted the level of activities in the global commons. Hence, better consistency, coordination, and collective action at the international level, based on the international standards and laws developed by international bodies, are essential in establishing effective global governance regimes. However, national, regional, and international arrangements and policies have not kept pace with these global activities.

Governance of the global commons constitutes a particular feature of international environmental governance and it has been conventionally identified as those fields of the world that fall outside national authority and to which all states have access (OHCHR, 2013). International law identifies global commons as the oceans and high seas, Outer Space, the Atmosphere, and the Polar Regions (OHCHR, 2013). These resource fields are guided by the notion of the shared heritage of humankind. More recently, reserves of interest or assets to the prosperity of the societies of nations – such as biodiversity, groundwater, and rain forests – have been added to the conventional global commons. However, some define the commons even more comprehensively to include cyberspace, information, and peace (David, 2000).

The World Conservation Strategy defines the commons as *“a tract of land or water owned or used by the members of a society, and it comprises the open oceans, the atmosphere, Antarctica, and the resources originate within these areas”* (WCS, 1980, p. 52). Similarly, according to the United Nations (UN), the ‘Global Commons’ refers to *“resources and territories beyond any state’s appropriation and political hegemony”*, and it categorises the global commons as the High Seas, the Atmosphere, Antarctica, and Outer Space (UNEP, 2015). In addition to their geographical and conceptual differences, these arenas, particularly outer space and the oceans, share many common features. They are both joint supranational territories where national armed forces cannot settle and subsist (Brown, 2012).

Historically, accessing the resources discovered within these territories (such as the ocean floor) has been challenging, but the potential resource yields have been plentiful. Yet, the progress of technology and science during the 20th and 21st centuries and the intensified

demand for resources have led to a rise in activities in the global commons, such as aviation, flight, navigation, fisheries, drilling, bioprospecting, scientific research, and the placing of submarine cables. Meanwhile, our planet is confronting large-scale, inter-related environmental and security problems, such as global warming, orbital debris, climate change, militarisation of space and the high seas, and rapid environmental degradation in the Arctic regions. If these problems prevail, the conditions are likely to deteriorate. Ultimately, this will have negative impact on the global commons' function to deliver various ecological benefits for human welfare.

The international community recognises the necessity to preserve these resource domains for international peace and stability. A number of international conventions and agreements aimed at governing the global commons have been implemented. These efforts include the United Nations Convention on the Law of the Sea (UNCLOS) of 1982; the Treaty on Principles governing the Activities of States in the Exploration and Use of Outer Space (OST) of 1967; the Antarctic Treaty System (ATS) of 1959 that aimed at ensuring the preservation and protection of the Antarctic flora and fauna; a collection of international environmental conventions that focus on the protection and administration of the atmosphere and various pollution and depletion related problems, such as the Montreal Protocol on Substances that Deplete the Ozone Layer and the United Nations Framework Convention on Climate Change (UNFCCC) of 1992.

Although the nature and structure of these commons are different, common theoretical and practical approaches can be used when they are evaluated and regulated under the realm of the global commons. It is therefore necessary to establish a common governance method in such environments where the concept of communalism is imperative. Hence, over the years, attempts have been made to regulate the above-mentioned regions through a common sense of governance. However, as Shearing and Wood emphasise, such regime efforts have contended with a number of "governance deficits", namely "deficits in community self-direction, deficits of community capital and of regulation" (Shearing & Wood, 2003, p. 207). These deficits result in imbalances in the determination of, and access to, common assets. They are also the main cause of the absence of effective regulation and governance (Shearing & Wood, 2003). These deficits lead to the so-called "tragedy" of the commons, as outlined by

Garett Hardin (1968). This “tragedy” includes overfishing and pollution in the oceans, meltdown in the polar regions, and debris in outer space.

1.2. Problem Statement

Since the launch of Sputnik in 1957, there have been thousands of spacecrafts launched. As a consequence, excessive amounts of debris have been left in the Earth orbit. This debris generally consists of abandoned and non-operational satellites, upper stages of the launchers that used to deliver spacecraft, fragmented debris that are produced as a result of collisions in space, and fragments created by explosions during ASAT tests (Alby, 2015). According to NASA, the number of trackable space debris is more than a half million, and they travel at speeds of up to 8 miles per second in Earth orbits (Garcia, 2013). At that velocity, space debris can pose various threats both on the ground and in orbit. The primary danger of space debris lies in the possibility of further collisions and the resulting operational problems in active spacecrafts, space shuttles or space stations. Due to its hyper velocity, even a small collision can cause catastrophic results in space. As Garcia (2013) argues, debris as small as one centimetre is capable of penetrating components of the existing space station. Moreover, as Donald Kessler argues, a collision in space can become a self-sustaining collision which generates thousands of extra debris by colliding into other space objects (Kessler & Burton, 1978). Although covering a wide-range of issues concerning outer space, the OST regime has not managed to provide effective governance and control nor has it managed to establish collective action between space-faring states. Therefore, the international community fails to prevent the so-called “tragedy” in space, with some, such as Lawrence Roberts (1992), arguing that the regime is partly responsible for creating the “tragedy”.

1.3. Research Objective

The purpose of this research is to examine the outer space governance regime and to identify key governance deficits which are, as argued here, the main reason for the far-reaching proliferation of space debris in the outer space commons. To this end, the research initially inspects two of the existing global commons – the maritime and polar regions – their governing regimes, and the regulatory, legal, and political challenges encountered along the way. The discussion on the connection between global governance deficits and the environmental tragedies within these domains establishes the conceptual foundation of this study. Based on this foundation, the research discusses legislative and regulatory dimensions

of outer space governance and international responses to the challenges facing the outer space commons. It concludes with the examination of the space debris problem and potential policy responses to address this global environmental tragedy. Therefore, this research intends to contribute to the understanding of the space debris problem, its consequences for global welfare, and fruitful avenues for addressing its challenges.

1.4. Theoretical Framework

In this discussion the researcher draws on the conceptual ideas of Garrett Hardin's "The Tragedy of the Commons" (1968). His model engages with the ultimate overexploitation or degradation of open resources used in the commons. Proceeding from an economic model of a shared resource system where he sees irresponsible exploitation contradicts the common good and results in environmental destruction, which he refers to as "the tragedy" (Hardin, 1968). Although Hardin focused on the issue of overpopulation and its consequences, the dominant legacy of his work has been the concept of common property resource management (Feeny, et al., 1990).

The Tragedy of the Commons has been subject to comprehensive discussion in relation to global environmental issues. For instance, Erin A. Clancy discussed the case of open seas and the importance of sustainable development in preserving the global commons (1998), Stephen Gardiner again focused on the case of climate change and the effects of global agreements (2004), Scott Ervin (1984) explored the case of outer space, and studies were also conducted on the impact of technological developments on the public knowledge commons (David, 2000). For purposes of this enquiry, the researcher focuses on the issue of space debris as an environmental tragedy within the outer space commons. As part of this discussion, two of the most prominent global commons and the tragedies therein are examined, in order to identify commonalities between outer space and terrestrial commons.

To avoid these tragedies, Hardin (Hardin, 1968) suggested that the commons should either be privatised or managed as public property so that the rights of use and access could be allocated. A decade later, he offered two solutions for preserving the commons; namely *private initiatives* and/or *socialism* where publicly-owned property managed by a central authority (Hardin, 1978). He argued that these are the only ways for sustaining and preserving the commons. The basis of privatisation of the commons emerges as opposed to the Locke

model of governance and the prohibition of private property. Similar to Hardin, classical liberals argue that the solution to the tragedy of the commons was privatising resources by allowing individuals to acquire property rights vis-à-vis the commons. Robert Smith also supported the idea of privatisation in order to enforce an effective and sustainable regime in the commons (Smith, 1981). This research on the other hand argues that preventing the large-scale tragedies is only possible when private, commercial, state-centred, and international community entities cooperate and establish norms, institutions, and a system of international relations that can integrate global changes. In this regard, Elinor Ostrom's design principles (2010) (2003) are elaborated within the context of global commons governance to provide a polycentric system that is most capable of dealing these tragedies, particularly the tragedy in outer space.

Hardin's ideas were criticised by various scholars, Jensen in particular claimed that the tragedy of commons was used as a justification for privatisation and private ownership (Jensen, 2006). Partha Dasgupta also criticised Hardin's work as historically ill-informed for not considering the "demographic transition" and for neglecting to differentiate between common property and open-access resources (Dasgupta, 2001). Similarly, Carl Dahlman argued that the economic model espoused by Hardin was weak in historical terms as it misrepresented the successful common property usage models in history (Dahlman, 1991). Furthermore, he emphasised Hardin's negative approach regarding the roles of values and ideals in finding a solution to issues in common resources within local communities. Keith Stewart again argued that the tragedy could not be averted by privatising the commons as the very nature of governance was embedded in a strong public domain (Stewart, 2001). Instead, he argued in favour of expanding the role of public domain in environmental governance. This, he thought was a prerequisite for effective mechanisms so as to avert tragedies in the global commons (Stewart, 2001).

Ostrom argued that Hardin's idea of the tragedies of commons is correct but not unavoidable. She argued that, in order to prevent the tragedy, global institutions needed to be established or reregulated to overcome rising global challenges that face humanity (Ostrom, et al., 1999). She also proposed (Ostrom, et al., 2003) a system based on global attempts as well as collective action, to cope with the global environmental change, particularly with the emission of greenhouse gases (Ostrom, 2010). Similar approaches can be facilitated in avoiding the

tragedy in global commons. Sadeh too argued that preventing this tragedy requires either a main governing authority to create rules, verify compliance, and take action against violations, or less formal forms of self-regulation and self-restraint to secure sustainability of the space environment (Sadeh, 2015).

Despite the myriad proposals offered by scholars, various challenges confront the governance of global commons. The structures dealing with the global commons are complex and argued to be broken. Many of the previous agreements have not kept up with environmental changes and are out of date, and do not comprehensively deliberate the consequences of human activities on global environmental security, ecosystems and other vital aspects. In addition, many recent activities do not have specified frameworks to be governed in accordance with international rules and standards. For instance, in the international waters, bioprospecting is not entirely controlled by UNCLOS, and various activities like deep-sea mining and research are expected to increase in the near future. Moreover, similar activities in outer space, such as asteroid mining and space tourism are yet to be legally identified and regulated.

1.5. Research Question

The governance of the global commons encompasses a complex structure of political and legal affairs, thus the defining feature of the first question of this research must be far-reaching. Therefore, the first question aims at examining the key characteristics of global maritime and polar governance in legal and institutional dimensions. This examination includes the existing institutional and regulative arrangements as well as the challenges emerging from the activities of governing in these domains. The second question focuses on outer space governance and security, and the issue of space debris. It is practically inconvenient to address these issues within the same question. Therefore, it is necessary to have additional sub-questions to address these inter-connected issues adequately. The research questions can be formulated as follows:

- a)** How are global commons governed and what are the key challenges confronting governance?
 - a1)** How has the international community responded to the challenges confronting the governance of global commons?
- b)** How is outer space governed?

b1) What does security mean for outer space governance?

b2) How has the international community responded to a growing space debris threat in the orbital environment?

The second chapter of this research is dedicated to answering the first two questions which are twofold as it refers to the nature of global commons governance as well as challenges that emerge from governing measures. Global commons in this regard refers to the ocean and polar governance regimes which host the largest commercial, economic, and political activities of the global commons.

Chapters 3 and 4 engage the remaining three questions. Moreover, they aim to provide a more comprehensive analysis of governance including analysis of its legal framework and institutional structure. The reason for emphasising the term *security* in the latter is that it is historically and politically significant to the understanding of cooperation in outer space as well as providing an important perspective in offering appropriate solutions to the challenges concerning environmental security in space.

1.6. Research Approach

The research questions are explored through a desktop analysis of available research. The literature includes academic sources, policy papers and reports, legal documents, various online resources, as well as other forms of grey literature. The sections related to the governance structure of determined domains are mainly conducted based on the information received from grey literature, namely online resources, institutional regulations, and reports. Existing literature on the global commons governing regimes are subject to detailed review and analysis. In this regard, the study also uses an explanatory research method in providing the historical and institutional background of a number of organisations. This information, including international legally binding and non-binding agreements, principles, declarations, codes of conducts, guidelines, and other measures were obtained through online resources such as UN websites, and evaluated in terms of their feasibility and compatibility with the research structure.

With respect to sections on the challenges occurring within the given commons regimes, the research utilised journal articles and various online resources. The research questions in this minor dissertation are of a truly interdisciplinary nature. It involved complex environmental

issues which had to be considered both from ecological and legal perspectives. For instance, in the second chapter, the ecological literature is harnessed in analysing problems such as ocean acidification and arctic melting. The sections exploring environmental tragedies interlink the ecological and scientific literature with legal and political discussions as well as existing initiatives to address these environmental tragedies. Policy initiatives from various national, regional, and international organisations also had to be considered in the final sections of every chapter.

The main reason for choosing this method is because it offers an appropriate approach to answer the given questions with respect to global commons and outer space. Yet, the selected topic and the research method posed various challenges to the researcher throughout the study, and these are considered in the next section.

1.7. Limitations

The research topic presented various challenges given its very complex and inter-related disciplinary nature. First of all, as the research topic was broad, it required a wide and comprehensive literature scan. In addition to legal and political discussions on the global commons subject, the area of environmental security further broadened the scope of this research. In the initial phase, the researcher considered and included cyberspace and the atmosphere as two of the global commons emphasised in the second chapter. The purpose of having such a broad focus was to provide a comprehensive foundation for the discussion on the outer space commons. Before long however, it became clear that reflecting institutional, legal, and political developments within so many different domains had shifted the focus of this study and resulted in a conceptual disorder. Therefore, only two of these global commons (the oceans and polar regions) have been subject to discussion to narrow down the research focus and prevent conceptual proliferation.

Secondly, the research is comprised of legal, political, and environmental discussions and information. Each of these issues has given rise to numerous research debates and data across many disciplinary fields. Thus, providing a theoretical foundation in order to link these disciplines and to demonstrate a common understanding of the matter was quite a challenging task. Given the researcher's law enforcement background, lack of training in the fields of international law and natural science has also been an obstacle the research had to

contend with. Moreover, investigating new global domains, other than outer space, and their legal and environmental state has been quite challenging. The researcher experienced a substantial lack of prior research, particularly with regards to legal and scientific aspects of other global commons. However, the researcher attempted to address this particular challenge by attending various courses before drafting this research.

This research enquiry focuses on the nature of and challenges confronting the governance of the global commons. This requires that the concept of governance is considered and theoretical approaches to governance briefly considered. Yet the lack of training on the theoretical side of governance required further research in the field. By incorporating various literature, the researcher has attempted to address this issue.

1.8. Conclusion

The stability and sustainability of the global commons and particularly the outer space commons are critical to the provision of international security. However, there have always been difficulties with respect to governing and regulating these commons. These difficulties, in general, have resulted in growing environmental, political and legal crises that directly affect international stability. Space debris, in particular, is the most emergent environmental crisis that endangers space assets and the sustainability of the space environment. Even though there are a number of promising responses to the problems posed by space debris, effective mechanisms to implement these responses are yet to be established. It is, therefore, necessary to investigate the deficiencies associated with existing prevention measures taken by the international community and to analyse similar practices employed in other global commons. At this juncture, this research initially aims to illustrate the nature of governance of global commons, as well as the inadequacies within these governance regimes that led to various environmental tragedies. To this end, in chapter 2, the study purposes to provide an extensive analysis of legal and policy implications of existing problems in maritime and polar regimes. Based on this extensive foundation, in chapter 3 and 4 it discusses outer space governance and the issue of space debris. In chapter 5 it concludes with conceptual discussions and policy proposals founded on the principles provided by Elinor Ostrom. Within this chapter, the researcher has attempted to provide a theoretical and pragmatic background for this research by examining the global commons regimes and the concept of the tragedy of the commons concept.

2. Governing Security in Global Commons

This chapter reviews the nature of the existing global regimes governing the commons, and their limitations. Present issues threatening the security and sustainability of these domains will be identified and assessed, including their significance for global and environmental security. The previous, present, and future mitigation efforts and prevention policies and initiatives from the international community will be discussed. Finally, an overall evaluation and illustration of the literature on this matter will be offered. Even though the security focus in this chapter is predominantly based on environmental concerns, it is important to emphasise that environmental security is interconnected with economic, social, and military security within these domains. Therefore, the chapter will cover a truly multidisciplinary topic, including legal, ecological, and political aspects, to provide an overview of key facets of governance of the global commons.

2.1. Maritime Regimes

2.1.1. Law of the Sea

The ocean is one of the classic global commons and the primary avenue for international trade since ancient times. Norms and rules for governing access and use of the oceans have developed and changed over time (Stang, 2013). Only very recently has there been an international body of governance established to control activities of states in the oceans. The UN Convention on the Law of the Sea (UNCLOS - 1956) is the primary international treaty that governs the relationships between states with respect to boundaries, navigation, and coastal water jurisdictions. The convention was opened for signature only in 1982 and came into force in 1994 (UNCLOS, 2013). Although this is relatively recent, it is based on centuries-old practices, customary laws, and fundamental principles such as freedom of the seas (Economist, 2014).

The UN convention itself is very comprehensive. Its main focus is on dispute resolution (Clancy, 1998). The objective of UNCLOS, as summarised in its foreword, is to create “a legal order for the seas and oceans which will facilitate international communication, and will promote the peaceful uses of the seas and oceans, the equitable and efficient utilisation of their resources, the conservation of their living resources, and the study, protection and preservation of the marine environment” (UN, 1982). The convention included the

responsibilities and rights of each state with respect to natural resources within the limits of their sovereignty as well as within international jurisdiction (Clancy, 1998). In other words, it created new regional boundaries both in sovereign and in international waters. UNCLOS also established central legislative and judicial bodies to implement the rules and principles of its provisions (Treves, 1998).

On paper, UNCLOS appears to be a substantial step towards peaceful, secure, and sustainable waters for the nations of the world. However, in practice, it has achieved far less than it aspired to. The provisions and the amendments of the treaty have failed to preserve the common areas. Moreover, some of them served to contradict the principle of “common heritage of mankind”, the very theory that the convention is inspired by. Ultimately, the convention’s shortcomings have made possible over-exploitation, which caused significant degradation and deterioration of common resources (Clancy, 1998) resulting in the tragedy of the maritime commons.

2.1.2. Jurisdictional Encroachment – Exclusive Economic Zone

In terms of its jurisdictional approach, UNCLOS sets out two levels of jurisdiction in order to establish territories and states’ responsibilities and rights within them. The first degree of jurisdiction is the “Territorial Sea”, where states maintain sovereignty in coastal waters up to 12 miles from their coastlines (UN, 1982). The second is the “Exclusive Economic Zone” (EEZ), where states enjoy the right to extract resources up to 200 miles from their coasts (Denmark, 2010). The EEZ constitutes roughly 35 per cent of the entire ocean space and covers more than 90 percent of all exploitable fish supplies (Dux, 2010). This “jurisdictional encroachment”, as referred to by Erin Clancy, causes a number of serious consequences (Clancy, 1998).

Firstly, even though states have no absolute sovereignty over the EEZ, it causes a particular threat to the marine commons as it grants somewhat sovereign rights to the coastal state for exploiting the living and non-living resources therein, as well promoting maximum exploitation (Wijkman, 1982). In fact, most of the ecological problems within the maritime commons originate from the EEZ (Economist, 2014). These include acidification and pollution that derive from the land and the 200-mile limit. According to National Oceanic and Atmospheric Administration (NOAA), roughly 1.4 billion pounds of trash enter the ocean

annually (NOAA, 2011). Moreover, irresponsible and ill-regulated offshore drilling creates various forms of pollution that have negative impacts on the marine ecosystem as well as on human life (OCENA, 2016). The concept of the EEZ also endangers specially protected marine species and habitats (Dux, 2010). The convention falls short in addressing these problems. Partly, this is because it is inadequate in terms of conservation since most of the convention was negotiated in the 1970-80s when these issues were rarely taken into account (Economist, 2014). It also has no means to apply sanctions or enforce them accordingly. Another reason is that the states that play a very active role within the EEZ, such as the United States (US), refuse to sign the convention.

Secondly, existing arrangements of the EEZ are being abused by the rise of maritime actors who are increasingly using their naval forces to impose permanent claims over disputed waters (Denmark, 2010). China's claim over the artificial islands in the South China Sea is a striking example, where its actions pose drastic consequences for the legitimacy of the convention, as well as for regional security and stability. The implications of China's understanding also result in an extremely problematic practice for other disputed maritime commons (Johnson, 2014). Yet, the Chinese government claims that other states must receive authorisation before entering its EEZ, whereas, as indicated in UNCLOS, the EEZ remains a global waterway which other parties are able to traverse freely (UN, 1982).

The EEZ has always been a source of dispute amongst states over maritime waters. The Cod Wars between the UK and Iceland over the fishery stocks is a well-known example of such conflicts (Mitchell, 1976). The dispute over the Svalbard island between Russia and Norway or the crisis between Eastern Mediterranean countries over the discovered oil and gas reserves are also two of the critical cases in this regard (Stocker, 2012). These conflicts affect the economic, energy, and political security of countries involved, as well as indicating the significance of UNCLOS's EEZ encroachment.

The implications of the EEZ provisions of UNCLOS causes practical challenges in dealing with other problems in open waters, such as piracy. According to the Statistics Portal, 4,837 incidences of piracy have been reported since 2009 (Statista, 2017). Even though UNCLOS sets out a legal framework applicable to preventing piracy, it remains insufficient in the application of a consistent penal code in the seizure, arrest and prosecution of pirates captured on the EEZ. It has also not succeeded in establishing a universal exercise of jurisdiction within the

EEZ, or in providing a framework to address practical problems such as transferring of suspected pirates for prosecution (Surbun, 2010).

2.1.3. UNCLOS on the High Seas

In terms of its approach to the high seas, UNCLOS considers international waters, including living and non-living sources and the ocean bed as free and excluded from the EEZ (UN, 1982). This means that the common areas are governed according to the principle of the common heritage of mankind (CHM), and the benefits obtained therein are vested to all nations of the world. The convention also specifies that the “high seas shall be reserved for peaceful purposes” and activities shall be conducted in a way that promotes development and cooperation for international relations and trade (UN, 1982). These activities include a number of traditional uses (fishing, telecommunication, military manoeuvres, and scientific research), as well as emerging modern activities such as ocean bed mining.

In the light of these provisions, it is clear that the main focus in international waters is not preservation, but exploitation. The convention not only promotes uncontrolled economic growth, but also feeds into controversies in common waters. Such unrestricted economic growth demands natural resources, which can be extracted through the abuse of maritime commons. In turn, an unprecedented chain reaction causes various ecological, political, and regional security problems. In some cases, ecological issues directly evolve into political crises.

For instance, with the rapid melting of ice in the Arctic region (due to irresponsible consumption of fossil fuels and deforestation), the long-inaccessible territory becomes more accessible for economic activities such as fishing, mining, oil/gas production, and shipping (Foizee, 2016). Hence, the area is becoming increasingly attractive to industrial powers. In addition to Arctic states, many other non-Arctic actors, including China, are now in a rush to exploit the Arctic’s resources (Ross, 2017). Consequently, some of the Arctic countries are shifting towards militarisation in order to claim their so-called share. The regulations provided by the existing framework fail to oversee and counter the increased attention and militarisation of the Arctic. A new agreement is required, which includes specific regulations for establishing coordination, security, and stability in the region (Emmett & Stuhltrager, 2011).

While the Arctic ice melts, the condition of the high seas is worsening. According to the UN Food and Agriculture Organisation (FAO), more than 85 percent of the world's fisheries were being exploited beyond their sustainable limits (FAO, 2014). Besides overfishing, pollution is an ever-growing problem for the marine ecosystem. It is estimated that the ocean will contain 1 tonne of plastic for every 3 tonnes of fish by 2025, and by 2050 there will be more plastic than fish in the high seas (MacArthur, 2016). In addition to pollution, the accumulation of carbon dioxide in the atmosphere increases the acid levels of ocean water and harms global reef habitats (Caldeira, 2016). Finally, there is a rising trend in deep sea mining that could pose serious environmental risks and consequences for marine ecosystems over immense ocean areas (Kraniotis & Griffis, 1996). Unlike in the EEZ case, the high seas cannot be preserved by assigning sovereign rights over them. Under international law, all marine resources are open to all nations due to the CHM principle. Therefore, international rules and institutions determine the state of the marine commons. However, UNCLOS and its related institutions fail to address emerging problems.

2.1.4. Tackling the Tragedy

Under the auspices of the United Nations, the UNCLOS has established a number of administrative and regulatory conventions and institutions to govern sectoral activities in the oceans, such as fisheries, ocean bed mining and shipping. To this end, specialised bodies and agreements have been established to accommodate the gaps in the treaty. For example, the UN Fish Stocks Agreement of 1995 aimed to provide a framework for cooperation in the conservation and management of fishery stocks (UN, 2013). The International Seabed Authority (ISA) was established in 1994 to organise and regulate mining activities beneath international waters (ISA, 2017). Although, it has not yet been tested, ISA is more up-to-date than most of the international mining protocols. The Commission on the Limits of the Continental Shelf (CLCS) meets twice a year in order to facilitate the implementation of UNCLOS and to offer recommendations on the matters related to continental shelf limits (CLCS, 2012). Finally, the International Tribunal of the Law of the Sea was established as an independent judicial body to adjudicate disputes occurring as a result of the interpretation and implementation of the Convention (ITLOS, 2017).

Such agreements notwithstanding, there is insufficient interaction between these bodies. Unlike many other global agreements established in the past several decades, UNCLOS does

not have a separate secretariat tasked with monitoring its implementation. It also has no built-in compliance instruments to observe the performance of states and apply sanctions when necessary (GOC, 2015). In addition, in most cases UNCLOS depends on existing organisations for enforcement and monitoring (Economist, 2014). The International Maritime Organisation (IMO), for instance, operates a regulatory framework for international shipping activities. It created a universally adopted forum that is responsible for not only the safety and security of shipping but also the prevention of marine pollution through shipping activities (Oxman, 1995). The UN Environmental Programme (UNEP) provides global and regional assessments and reports on ecological and environmental matters. The UN Office of Legal Affairs (OLA) supports UNCLOS in promoting and strengthening implementation of the international legal order for the high seas. Many other UN institutions and conventions, mandated to regulate respective sectoral activities, are affiliated or related to UNCLOS. In terms of enforcement, UNCLOS continues to depend on the principle of “flag state responsibility”¹ as the default position (GOC, 2015).

Over time, international ocean governance has become a “bewildering proliferation of authorities, often with competing and overlapping mandates but for the most part lacking any real regulatory or enforcement power” (GOC, 2015). At the international level, as Klein argues, accountability is inadequate and states are almost free to operate outside of rules and measures (Klein, 2014). Transparency and compliance-monitoring are inadequate, and very few instruments evaluate or control the cumulative effects of various industrial involvements on the ocean environment. It is obvious that the risks facing the oceans today are global and ever more serious. International cooperation is crucial to overcome these problems (GOC, 2015). However, the current governance system for the high seas is not effective and does not offer a promising long-term sustainability agenda. In this context, the ocean commons exemplify the “tragedy of the commons”, where individual users abuse a commonly owned property for their short-term interests, but actually harm their own long-term interests as a result. The ocean version of this tragedy will not be restricted to a limited body of water of water but rather leads to a never-ending circle of destruction to the entire ocean ecosystem, and consequently the whole planet.

¹ Flag state responsibility refers to the principle that all ships must be registered under a national, flag and are subject to the legal jurisdiction of that country on the high seas. Article 91 of UNCLOS

2.1.5. Final Remarks on UNCLOS

The major consensus in the literature is that the convention is inadequate – like other international governing bodies for commons – in solving the environmental and security issues like pollution, conservation, overfishing, and various challenges in the international waters and polar regions (Stang, 2013). Churchill discusses how the convention fails to provide efficient governance and leadership primarily due to continuing non-compliance with many of its provisions. He further stresses that the degree of non-compliance destabilises the reliability and legitimacy of the convention (Churchill, 2012). Johnson also emphasises the growing problem of non-compliance with UNCLOS by highlighting the problems in the Arctic region and in the South China Sea (Johnson, 2014).

In contrast, some other scholars claim that UNCLOS has empirically been confirmed to be successful (UNCLOSDEBATE, 2015). These claims mainly revolve around the consistency of states' practices over the provisions. For instance, Kraska claims that UNCLOS has already proven itself as a strong instrument that provides public order to the maritime realm (Kraska, 2007). Groves also argues that the convention brought consistency to states' actions with respect to navigation provisions (Groves, 2012). There are various approaches to the international water regime in the literature. Nevertheless, the literature predominantly tackles the regime's weak control mechanisms, and the issue of non-compliance. Even though the sea regime possesses unique peculiarities and challenges, it mainly poses familiar problems in its provisions with respect to issues of sustainability, compliance, accountability, and liability for international cooperation and governance.

Despite these shortcomings, institutionally and historically, the sea regime indicates a prominent and strong posture in relation to other commons regimes, and it may constitute an example for governance of other global commons, particularly the outer space commons. As Zhao argues (Zhao, 2004), the problems that the international community aimed to resolve over the open seas have the potential to function as a source for relevant arrangements and agreements for outer space governance. Jonathan Thomas argues that the UNCLOS regime presents the most viable legal model for outer space since many of its provisions regarding territorial regions of seas, military and environmental use, and jurisdictional matters are applicable to, and convenient for, the space medium (Thomas, 2005). He further claims that the UNCLOS provisions on environmental protection and risk evaluation offer models for

preserving and sustaining the outer space environment. Yet, as mentioned before, no effective solution has thus far been provided by UNCLOS for the environmental problems of the oceans.

2.2. Polar Regimes

2.2.1. Arctic Region

Even though there is currently no universally recognised definition for the spatial extent of the marine Arctic, the international community considers the marine areas north of the Arctic Circle as the marine Arctic areas (Weidemann, 2014). According to the Arctic Monitoring and Assessment Programme (AMAP), the international marine boundary in the Arctic is between 60°N and the Arctic Circle (AMAP, 1997). AMAP also establishes a circumpolar region as a focus for its evaluation activities, which includes both the high and sub-Arctic regions. The Arctic region is surrounded by the territories of eight countries, namely, Canada, Denmark, Iceland, Finland, Norway, Russia, Sweden and the U.S. However, this section will only focus on the areas not falling under national jurisdiction.

The Arctic marine environment is subject to several governance systems (Koivuro & Molenaar, 2010). Fundamentally, UNCLOS and the provisions of its CLCS apply to the entire Arctic area and have been ratified by all Arctic states except the US. UNCLOS defines and determines the boundaries of states' jurisdiction in the Arctic waters and establishes the limits of territorial and EEZ boundaries (Berkman & Young, 2009). However, as of September 2017 only the Russian Federation and Norway have made submissions to the CLCS with respect to their continental shelves that rest within the Arctic Marine field (Koivuro & Molenaar, 2010). In addition to the convention, as parts of the international sea law regime, the Deep-Sea Mining Agreement and the Fish Stocks Agreement also apply to the marine environment of the Arctic.

A number of international regulatory organisations emerge in the Arctic marines, such as the IMO which sets out a guideline concerning the Arctic climate² for ships operating in the territory. The Northeast Atlantic Fisheries Commission has adopted measures to preserve the marine ecosystem in the Arctic Basin. The Convention for the Protection of the Maritime Environment of the North-East Atlantic of 1992, which concentrates on environmental

² Guidelines of Ships Operating in Ice-Covered Arctic Water 2002

preservation and pollution, is also applicable to a significant portion of the Arctic Ocean (Berkman & Young, 2009). Moreover, most of the international instruments, whether they are legally binding or non-binding, related to main sectoral focuses such as fisheries, shipping, and scientific research are also applicable to marine territories in the Arctic. The most significant of these are the Fish Stocks Agreement, FAO Compliance Agreement, and IMO's mandates which are primarily focused on maritime safety and security (Koivuro & Molenaar, 2010).

The Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Convention) includes a number of fundamental rules and instructions for international cooperation with respect to environmental protection in the North-East Atlantic (OSPAR, 2015). It is the current legislative instrument, which is a combination of the Oslo Convention of 1972 and the Paris Convention of 1974, and is enforced by 15 governments and the European Union (EU) (Koivuro & Molenaar, 2010). The significance of the OSPAR Convention is that it can adopt measures and plans in the form of legally binding decisions, agreements, and non-binding recommendations (OSPAR, 1992). As stated in its preamble, the ultimate goal of the OSPAR Convention is "to prevent and eliminate marine pollution and to achieve sustainable management in the region" (OSPAR, 1992). In line with this objective, the OSPAR Commission is supported by five main committees with different sectoral focuses, such as Offshore Industry, Biodiversity, and Radioactive Substances (OSPAR, 2015). Finally, the OSPAR Commission assists other intergovernmental and non-governmental organisations in adopting strategic and effective measures to achieve cooperation with a strong emphasis on ecological sustainability and security (Koivuro & Molenaar, 2010).

As a leading intergovernmental body fostering cooperation, organisation, and interaction between the Arctic states, the Arctic Council plays a significant role in the region (ArcticCouncil, 2017). All the Arctic states are members of the Council. Observer status in the Council is available to non-Arctic states, along with other international and regional non-governmental and intergovernmental organisations. In addition, a unique characteristic of the Council is the function it gives to indigenous peoples living within the region (Koivuro & Molenaar, 2010). Six different indigenous communities³ within the region have permanent

³ Namely, Aleut, Athabaskan, Gwichin'in, Inuit, Saami and the Russian indigenous peoples

participant status in the Council and it is a requirement that they be consulted with prior to any decision-making (Koivuro & Molenaar, 2010) (ArcticCouncil, 2017).

The Arctic Council is a non-governmental forum that was established as a non-legally binding declaration, and consequently does not have the authority to impose legally binding measures on any of its members or observers (ArcticCouncil, 2017). Although the Council does not have such a regulatory authority, it has accomplished considerable success in producing policy assessments and recommendations by means of its Working Groups (Berkman & Young, 2009). Besides bringing Arctic matters to the attention of international forums, the Council has also served as a setting for the development of a number of legally binding agreements between Arctic states, such as the *Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic* of 2013 and the *Agreement on Enhancing International Arctic Scientific Cooperation* of 2017 (ArcticCouncil, 2017).

Challenges in Arctic Governance

First of all, the current regime of the law of the sea and its sub-agreements is an extensive international legal framework that applies to all marine territories in the world. In many cases, the provisions of the convention are mainly enforced by member countries or through other international organisations. This, in turn, often results in inadequacies in implementing regional measures that allow for taking proper account of the various Arctic characteristics. These failures have been implicitly acknowledged by the Arctic member countries in the Ilulissat Declaration (2008). This is because of the Arctic region's unique ecological, environmental and political significance, which requires specific fisheries management, shipping management, marine environmental protection, and so on.

Moreover, alongside UNCLOS, the Deep-Sea Mining Agreement and Fish Stocks Agreement are the cornerstones of the existing marine law regime (Weidemann, 2014). However, there are fundamental organisational and regulatory gaps within their structure. The regime does not have an efficient regulatory body to control several existing maritime activities, such as seabed construction, artificial islands, and military activities in the Arctic (Koivuro & Molenaar, 2010). It also falls short in providing default regulatory mechanisms for emerging activities, such as tourism, development of oil and gas technologies, and floating structures in the Arctic waters. With respect to its governance gaps, it lacks regional organisations

responsible for regulating these maritime activities. Also, due to its very board framework for marine management, the regime has a very limited capacity to offer protection for Arctic wildlife and for preserving ecological balance (Rothwell, 2013). One of the most noticeable weaknesses of the regime as an Arctic legal framework is that it merely applies to the marine areas of the Arctic. It lacks terrestrial emphasis for the unique seasonal changes in the region. Therefore, it is not capable of offering an effective legal framework for the Arctic as a whole (Rothwell, 2013).

Secondly, even though it contributes a great deal to ensuring political stability and environmental security in the region, the Arctic Council and its constitutive instruments are not entitled to enforce legally binding obligations (ArcticCouncil, 2017). The impact of the offered guidelines and recommendations is difficult to evaluate due to the fact that the Council is not an operational body and does not have instruments to systematically monitor and evaluate member states' compliance. The Council does not have a permanent independent secretariat nor structural funding (ArcticCouncil, 2017). Thirdly, the Council offers limited participation to non-Arctic states, and various other non-governmental actors. Thus, there is a need for regulatory arrangements that include various stakeholders to deal with the challenges arising from the expansion of different sectoral activities in the Arctic.

Finally, in addition to issues of regulation and governance, the environmental tension is increasing in the region due to climate change. Consequently, environmental changes in the Arctic alter the geostrategic dynamics of the region, which could have dramatic consequences for international security and stability, as well as posing inconveniences for policy efforts to strengthen the existing legal regime. Growing attention from the non-Arctic states and non-state organisations brings further complications to the Arctic governance (Berkman & Young, 2009).

Environmental security becomes the determining factor in the Arctic region, as the environmental degradation and resource rivalry may generate violent conflicts (Stokke, 2011). For some, rapid changes in the Arctic offer a unique chance for states to enhance international cooperation and to strengthen existing legal frameworks (Stokke, 2011). However, a substantial platform is yet to be established to maintain stability and security in the Arctic, while this uncertainty becomes a matter of global security.

2.2.2. Antarctic Region

Antarctica on the other hand, is also a global commons and according to the Antarctic Treaty, “the area south of 60° South Latitude, including all ice shelves”, is considered to fall within the boundaries of the Antarctic territory (The Antarctic Treaty, 1959). The governance of the Antarctic area centres on the Antarctic Treaty System (ATS) together with other mechanisms of international law and international marine law. The introductory instrument of the System is the Antarctic Treaty of 1959, which entered into force in 1961, and was signed by 12 states, seven of them with territorial claims⁴. As of 2017, 41 other countries have signed to the agreement, 17 of which have been actively engaging in various activities in Antarctica (ATS, 2017). In addition to the Treaty, a number of associated measures have been introduced. These measures include the Protocol on Environmental Protection of 1991, the Convention for the Conservation of Antarctic Seals of 1972, and the Convention on the Conservation of Antarctic Marine Living Resources (Weber, 2012). The main executive body of the System is the Antarctic Treaty Consultative Meetings (ATCMs), where the consultative members take actions based on consensus decisions. Thus, the ATCM is the primary platform bringing stakeholders together, for both formal and informal matters, to take binding measures or voluntarily implement resolutions (Weber, 2012).

The main emphasis of the System to date has been on environmental conservation and scientific research. Indeed, due to the absence of a permanent Antarctic population, the discussion on the issues of Antarctica has been predominantly about scientific and environmental matters (Clayton & Wilson, 2008). The treaty, in its respective articles, focuses on a peaceful environment, free from any aggressive military presence, to establish freedom of scientific research and information exchange in order to avoid potential disputes between parties and to sustain scientific cooperation between states (The Antarctic Treaty, 1959). For many scholars and international law experts, the signing of the Antarctic Treaty was a remarkable accomplishment, despite the existing Cold War crisis and many other unresolved territorial disputes on the Antarctic continent (Scott, 2003). By designating Antarctica as “a natural reserve, devoted to peace and science”, this commitment was strengthened by the 1991 Protocol on Environmental Protection (Roura & Hemmings, 2011).

⁴ Argentina, Australia, Chile, France, New Zealand, Norway, and the United Kingdom

In addition to the ATS, there are a number of international agreements that have an impact on Antarctic governance, such as the International Whaling Commission and the IMO. The IMO is an important body for Antarctica because the ATS is not capable of regulating all ships operating in Antarctic waters and the Southern Ocean. In addition to its regulatory role in the region, the IMO is also active in accident prevention and environmental protection. In this regard, the IMO is currently developing the International Code of Safety for Ships in Polar Water to assist vessels operating in Antarctica and to prevent environmental harm (ASOC, 2016). Finally, most of the other international organisations and agreements, such as FAO, mentioned in the Arctic section, are either completely or partly applicable to the Antarctic region.

Challenges in Antarctic Governance

Even though there are climatic and environmental similarities between the polar regions, the Antarctic region is considerably more stable and faces fewer problems compared to the Arctic region. However, as within the Arctic regime, it is possible to classify the challenges that face the Antarctic region into regulatory and governance categories. In terms of the regulatory gaps, there are two main industries subject to extensive discussion, bioprospecting and Antarctic tourism. These are the two main fields in which the region witnessed considerable growth since the end of the Cold War (Hemmings, 2017). The consequences of neither tourism nor bioprospecting have been subject to substantial environmental assessment. An increasing number of incidents in the Antarctic have raised concerns about environmental and human security. Although several measures⁵ with respect to tourism were adopted by the ATCM, none of them have been enforced (Hemmings, 2017).

Throughout the history of Antarctic governance, especially prior to the 1991 Environmental Protection Convention, serious challenges, such as territorial claims and resource exploitation demands, had been successfully resolved by democratisation of the regime (Bray, 2016). The democratisation included increased participation, complete transparency and accountability amongst the member states, international organisations, and non-governmental bodies (Bray, 2016). Yet, in the past two decades, a number of issues have developed that endanger the legitimacy of the ATS, as well as the environmental security of the region. This inadequacy

⁵ Measure 4, sets out requirements of the touristic areas (2004)

Measure 15, impact assessment of landing of persons from passenger vessels in the Antarctic Treaty (2009)

indicates the governance gaps within the ATS. Indeed, it has become very time consuming and problematic to establish consensus between member states as the number of the participants and interests have grown with the industrial boost after the end of Cold War. In other words, developing regulatory conventions that incorporate emerging commercial and scientific activities, such as tourism and bioprospecting, while strengthening the existing agreements, have become the main challenge for the ATS.

Similar to the Arctic region, illegal and unregulated fishing poses grave threats to the ecological security of the Antarctic region. As fish stocks in other marine areas have collapsed or become endangered, illegal and unreported fishing has increased in scale in the Antarctic waters and in the Southern Ocean (Dodds, 2010). In addition, despite the regulatory efforts developed by the International Whaling Commission, several countries have caused regional disputes over illegal whaling in the Antarctic Treaty jurisdiction, such as the ongoing dispute between the Australian government and the Japanese Whaling Commission (Dodds, 2010). This problem is also connected with Australia's recognised continental shelf that overlaps the Antarctic Treaty area. Thus, issues occurring within certain parts of the Australian continental shelf also fall under the Antarctic legal regime. Consequently, the interaction of two legal regimes – the Law of the Sea Convention of 1982 and the Antarctic Treaty of 1959 – produces regulatory and governance gaps in the region.

2.2.3. The Way Forward for the Polar Regions

Although the governing systems of the polar regions are structurally different, they face similar challenges within their regulatory and governing bodies. However, compared to the Arctic, the Antarctic remains a territory that is still relatively pristine, with few industrial and human impacts (Convey, et al., 2012). This is partly because of its distance and isolation from the industrial world, but also because of the effectiveness and foresight of the ATS. As a result, the Antarctic region has become a great example of international cooperation, where nations conduct and exchange scientific experiments for the sake of regional and global environmental development, sustainability, and security. With globalisation, technological developments gained momentum and mobility increased significantly. These developments offered a more accessible Antarctica, and consequently increased attention on the Antarctic resources for various sectoral activities. In addition, the number of permanent stations in the

region has increased significantly with the involvement of new states, such as China (Brady, 2010).

As a result of these developments, the Antarctic region has been witnessing an industrial and structural evolution over the last two decades. As mentioned in the previous section, this has resulted in the proliferation of actors and interests and raised several challenges in the region. The Treaty System has not been able to take the necessary measures to address issues like tourism, overfishing, and bioprospecting. Even though regional and international organisations, such as the International Association of Antarctic Tour Operators (IAATO) and the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), provide mechanisms to manage and monitor these activities, the overall environmental impact remained alarming (Dodds, 2010).

Early decisions taken by the ATS, in terms of environmental conservation and cooperation, provide proof that emerging issues can be accommodated and addressed (Weber, 2012). Accordingly, these challenges can be confronted by securing global public interests and by providing a developed and updated understanding of 'democratisation' within the Antarctic regime. In other words, in addressing emerging concerns, the regime needs to employ the necessary tools to ensure environmental security, regional and international cooperation, and future industrial development in the Antarctic. Hence, these challenges reflect a chance for further cooperation and environmentally secure outcomes for the region, provided that participants are willing to collaborate.

As for the Arctic region, due to climate change, environmental security is the main concern for the international community. The region is in the midst of a vast environmental transformation which is expected to last for decades (Yough, 2012). Despite this ecological imbalance, the Arctic states currently have relatively few unresolved maritime disputes (Stokke, 2011). At the same time, owing to industrial congestion, geopolitical tension is higher and riskier than ever before. At this juncture, there is a need for a unified legally binding convention, along with a jurisdictionally strengthened Arctic Council and constitutive instruments to monitor and to enforce environmental and legal measures in various sectoral fields, such as fisheries, military, shipping, and resource exploitation, including offshore hydrocarbon activities. An updated version of the ATS, with a strong focus on environmental security and sustainability and international cooperation, for its polar counterpart, would be

an appropriate step to take to ensure the maintenance of political and environmental stability in the region. This is only possible if UNCLOS takes parallel measures to adjust its legal regime to the environmental transformation and shifting geopolitical balances.

2.3. Conclusion

Based on Garrett Hardin's "Tragedy of the Commons" notion, this chapter aimed to provide an overview of today's most prominent Global Commons and their own "tragedies" along with their governance regimes and challenges. In many cases, these tragedies were found to be largely inter-related. In other words, as described by Ostrom, the environmental crisis occurring in these common resources is based on a web of "interlinked complications" (Ostrom, et al., 1999). This can be seen in fossil fuel consumption over land and its consequences for the maritime and polar regions. At the same time, in contrast to Hardin's prediction, today's version of herdsmen, which can be considered to be the members of international community, have sought ways to manage access to these commons and agreed upon a set of norms of conduct, including limiting economic and political activities therein.

Now, more than ever, international peace and security, as well as financial prosperity, rely upon safe and legitimate access to the common domains that comprise the global commons, namely, the oceans and high seas, polar regions, the atmosphere, cyberspace, and outer space. Starting with the oceans and high seas in the earliest days of human civilisation, and the 20th century's addition of the atmosphere, and outer space, these domains have served as essential mediums through which international communication, trade, relations, and governance flourish. However, as this chapter attempted to illustrate, the international community has realised that the environment and resources within the global commons are very fragile and finite. Further, access to and use of this environment and these resources is congested, contested, and competitive (Kumar, 2015).

Although significant efforts have been made to address these global issues, the world now faces new environmental and political difficulties in governing global commons. Firstly, the number of participants in common resource pools has increased significantly over the past few decades. As a result, organising international meetings, agreeing on regulations, and enforcing these regulations become very time-consuming and difficult. Secondly, along with financial globalisation, the world is in a period of "reculturation" and populism where major

political and ideological shifts change the international political and cultural landscape. These factors have the potential to decrease the probability of global actors reaching agreements based on common interests (Ostrom, et al., 1999). Thirdly, the very inter-related nature of the global commons presents the potential of exceptional environmental chain reactions⁶. Thus, it is quite challenging to assemble global regimes to work together and prevent these reactions from happening. Fourthly, unlike in previous generations, economic and financial development, technological and scientific change, and population growth are now increasing at an unprecedented rate. Therefore, past experiences are far less applicable to present global concerns, which leads to the final difficulty that there is no longer flexibility to allow for mistakes when dealing with these global challenges.

As Tara Murphy argues (2010), tragedies, along with the difficulties in governing global commons, require global solutions that can harness innovation to utilise countermeasures and cooperation – between public and private sectors, and amongst state and non-state actors – and to ensure these risks are sufficiently addressed. This collaboration must be backed by legally binding treaties, institutionalised administration structures, and effective enforcement bodies and mechanisms (Stang, 2013). International attempts to renovate, modernise and intensify governance regimes are a significant additional step, as are international legal frameworks and norms which pressure states to act accordingly (Murphy, 2010). Finally, the UN must ensure, by working with the nations of the world, that the global commons are secure and accessible for responsible and peaceful use.

⁶ For example, the more ice melts, the less sunlight is reflected into space, and the warmer oceans get, thus melting ice faster.

3. Outer Space Security and Governance

3.1. Introduction

Since the launch of Sputnik in 1957, space has become an imperative environment for the political, economic, and diplomatic developments across the globe. States, especially the Soviet Union/Russia and the US, have used space as an instrument to demonstrate their political, financial, and military powers. Over time, outer space turned into an increasingly crucial domain for the international community as many more states became space-dependent. The security and safety of the space medium, especially during and after the Cold War, has proven to be very significant for economic and social prosperity. These developments, in return, created a need for a multifaceted global space governance regime that includes codes of conducts, confidence building measures, international institutions and treaties, and enforcement mechanisms. In other words, what is needed is a concept of global space governance which can successfully govern and regulate space-related activities based on international laws and regulations utilised for global cooperation and integration.

The necessity for a global governance regime derives from the specific nature of outer space as the space domain lies beyond states' sovereignty. As indicated in the Outer Space Treaty's Article 2, "*outer space, including the Moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty*" (UN, 1967, p. 4). Even though the majority of states have not agreed on the exact meaning of the 'common heritage' principle, the international community approaches outer space as a global commons as well (Ervin, 1984). As with the other global commons, space is also in collective supply and use where all states can equally benefit from the assets and resources of outer space. However, the freedom to access and use the space environment is meant to be limited to peaceful purposes that include civil, industrial, and commercial fields (UN, 1967). The Outer Space Treaty regime (OST regime), along with the Committee on the Peaceful Uses of Outer Space (COPUOS) provided by the United Nations, are the main legal and institutional bodies which regulate the right of access and action in space (Freeland, 2015). They also constitute the primary international fora for the legal framework for governing and monitoring activities in space.

However, as Sadeh (2015) stresses, the OST regime remains inadequate in overcoming obstacles to governing the outer space commons for several reasons. The regime does not

provide comprehensive rules or an effective administration for deciding what forms of space activities might harm the space environment and assets, and how profits from space activities and explorations should be shared between nations (Sadeh, 2015). Steven Freeland is also of the opinion that the ineffectiveness of the current legal and regulatory regime is due to its incompatibility with the significant scientific and commercial progress of space activities since Sputnik (Freeland, 2015). Other scholars argue that the inadequacy of the legal and normative structure is caused by the lack of cooperation and dialogue between the major spacefaring countries (Mutschler, 2015) (Grego, 2011) (Stang, 2013).

This chapter aims to introduce the fundamental characteristics of outer space governance and security, as the final part of this study's global commons focus. Unlike the other global commons presented in the previous chapter, this chapter provides a more detailed pragmatic background on space governance in order to establish a comprehensive foundation for the last phases of this study. The chapter begins with the environmental aspects of outer space, including its traditional and legal approaches to the domain's boundaries and resources. Secondly, it reviews the concept of space security and its definition from a number of perspectives, such as military security, environmental security, and humanitarian security. In addition, the terms of space safety and sustainability are also addressed within this section.

Thirdly, it reviews the outer space governance regime's legal and regulatory dimensions, the institutional and organisational aspects, as well as the extent and nature of cooperation taking place therein. The regulatory dimension includes five core outer space treaties and a number of principles and declarations along with numerous codes of conducts, guidelines, and other measures. The institutional dimension consists primarily of UN bodies, but there are several other inter-governmental and non-governmental organisations involved in governance fields, such as space traffic management, space vehicle launches and re-entry measures, or space vehicle registration. Moreover, international and regional levels of platforms for dialogue, such as Heads of Space Agencies Summits or European Space Agency (ESA) Ministerial Council, are also mentioned within this section. Fourthly, this chapter assesses the ideological factors that shape states' national space policies along with the international space cooperation landscape. Finally, in light of these aspects, it identifies the existing and emerging threats and challenges facing the security of the outer space environment and its governance.

3.2. Outer Space Environment

Outer space, or simply space, is the area that exists between celestial bodies, such as planets, moons, and stars. Although space, as a hard vacuum, is primarily empty, it contains electromagnetic radiation, cosmic rays, and dust, as well as a low density of elements such as plasmas of hydrogen and helium (Finckenor & Groh, 2015). Theodore von Karman, in his book, set the boundary between Earth's atmosphere and outer space at an altitude of 100 km, which was later recognised as the "Karman line" (Karman & Edson, 1967). Although international legal bodies have been unable to agree on the boundaries of outer space, Karman's definition is conventionally used as the beginning of space. The Outer Space Treaty of 1967, in its Article 2, defines outer space as the areas of "space including the Moon and other celestial bodies" (UN, 1967). In addition to the OST's definition, outer space commons comprise spatial resources surrounding the Earth, namely, Lower Earth orbit (LEO), Medium Earth orbit (MEO), and Geosynchronous Orbit (GEO). These are regular and repeating paths that objects in space, such as the moon, man-made satellites, comets, or asteroids, follow as they orbit planet Earth.

Today, there are thousands of artificial satellites moving within these specific orbits in order to provide various services across the world. Considering the extent of services provided by satellites, outer space and its spatial resources have become a crucial part of our modern society. Thus, maintaining a secure and peaceful outer space environment is a matter of international stability and prosperity.

3.3. Outer Space Security

Conventionally, "space security" has been linked with the military security of nations, and this is still the main use of the term in the literature (Moltz, 2014) (Sheehan, 2015) (Grego, 2011). As Michael Sheehan points out (2015), a central aspect of the space security term is the contribution that satellites yield to the military security of countries and the sustaining of global stability, as well as the technological and military risks to satellites and their capacity to support international security. In the last few decades, however, this traditional approach has been widened to include a number of dimensions including environmental and humanitarian aspects. This is primarily because of the significant change in the understanding and the meaning of the term "security" after the Cold War (Peter, 2006).

Throughout the Cold War, “security” was understood in distinctive and narrow ways (Sheehan, 2015). It used to refer to threats from other states or internal and external bodies against state sovereignty. This approach to the term was seen as problematic as it did not address the different concepts of security issues (environmental and humanitarian) of the post-Cold War era (Buzan, 2007). As a result of the modification efforts, especially within western societies, the security discourse has been rearticulated from the conventional concerns. Therefore, while military security was viewed as an essential field, new fields such as environmental, societal, economic, and technological security concepts emerged. Notwithstanding, as Dalby emphasises, the impact of the Cold War on the concept of security is still profound (Dalby, 1992).

In the light of these developments, just like in other commons, the concept of security in space changed over time and according to circumstances. As mentioned earlier, although the term space security has been discussed and emphasised extensively in the literature, it has not been officially defined. However, space security, fundamentally, involves several aspects, including the security of satellites and spacecraft in orbit, the security of accessing and utilising space, and also the security of ground complexes that provide communication and data transfer, as well as the security of people who are using various services provided by satellites (Sheehan, 2015). These dimensions of space security are associated with environmental, humanitarian, and military security fields, as well as in relation to each other. Likewise, Blount argues that space security encompasses three dimensions (Blount, 2011). The first is international peace and security, which includes the use and application of space technologies for the purpose of ensuring the compliance with international conventions. The second dimension covers the provision of national security and protection of the state from internal and external threats. The final dimension of space security includes environmental security of the space environment that also covers the issues of space sustainability and accessibility (Blount, 2011). These approaches to the term are also reflected in the definitions of space security.

Similar to the OST regime’s approach, the Space Security Index (SSI) defines space security as *“the secure and sustainable access to, and use of, space and freedom from space-based threats”* (SSI, 2013, p. 5). According to the authors of SSI, the fundamental consideration of the SSI definition comprises the sustainability, safety, and security of outer space as an

environment that can be utilised carefully and responsibly by all (SSI, 2013). A more specific definition by the Space Generation Council, which particularly emphasises its political sphere, is *“secure and sustainable access to and use of outer space in accordance with international laws and treaties, free from threat of disruption”* (Cornell, 2009, p. 3). Moltz, on the other hand, defines space security with a more operational focus as *“the ability to place and operate space-crafts outside the Earth’s atmosphere without external impediment, impairment or destruction”* (Moltz, 2011, p. 11).

More comprehensively, according to the European Space Policy Institute (ESPI), there are various interpretations of the term “space security” and they are mainly founded on national interests, previous space activities, and immediate and varying foreign policies (Robinson, 2011). Furthermore, ESPI offers two distinct “space security” definitions. The first is the protection of the environment of outer space, particularly Earth orbits, as a secure and safe region for organising space activities, as well as protecting commercial, military, and civilian space assets from artificial and natural threats (Robinson, 2011). As for the second model, space security involves the use of space to enhance terrestrial security (e.g. the use of navigation and communication systems, and earth observation satellites for border control, disaster management, maritime safety, etc.).

Considering these definitions and concepts, it is clear that the term space security is not something that can be summarised in a single notion. Therefore, it is required that a definition needs to cover an interconnected three-dimensional concept that embraces two existing post-Cold War understandings of environmental and military security, as well as the humanitarian security of our modern age. Jean Mayence from ESPI fills this gap with a much broader approach that covers these issues simultaneously (Mayence, 2011, p. 35):

“(1) Outer Space for security: the use of space systems for security and defence purposes; (2) Security in outer space: how to protect space assets and systems against natural and/or human threats or risks and to ensure a sustainable development of space activities; (3) Security from outer space: how to protect human life and earth’s environment against natural threats and risks from outer space”.

On the other hand, Sheehan argues that expanding the concept of security may also cause problems for policy makers as the term eventually would have an even less consistent

understanding and focus to guide policy (Sheehan, 2015). It is also important to note that the model of space security has a significant role in international space cooperation and governance. More precisely, the understanding of security is crucial for the UN and spacefaring states in managing and addressing the security issues in space.

3.4. Space Safety and Sustainability

Space is a geographical territory that can be conceptualised as a model of environmental security. Many countries have acknowledged this by highlighting the concept of “space sustainability”. In fact, space sustainability, as Peter Martinez defines, is a term that has arisen within the last decade to refer to a number of concerns linking outer space as an environment for performing space activities securely and without restrictions, as well as ensuring continuation of the benefits gained from space activities (Martinez, 2015). The U.S. for instance, has considered space sustainability as a vital aspect for its national interests (NSP-US, 2010). Germany has also orientated its policy toward the principle of space sustainability (Willsch, 2015).

Beginning with the 2010 Scientific and Technical Subcommittee, the United Nations Office for Outer Space Affairs (UNOOSA) has been actively considering the issue long-term sustainability of outer space in their agenda (UNOOSA, 2017). To this end, The Working Group on the Long-Term Sustainability of Outer Space Activities was established under the Technical Subcommittee in order to identify issues of concern for the long-term sustainability of outer space commons (UNOOSA, 2017).

Civil society, on the other hand, is becoming an increasingly active player in the identification of concerns with respect to long-term outer space sustainability. Regional and international organisations such as the International Academy of Astronautics, Committee on Space Research (COSPAR), and the International Institute of Space Law have been taking significant steps to raise awareness for more responsible outer space activities (Martinez, 2015). This indicates the realisation of the limitations of Earth’s orbital environment, and of how important sustainable space is for the national and international development.

Space safety, on the other hand, refers to avoidance and mitigation measures for space missions, and it consists of three stages, namely, launch safety, on-orbit safety, and re-entry safety. (Pelton, et al., 2015). Maintaining safety throughout these stages carries a significant

importance for the sustainable development of space activities. In other words, space safety is devoted to keeping the space environment sustainable by protecting space infrastructure and assets from an ever-growing man-made orbital debris threat as well as the risks deriving from technical and environmental aspects. Therefore, along with the space sustainability term, space safety is also related to space security. However, space security encompasses both of them, in terms of scope and content (Pelton, et al., 2015).

Some spacefaring nations and inter-governmental organisations, such as the US and the EU, have established detailed national regulations for launch and re-entry activities (FAA, 2017) (ESA, 2015). However, an international framework applicable world-wide is yet to be established. Particularly after the Challenger and the Colombia disasters, national measures and standards for spacecraft safety during launch and re-entry have gained significant momentum (Pelton, et al., 2015). For example, NASA has established an updated public safety policy regarding the Shuttle re-entry to prevent future catastrophes (NASA, 2010).

Perhaps the biggest concern for the long-term sustainability and safety of the outer space medium occurs throughout the on-orbit missions. This is due to the harsh environment of outer space which includes extreme temperatures, ultraviolet radiation, and most importantly, both natural and man-made space debris. The probability of collision between a space vehicle and orbital debris is the primary source of risk for the outer space environment. A collision is not only capable of putting human spaceflight into danger but also capable of causing further collisions. Therefore, controlling orbital debris risk and remediating the orbital environment with active debris removal policies and measures have become the ultimate task for the spacefaring states when it comes to providing a safe and sustainable outer space environment (Crowter, 2003).

Consequently, the discussions in the literature indicate that a sustainable and safe outer space environment can only be provided by collective action and common understanding in policy approaches, which is only possible when these safety risks are tackled with a comprehensive international framework. Therefore, the following sections of this chapter will examine the existing outer space governance, challenges with outer space governance, and the underlying ideologies that determine states' posture with respect to cooperation in space.

3.5. International Space Governance and Cooperation

Shortly after the launch of Sputnik (1957), the UN founded the “United Nations Committee on the Peaceful Uses of Outer Space” (UNCOPUOS) in 1958 to take the leading responsibility for the enforcement and development of the essential statutes concerning the exploration and exploitation of outer space (Freeland, 2015). Through UNCOPOUS, the UN has established five core multi-lateral treaties in order to regulate and control the activities in space within the most intense period of space exploration (1967-1979) (UN, 2002). The Outer Space Treaty⁷ (OST-1967), considered the Magna Carta of space (Bourbonniere, 2005), and its supporting agreements are the primary sources for global space governance (UN, 1967). It establishes provisions that aimed to ensure equal access to space for peaceful purposes. This convention was basically intended to provide a safe and peaceful environment to promote international cooperation, as the primary concern of the global agenda was “security” during the Cold War era (Baldwin, 1995).

Apart from the UNCOPUOS and OST regime, the existing global space legislation consists of a number of other international treaties, such as the Partial Nuclear Test Ban Treaty (1963) and Constitution and Convention of the International Telecommunication Union (1992), a number of customary international laws, and many other non-binding codes and guidelines (Jakhu, 2016). Moreover, additional international and inter-governmental bodies were established under the auspices of the UN to regulate and govern various activities in different sectoral applications. In essence, the international space governance framework is implemented through the UN committees and institutions. At this point, it is necessary to elaborate on these international bodies and related conventions to illustrate the legislative and institutional dimensions of outer space governance.

3.5.1. The United Nations and Outer Space

As indicated in the previous sections, initially, outer space was perceived as an environment in which to conduct military actions. In this regard, the successful launch of Sputnik-1 in 1957 was a decisive demonstration of the possibility of utilising the outer space domain for intercontinental ballistic missiles and reconnaissance satellites. This has increased the

⁷ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (1967)

international demand for a dedicated set of rules for the space domain which can be separated from air law (Froehlich, 2017). Consequently, UNCOPUOS (hereafter COPUOS) and its Subcommittees⁸ were created within the UN to promote and enhance international cooperation on the peaceful uses and exploration of space; to resolve legal problems which might arise during space exploration and exploitation missions; to provide a supranational platform for stakeholders to exchange information related with outer space affairs; and to keep a public registry of space missions and launches based on the information provided by states, inter-governmental organisations, or private entities (Froehlich, 2017).

The United Nations Office for Outer Space Affairs (UNOOSA) is the UN office and the secretariat of COPUOS that conducts related policies and responsibilities as part of the higher UN Secretariat (UNOOSA, 2018). Similar to the COPUOS, UNOOSA has two sub-sections: The Space Applications Section (SAS) which manages and conducts the UN Programme on Space Applications, and the Committee, Policy and Legal Affairs Section (CPLA), which delivers essential secretariat services to the main Committee as well as its subcommittees (UNOOSA, 2018). SAS has two important institutions under its supervision. The first is the United Nations Platform for Disaster Management and Emergency Response (UNSPIDER) which aims to provide a globally available space-based information system to support and overcome natural disasters (UNSPIDER, 2017). The second is the International Committee on Global Navigation Satellite System (ICG), which is a voluntary platform providing cooperation and coordination among suppliers of global navigation satellite systems (GNSS) “to enhance and facilitate compatibility, interoperability and transparency between all the satellite navigation systems to promote benefits for the global community” (UNOOSA, 2018).

During the 1960s, it was understood that public and private use of GEO for communication and various other services needed to be regulated by a global system agreed upon by stakeholder organisations and nations. This need was provided for by the International Telecommunication Union (ITU) when it was tasked by the UN in 1963 to control the GEO belt with objectives to prevent physical and electromagnetic complications and interferences (SWF, 2013). Since then, the ITU manages outer space traffic by assigning GEO slots to States by assessing orbital parameters and types of frequencies required (ITU, 2018). Over time, it

⁸ Scientific-Technical Subcommittee and Legal Subcommittee under the auspices of the Main Committee

also became obvious that the outer space environment was becoming increasingly congested and was deteriorating due to irresponsible use of spatial resources (Couriel, 2016). In response, the Inter-Agency Space Debris Coordination Committee was established in 1993 to provide an international forum for governmental bodies to coordinate and exchange information on orbital debris research, and to identify and utilise debris mitigation policies and actions (IADC, 2016).

As for the regulatory dimension, in addition to the Outer Space Treaty, together COPUOS and the UN General Assembly have developed four more core international treaties, five sets of principles, and a number of related resolutions and guidelines with respect to space affairs and activities (UNOOSA, 2017). To begin with the remaining core treaties, after the OST, the Rescue Agreement⁹ was the first agreement considered and negotiated by the Legal Subcommittee. After years of negotiations, the Agreement came into force in 1968 to elaborate on provisions of Article 5 and Article 8 of the Outer Space Treaty, which requires states to rescue and assist astronauts or cosmonauts and return them to their countries in case of an accident (UNOOSA, 2017). Secondly, the Liability Convention¹⁰ entered into force in 1972 and establishes a binding liability to pay compensation by launching states for damages caused by their space vehicles both on the surface and the space (UNOOSA, 2017). Despite this, it was later realised that its provision for the determination of compensation was not clear and this resulted in legal ambiguities, for example in the Cosmos 954 incident, when the Russian reconnaissance satellite re-entered the Earth's atmosphere and crashed on Canadian soil with a nuclear reactor on board (Burke, 1984).

The Registration Convention¹¹ was adopted and entered into force in 1976, and it is built upon the commitment expressed in the previous agreements and aims to maintain a public registry of the space objects launched into outer space (UNOOSA, 2017). Finally, the Moon Agreement¹² came into force in 1984 and aimed to reaffirm and emphasise the relevant provisions of the OST. It emphasises that the celestial bodies should be used and exploited for peaceful purposes and that their environment should be preserved from man-made

⁹ Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (1968)

¹⁰ Convention on International Liability for Damage Caused by Space Objects (1972)

¹¹ Convention on Registration of Objects Launched into Outer Space (1975)

¹² Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1984)

disruptions. Moreover, its Article 11 signifies the notion of global commons by expressing the Moon as the common heritage of mankind (UNOOSA, 2017). Although officially in force, this agreement has been signed and ratified by comparatively few countries and is ignored by most of the spacefaring nations (Sadeh, 2015). However, this principle is based on the common heritage of mankind notion which can also be seen in other UN-based global commons legal regimes such as Law of the Sea and its associated regime of governance in the International Seabed Authority as well as the Antarctic Treaty. Consequently, a number of principles and resolutions were adopted by the General Assembly on related matters, such as the use of artificial satellites and remote sensing satellites, and on the use of nuclear power sources in outer space (UNOOSA, 2017).

It can be seen that the United Nations along with COPUOS have set the foundations of outer space legislation with the 1967 Outer Space Treaty, and elaborated on it with additional binding and non-binding agreements to address various concerns in outer space, and to provide a platform for an effective and comprehensive dialogue through its committees. In order to scrutinise the nature of global space governance, which is embedded in these UN institutions and treaties, one needs to elaborate on the fundamental legal principles provided by the OST. In addition, discussions on these principles will link this section to the concept of global commons, hence, they will also serve as a legal and practical basis for the issues discussed throughout the study.

3.5.2. The Outer Space Treaty

First of all, as indicated in the first and second article of the OST, the exploration of outer space should be achieved for the benefit and common interests of all nations without any discrimination and interference of any kind, on a basis of freedom and equality (UN, 1967). Also, outer space and celestial bodies are not subject to any appropriation, occupation, or sovereignty of any state (UN, 1967). These two articles establish the most foundational principals of the international law of outer space. In particular, the “equality”, “common interest”, and “non-appropriation” terms constitute the first binding piece of legislation for space governance (Freeland, 2015).

Through these principals, the space environment has gained status as a global commons at the international law level. Moreover, they provide the opportunity to space-faring states and

developing countries to undertake broad-ranging discussions of international cooperation and sustainable development in outer space on the basis of Article 1. Even though the non-appropriation principle is stated in explicit terms in Article 2, it only refers to “national” entities. Therefore, its applicability to non-governmental and private entities caused controversies in the literature (Lee, 2004). With increasing investments and initiatives from the private entities in sectors such space mining and space tourism, it becomes even more necessary for the international community to clarify the issue of “non-appropriation”.

The Treaty’s third and fourth articles emphasise that space activities should be carried out in compliance with “international law” and with the purpose of maintaining “international peace and security”. Moreover, it also forbids the use of “nuclear weapons” in orbit to avoid “militarisation” in space (UN, 1967). In addition to the Treaty’s political importance as a stage in the development of global cooperation and effective communication between the U.S. and USSR, these provisions have precluded the positioning of nuclear and mass destruction weapons in earth orbits and on celestial bodies (Menon & Stover, 1987). In addition to the legal framework provided by Article 4 with respect to placing nuclear or mass destruction weapons in orbit, the Conference on Disarmament (CD), under the auspices of the UN, deals with the space security issues as well as militarisation of space through its annual findings (UNODA, 2017).

The remaining articles of the Treaty primarily focus on the preservation and continuity of international peace and cooperation, as well as on the specific issues with respect to liability and responsibility, and protection of astronauts, which are also covered by the related agreements. The Treaty was an important step for world peace and stability as it was created in the very tense and dangerous atmosphere of the Cold War. Hence, by virtue of the agreement, the two major space powers, as well as many other states, agreed to seek peaceful resolution. Nevertheless, following the approval of the OST, several fundamental legal and practical questions emerged with respect to the core principals mentioned above. In addition, with the growing diversity of space players and activities, particularly in the economic and social fields, the need for the development of new legal regulations to govern outer space affairs has intensified.

3.6. Challenges in Outer Space Governance

Outer space governance is fundamental to realising the benefits that we acquire from the space environment. The primary objective of space governance is to maintain secure and sustainable uses of space for civil, commercial, environmental, and military purposes. However, there are a number of challenges to outer space governance that require global attention to enhance the realisation of this objective. As indicated in the previous section, some of these challenges derive from the regulatory framework provided by the Outer Space Treaty Regime as well as states' failures related to self-restraint and self-regulation in accordance with the regime. Other obstacles are related to achieving collective action in relation to the commons of outer space and attaining strategic assurance between the stakeholders.

3.6.1. Outer Space Treaty Regime

The early literature on the Treaty's provisions was mainly focused on the ambiguous language that was used. With respect to Article 1, for instance, Jasentuliyana pointed out the lack of legal enforcement mechanisms to provide "co-operation" between states in space. He asked, "to what degree are States obliged to cooperate and share information on their activities with other States?" (Jasentuliyana, 1989, p. 140). In fact, this question was also applied to the "common interests" and "equality" principals of the Treaty as the exploration of outer space is to be conducted "for the benefit of all countries". Moreover, the question of international cooperation emerged once more when private entities with commercial motivations became involved in the space arena (Hoover, 1983). It is still not clear to what extent private entities are required to contribute to international cooperation.

Similar to Article 1, the scope and effect of Article 2, with respect to the prohibition of State sovereignty and non-appropriation principle, are not clearly articulated. As Ricky Lee argues, Article 2 does not refer explicitly to private entities or other non-governmental bodies (Lee, 2004). Although this gap was later filled by the Moon Agreement's (1979) several Articles, none of the major spacefaring countries has ratified it¹³. On the other hand, Freeland argues that both the US and USSR had already been engaging in various space activities, yet neither of them had claimed sovereignty over any part of space (Freeland, 2015). Ironically, following

¹³ There are only 17 states that ratified the Moon Agreement as of November 2016.

the treaty, the legal debate on the “non-appropriation” term has increased due to the ambiguous language of the Treaty.

The Treaty’s following articles, concerning the principles of “in accordance with international law” and “peaceful purposes”, have also been subject to comprehensive criticisms within the literature (SSI, 2014). Nancy Gallagher (2010) argues that this is due to the OST’s lack of conceptual clarity and insufficient control mechanisms that failed to provide detailed statutes or an authoritative course for deciding what forms of space activities are incompatible with the given “international law” and “peaceful purposes” principles. Moreover, it is also unclear what types of individual or collective actions are appropriate to or might damage the common benefits and interests (Gallagher, 2010).

As reflected in the literature, the regime falls short in providing an efficient and regulatory language. Consequently, it also fails to provide authoritative governance to overcome the legal, political, and environmental crises occurring in space. In such environments, existing regimes, in the past and present, could not prevent some states from causing large scale problems. However, this is not only due to inadequate governance. The environment can also be contaminated by irresponsible space behaviour, and lack of collective action between states. For example, China conducted an anti-satellite (ASAT) test in January 2007 to destroy its own satellite, which produced thousands of additional pieces of debris that still endanger the space environment and space assets (Gill & Kleiber, 2007).

3.6.2. Challenges of Collection Action and Strategic Assurance in Outer Space

In order to prevent such tragedies occurring in outer space, collective action is indispensable. Yet, the commons of outer space represent a collective action challenge for policy makers and stakeholders in formulating and implementing a space governance regime to restrict and regulate free access and free use of space resources (Sadeh, 2015). The primary obstacle to achieving a collective action regime in outer space, as discussed previously, is the OST regime. In spite of promising efforts to maintain collective action within the framework of the treaty regime, as well as enthusiasm in the forms self-regulation and self-restraint by some states, the increasing presence of orbital debris and congestion in space seem to cause further problems for international community in establishing collective action.

Secondly, perhaps the most emerging and threatening challenge for collective action is the issue of orbital debris. As of 2017 January, according to the European Space Agency, the number of debris objects regularly tracked by the Space Surveillance Network is about 23,000, and the total number of debris bigger than 10 cm is estimated to be more than 29.000 (ESA, 2017). When these existing figures are combined with irresponsible space behaviour, such as the Chinese ASAT test, and orbital conjunctions, such as the February 2009 collision between a US Iridium and a dysfunctional Russian Cosmos satellite, the space debris problem is highly likely to result in an environmental catastrophe (Bradley & Wein, 2009). Even though there are collective action developments with respect to orbital debris mitigation performed by the IADC, regional and national efforts, and the UN resolutions and guidelines, with the continuing irresponsible behaviour and lack of binding legal arrangements the goal of long-term sustainability of outer space seems unlikely to be reached (Sadeh, 2015).

The third and final obstacle facing global collective action in outer space is the case of Earth observation. Historically, Earth observation has been one of the most successful fields in international outer space cooperation and harmonisation. The vital aspect in this case of global cooperation is the possibility of scientists and policy makers across the world to work together in examining and analysing global data and to use it for policy-related purposes (Sadeh, 2015). Particularly, the Committee on Earth Observation Satellites (CEOS) played an important role in coordinating and harmonising earth observations globally (CEOS, 2017). Yet, these observations with remote sensing satellites are capable of observing a wide range of properties of a country's land use, agricultural data, air quality, and so on. Such a violation of the sovereignty of nations may lead to lack of co-operation and co-ordination between states, especially when these assessments are made of natural resources with large economic value (Macauley, 2010).

Moreover, as Sadeh points out (2015), sovereignty issues are also emerging in the cases of commercial and military remote sensing systems. With the development of high-resolution imagery technology, intelligence information gained via such tools can put the idea of collective action into jeopardy (Macauley, 2010). Unequal access to such satellite imagery and processing systems can cause substantial differences between developing states and developed ones and create destabilising impacts on the international community (Sadeh,

2015). Therefore, it is crucial to ensure that the data obtained from these tools will only be used to enhance international security and stability.

As for the strategic assurance model, the obstacle to outer space governance is linked with the international community's collective action on the basis of international strategic goals (Rendleman, 2013). These strategic goals evolve in ensuring outer space cooperation and involve aspects of space situational awareness, global engagement, lawful means of outer space protection, and deterrence to protect space assets (Sadeh, 2015) (Rendleman, 2013). To begin with lawful means of space protection, the existing outer space law regime oblige potential conflicts, space warfare, and various other risks to the space environment and assets (Sadeh, 2011). Nevertheless, such legal instruments either have limited validity, such as the Moon Agreement, or weak enforceability like the Anti-Ballistic Missile Treaty (Sadeh, 2011). As discussed earlier, these regulative deficits derive from the OST regime and its weak institutional mechanisms to enhance legal control over space activities, as well as the disinclination of spacefaring states to comply with these regulative frameworks.

The notion of deterrence to protect the outer space environment and assets is interconnected with global engagement and space situational awareness and it refers to the objective to overcome the challenge of protection of space assets from risks as a common strategic purpose (Harrison, et al., 2009). Deterrence, in this respect, represents a shared global interest in the space commons. For instance, damage to the telecommunication system would have devastating consequences for global financial stability and welfare. Such that, even a single missile test on any public or private space infrastructure would jeopardise the orbital environment. Achieving and promoting space situational awareness and global engagement in space affairs represents major enhancements in international peace and stability as well as regional and national economic developments. However, such a global engagement with mutual respect between stakeholders, like the Paris accord for climate change, is yet to be established in outer space. The environmental situation in the orbital medium, on the other hand, continues to deteriorate.

As a result, as discussed earlier, the characteristics of "the tragedy of the commons" are evoked in space as the contamination of the space medium, where unwise and self-interested states (like the Herdsmen in Hardin's concept) try to enlarge their own profits from a limited open source without considering the negative effects of their actions on other states, and on

finite resources. Thus, in addition to the central authority that establishes rules and responds to violations, the importance of collaboration and communication between states and non-state actors becomes very clear in ensuring security and sustainability in global commons.

3.7. International Initiatives & Concluding Remarks

Over the last two decades, there have been a number of initiatives established to cope with the challenges with regards to outer space sustainability and governance. These efforts differ from past initiatives in that they are rather “bottom-up” projects pursued to create voluntary principles or norms of conduct, and in some cases, include contributions from non-state actors (SWF, 2017). Some of these initiatives are discussed in below.

In 2010, a Draft International Code of Conduct for Outer Space Activities was presented by the European Union. It aimed to constitute norms of responsible behaviour in space that would decrease the threat of orbital debris and increase transparency in space activities, in order to prevent collisions between space vehicles and debris (EU, 2014) (Johnson, 2014). After its first meeting, the draft Code of Conduct received varied responses from the international community. Some developing space powers, such as China, Brazil, and India, stated that the process for developing the draft code was not transparent and expressed disappointment over not being adequately consulted (Farnsworth, 2014). Russia and the US argued that the draft code is not sufficiently equipped to prevent an arms race in space (Farnsworth, 2014). Even though no non-EU states signed the EU Draft, an agreement was reached between spacefaring states to use it as a foundation for further negotiations of an international Code of Conduct (Johnson, 2014). Moreover, it is widely argued that the Draft Code represents the EU’s current evolution into a more prominent international actor in space affairs (Rathgeber, et al., 2009).

In 2011, COPUOS founded the Working Group on the Long-Term Sustainability of Space Activities (LTSSA), to discuss subjects of concern for the long-term sustainability of outer space operations (UNOOSA, 2017). The Working Group was later divided into four Expert Groups to focus on particular subjects and create draft guidelines on the topics of sustainable space utilisation, space debris, space weather, and regulatory regimes and guidance for new actors in the space arena (Johnson, 2014). The discussions are still continuing on the compendium, which is expected to be referred to the UN General Assembly in 2018 (UNOOSA,

2017). In raising awareness towards the limited space sources and ensuring secure and sustainable access to space, the group has a potential to build a common approach between various stakeholders from national governments to commercial operators.

Finally, in 2010, Russia recommended to the UN Secretary General the establishment of a Group of Governmental Experts (GGE) to identify potential transparency and confidence building measures for outer space (Johnson, 2014). The UN General Assembly approved the proposal and fifteen states offered participant specialists to take part in the GGE meetings. The primary goal of GGE was to create a consensus framework that emphasises findings and recommendations on transparency and confidence-building measures that can promote stability and sustainability in the outer space medium (Koller, 2012).

The Group presented its final report, based on consensus, to the UN Secretary General in 2013 and concluded that the “world’s growing dependence on space-based systems and technologies and the information they provide requires collaborative efforts to address threats to the sustainability and security of outer space activities” (GGE, 2013). At this point, the group emphasises that transparency and confidence building measures can help in building consensus-based cooperation between states as well as contributing to reduce militarisation in the space domain. Moreover, the resolution is considered a new “step-by-step” approach to the prevention of an arms race in outer space, that may promote and encourage potential initiatives in the future (Tronchetti, 2016). However, due to its lack of mechanisms to verify compliance through its provisions, the resolution has received criticisms from the US and the EU. Their failure to support the Resolution reduces its ability to succeed in its objectives (Tronchetti, 2016).

It can be seen from these initiatives that the international community’s highly militarised focus towards the outer space commons has shifted to a more environmental one during the past two decades. With the involvement of commercial actors, this has shown itself through increasing emphasis on the sustainability of outer space activities. Today, more than ever, the international community is showing a strong commitment to reducing environmental risks towards orbital resources posed by irresponsible use. Even though there are a number of promising responses, such as reviewed policy initiatives, effective mechanisms to implement these responses are yet to be established. It is, therefore, necessary to investigate the deficiencies within the existing prevention measures taken by the international community

along with the regulatory regimes concerning outer space security and governance, and to analyse similar practices employed in other global commons. In conclusion, this chapter aimed to illustrate the nature of space security governance, as well as the inadequacies within this governance regime that failed to prevent the environmental tragedy from happening. The next chapter will focus on, and elaborate, this environmental tragedy occurring in the space domain, namely space debris. Following this, policy recommendations will be made for addressing this problem and shortfalls in outer space governance, centring on Ostrom's governing principles.

4. Tragedy of Outer Space: Orbital Debris

Despite the numerous efforts which have been undertaken, the international community is yet to provide adequate authority in outer space. As a result of the deficiencies within international space jurisdiction and the disinclination of space powers, various political and diplomatic crises took place in space between states throughout the history of the space age. Concurrently, the exploration and exploitation of space have proliferated significantly. Hence, the activities in outer space have produced a vast amount of space debris. Consequently, in addition to the existing political and diplomatic crises, environmental threats are also raised.

Amongst these environmental problems such as orbital crowding and radio frequency interference, space debris is the main emerging threat with the space arena. The space debris problem is an escalating concern for all spacefaring countries as the growing number of particles orbiting the Earth represents an accident risk to all space vehicles, particularly to the International Space Station (ISS) and other spacecrafts with human occupants. This means a relatively small piece of debris can endanger operational satellites used for private, military, industrial, and commercial purposes as well as human life in space. Therefore, the mitigation of space debris is of a great importance for the provision of environmental, economic, civilian, and military security of all nations. This chapter aims to evaluate the extent of the space debris problem as well as how it is addressed within the international legal framework. It then examines the existing policy initiatives which attempt to mitigate or reduce the growing orbital debris problem.

4.1. The Nature of Space Debris

Also known as space junk, according to the UNCOPUOS technical report in 1999 “space debris are all man-made objects including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorised” (Crowter, 2003). In other words, space debris is any man-made artefact discarded or accidentally produced from rocket stages and boosters, fragments of older or new satellites, or dysfunctional satellites as well as gears such as cameras and grease guns that were dropped during space walks around the ISS (Imburgia, 2011). Naturally forming debris such as

meteoroids and asteroids are part of the outer space environment and will not be subject to discussion as part of this chapter's focus.

According to ESA's Space Debris Office, as of January 2017, 4,300 space vehicles have been launched to Earth orbit. Only 1,200 of these vehicles are still functioning, which means the remaining 3,100 vehicles now serve as massive orbital debris as they have significant potential for break-ups, explosions, and collisions in the space environment (ESA, 2017). Some 23,000 pieces of debris are regularly tracked by the US Space Surveillance Network in order to prevent further collisions (ESA, 2017). There is an estimated mass of 7,500 tonnes of man-made space objects in Earth orbit and most of this mass is now considered as orbital debris, which is forming a massive cloud around planet Earth and which poses a number of threats to the long-term sustainability of space.

4.2. Threats Posed by Space Debris

The primary threat of orbital debris is the risk of damage resulting from collision with spacecrafts, satellites, and other space vehicles operating in space. What makes these fragments extremely hazardous is their extraordinarily high speed, which can reach up to 17,500 mph, fast enough for a relatively small particle to deactivate functioning spacecrafts (Bird, 2003). Due to their orbital velocity, any collision with a space debris fragment can cause significant damage to even well protected space vehicles. For instance, in 1983, a paint chip of approximately 0.2 mm, collided with the Challenger space shuttle and required a window replacement at a cost of \$50,000 (Mirmina, 2005). In 1996, a French reconnaissance satellite was struck by a rocket fragment and as a result of the impact lost its stabilisation bar (Bird, 2003). In 1997, a Japanese earth observation satellite, and in 1998, a US intercontinental ballistic missile, were destroyed after colliding with space debris (Bird, 2003).

Unfortunately, in a number of cases, the impact of collisions was far more catastrophic for the space environment. As mentioned in the previous chapter, the collision between the functioning Iridium satellite and a dysfunctional Russian communication satellite in 2009 in low earth orbit created over 1,000 new pieces of space debris larger than 10 cm (Chen, 2011). Similarly, a Chinese ASAT test in 2007 created more than 2,600 new pieces of debris larger than 10 cm. It is widely believed that together these collisions have altered the landscape of the orbital debris environment in the low earth orbit and are considered the "worst satellite

breakups in history” (David, 2013). Moreover, the test raised concerns over a possible arms race in space (David, 2013).

The cascade impact, which was initially proposed by Donald J. Kessler as the “Kessler Syndrome”, is perhaps the most severe consequence of the escalating issue of orbital debris (Baker, 1989). According to a study conducted by NASA’s Orbital Debris Program in 2006, the orbital environment has reached a level where collisions between existing debris will lead the space debris population to increase for the next two hundred years (Liou, 2011). Thus, the collisions between existing fragments will cause further collisions with other man-made space objects and will eventually introduce a constantly increasing space debris presence in the orbital environment (Kessler & Burton, 1978). Consequently, as many scholars have pointed out, such a cascading effect may result in an increasingly unmanageable space debris problem which is virtually impossible to prevent and is capable of leaving low earth orbits unusable for future space activities (Baker, 1989) (Chen, 2011) (Crowter, 2003).

Space debris is also capable of interfering with commercial, military, and scientific satellites and can cause misinterpretations in calculations of the data received from these satellites. Similarly, some space debris can be utilised for military purposes as effective countermeasures against other spacefaring countries and their satellites (Baker, 1989). However, threats from space debris are not limited to the orbital environment. Although most of the dysfunctional payloads burn up in the atmosphere at the end of their orbital lifetime, some of the large objects may survive atmospheric re-entry and fall down to Earth and may cause casualties as well as environmental problems, such as the Soviet Satellite Cosmos 954 which crashed in Canada and leaked radioactive substances over a large territory (Bird, 2003).

In short, space debris threatens human security in space and on the ground. Secondly, it can severely damage earth observation and remote sensing satellites which are being used for crucial purposes, such as crisis management, urban planning, agriculture, water management, and so on. Thirdly, it may critically affect or even collapse some essential services that satellites provide to modern societies on a daily basis, such as internet, banking, communication, navigation, and GPS. Finally, it may create a long-term orbital belt around the Earth and prevent space exploration activities for a very long time. In short, humanity has become so dependent on space applications that a threat towards the outer space commons and satellites therein, and their services, would have disastrous consequences. It is therefore

necessary to investigate the governing regimes and their measures with regards to the orbital debris problem.

4.3. Existing Legal Framework Regarding Orbital Debris

There are a number of established agreements that, to some extent, address the issue of space debris. However, as the previous chapter already outlined the international space governance and law, this section is dedicated to investigating the principles related to environmental security in outer space. To begin with the OST, although it signifies the view of outer space as a global commons its language delivers a minimal legal framework for the space debris problem or more broadly, the environmental protection of outer space. But some of the provisions within the Treaty, such as Article 9¹⁴, indirectly emphasise the significance of environmental protection and sustainability of space as it provides a more comprehensive limitation on activities that might harm the space environment. Yet, this limitation only applies to “scientific studies of outer space”, not the use of outer space resources (UN, 1967). Moreover, the treaty fails to assess proper counter measures in case of an accident caused by these scientific studies and investigations. Finally, due to the inadequacies within the language of the treaty, there is no consensus over the term “harmful contamination”, therefore, it raises questions as to whether it encompasses space debris or not (Imburgia, 2011) (Roberts, 1992).

The Moon Treaty has also developed provisions on the environmental protection of outer space. In its Article 7¹⁵, the treaty articulates that states should prevent activities in outer space that might disrupt the existing balance of the space environment (UN, 1979). Unlike Article 9 of the OST, Article 7 of the Moon Treaty explicitly emphasises the subject of environmental sustainability and protection. Nonetheless, it suffers many of the same inadequacies that Article 9 of the OST as its ambiguity on the terminology fails to define the terms of “harmful contamination” and “adverse changes” (Roberts, 1992). In addition, most nations have not ratified the Moon Treaty, which weakens its enforceability in keeping states

¹⁴ “States Parties to the Treaty shall pursue studies of outer space, including the Moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination” Article 9 – Outer Space Treaty 1967

¹⁵ “States Parties shall take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that, environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise.” Article 7 - The Moon Treaty 1979

accountable for their actions that cause environmental degradation (Bird, 2003). It is widely accepted that the OST and the Moon Treaty have not contributed extensively to preserving the outer space environment from the proliferation of orbital debris (Alby, 2015) (Mirmina, 2005).

The Liability Convention along with the Registration Convention, on the other hand, represent the most applicable and effective regulatory frameworks for protecting the space environment. With its liability provisions, such as Article 3¹⁶, the Liability Convention is the primary legal instrument for assessing compensation and sanction for damages caused by space objects (Roberts, 1992) (UN, 1972). The liability provisions are only applicable for persons or property in outer space, but not for damage caused to the environment itself (Imburgia, 2011). Therefore, similar to the other treaties, the Liability Convention falls short when it comes to minimising space debris. Nevertheless, it is an important instrument in protecting the space environment from intentional and unintentional incidences which can cause increases in the number of existing space debris as well as in establishing an effective, binding regime to prevent arms race in space which also can deteriorate the environmental tragedy in space.

The Registration Convention, on the other hand, facilitates compensation by ensuring that space objects which are responsible for damage are identified as clearly as possible. Article 1 of the Convention provides a broad definition for the term space objects, where it includes the “component parts of a space object as well as its launch vehicle and parts thereof” (UN, 1976). Several scholars have argued that the extent of definition encompasses all forms of space debris (Roberts, 1992). There are still concerns with regard to the ambiguity of the definition, which should be resolved in favour of a more comprehensive definition that addresses the term space debris explicitly. Moreover, an additional debris-related drawback to the Convention is the lack of clarity as to whether inactive satellites, rocket stages, and other space vehicle break-ups should be subject to registration (Imburgia, 2011). Such objects make up a significant proportion of the space debris population and even if the Liability Convention did assess the space debris issue, enforcing compensation and sanction over

¹⁶ “In the event of damage being caused elsewhere than on the surface of the Earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its fault or the fault of persons for whom it is responsible” Article 3 – The Liability Convention 1972

irresponsible behaviour would be impossible due to inadequate recording under the Registration Convention. Even though the Registration Convention provides a data-sharing platform to assist in observing and tracking of space objects, it fails to establish an applicable instrument to account for space debris (Imburgia, 2011).

In fact, all of the UN conventions clearly demonstrate that the space debris term and phenomenon remain an unsolved concern within its legal framework. Moreover, the Legal Subcommittee of the COPUOS is unlikely to reach legally applicable and enforceable commitments regarding the orbital debris issue in the near future. This is due to the failure of forming of consensus in favour of establishing a binding treaty on orbital debris as some of the States demand for further technical research on the issue. (Mirmina, 2005). Moreover, a general reluctance to enter into any new binding treaties since the Moon Treaty has also reduced the commitments towards a feasible binding treaty. Yet as mentioned previously, the environmental situation continues to worsen. Therefore, the international community sought ways to establish voluntary measures that can mitigate the space debris population or prevent it from increasing.

4.4. Existing Measures Confronting the Tragedy

A number of principles and guidelines have been established at both national and international level with the purpose of minimising space debris proliferation and protecting space assets from its effects. The problem of man-made orbital debris has been an important focus of UNCOPUOS' Technical Subcommittee's agenda since 1994. In 1999, UNCOPUOS published a comprehensive technical report on space debris where it outlined potential space debris mitigation measures (UNCOPUOS, 1999). Since the release of this report, there has been a common perception that the current space debris problem poses great risks to the outer space commons (UNOOSA, 2010). In addition to UNCOPUOS, a number of existing organisations play a significant role in this matter, such as the Inter-Agency Space Debris Coordination Committee (IADC), as well as regional and national space agencies and commercial actors.

In 2002, IADC adopted a set of guidelines which call for measures such as constructing satellites and rocket stages to reduce the number of mission-related debris released into orbit and to reduce the risk of collision with non-operating satellites (IADC, 2007). Based on the

measures provided in the IADC Guideline, UNCOPUOS adopted a set of space debris mitigation guidelines in 2007 (UNOOSA, 2010). In February 2008, the UN General Assembly endorsed and adopted these nonbinding mitigation guidelines, hereby enhancing the international efforts to tackle the space debris problem (Imburgia, 2011). Together, these guidelines established a foundation for international efforts to control the debris population. Moreover, national and regional space agencies, such as NASA and ESA, are involved in mitigation policies and have adopted a set of standards and guidelines on debris mitigation (NASA, 2012) (ESA, 2015). A number of other national agencies adopted technical guidelines and regulations to meet the presented requirements within these guidelines, such as the French Space Act (CNES, 2011).

Although the guidelines are not legally binding, they have proven to be partially successful. As Chen indicates, even where existing mitigation measures were not fully implemented, they still resulted in a decrease in the total amount of debris released between 1997 and 2006 (Chen, 2011). However, the benefit of these efforts was reversed after the collisions of Cosmos 954 and the Chinese ASAT test, which caused a steep increase in debris population (Liou, 2011).

The international community and national agencies have been working on a number of potential supportive approaches to space debris mitigation. The first approach is active debris removal (ADR), which refers to the removal of debris from the orbital environment (Chen, 2011). This approach has gained a significant momentum after the steep increase in the debris population and a number of guidelines and scientific proposals have been made to remediate the orbital environment (Alby, 2015). The first International Conference on Orbital Debris Removal was held in December 2009 and it represents the first joint effort by spacefaring countries to explore the issues and challenges deriving from ADR (Chen, 2011).

A number of initiatives and workshops have been organised by national space agencies, such as Clean Space by ESA, to work on scientific and technological matters related to ADR. A significant amount of research has been conducted to explore the financial and scientific aspects of ADR (Walker & Martin, 2003) (Wiedmann, et al., 2004) (Castronuovo, 2011). Various methods and techniques are presented throughout these researches and workshops. However, the majority of the proposed solutions are mainly perceived as technically

impractical, excessively expensive, or as posing a risk of environmental damage during operation (Sorge & Peterson, 2015).

As ADR methods are yet to be feasible, finding alternative methods to avoid in-orbit collisions and to reduce the risks to space objects has gained importance. Space traffic management, which refers to “activities intended to prevent orbital damage as well as actions that must be taken to reduce the long-term potential for future collisions” (Lala & Schrogl, 2006), is the primary method used to maintain safety in orbit. There have been valuable reports published under the auspices of ITU, UNCOPUOS, and IADC with regards to space-traffic management and even a new institution, the International Space Traffic Management Organisation, was proposed as the main entity to govern space traffic operations (Chen, 2011).

In light of the efforts made by these organisations and technical and scientific initiatives, it is possible to argue that a central body is essential for harmonising existing management platforms and for effective space traffic management. Currently, there is no unified organisation that encompasses the administrative, legal, operational, political, and technical backgrounds to successfully implement all these levels of space traffic management system (Chen, 2011). Such an organisational body needs to be capable of adjusting to an ever-growing and evolving space environment, while providing a solid foundation to ensure a secure and effective operating environment for space activities.

4.5. Conclusion

Over the course of the space age, space activities have produced a vast amount of orbital debris that threatens the orbital environment and space assets therein. Managing the debris population and preventing its population from increasing represent a crucial task for long-term sustainability of the space commons. The international community has taken significant steps in a positive direction by establishing debris mitigation guidelines and by encouraging and supporting scientific and technical initiatives to take part in debris removal activities. However, as some regions of space, especially lower earth orbit, have already reached critically high debris density, the debris population is likely to increase over the next two centuries.

This is a critical example of an environmental tragedy as conceptualised by Garrett Hardin where absence of, and deficiencies in, space governing authority led self-interested users to

engage in irresponsible behaviour in the outer space commons. As a result, the orbital debris population now poses a persistent threat to the spatial commons that could critically harm global social, economic, and political welfare. Preventing this tragedy, or at least weakening its impact on international security and stability, is a crucial task that a central governing authority should take. In addition, self-regulative norms based on transparency and collective action should be established through effective international diplomatic relations. Policy proposals for this emerging problem are provided in the last chapter.

5. Conclusion & Policy Proposals

As Paul Stern points out, Garrett Hardin's work "The Tragedy of the Commons" (1968) has inspired and challenged a generation of people concerned with the welfare of Earth's natural resources (Stern, 2011, p. 213). Over time, local environmental problems broadened to global-scale problems. Several other major works concerning the issue of environmental degradation, such as *The Population Bomb* by Paul Ehrlich and *The Limits to Growth* by Dennis Meadows, have argued that the scale of tragedy is no longer limited to small regions but has spread to a global dimension (Ehrlich, 1968) (Meadows, et al., 1972). These and many other works have indicated that the global commons were about to face unprecedented environmental tragedies. During the past four decades, the international community did far less than it was capable of to stop these tragedies from taking place. Even though there have been a number of successful measures implemented on a global scale illustrate opportunities for mitigation, the majority of tragedies are still present and growing.

This research has attempted to demonstrate that the existing governance measures in the global commons have not been able to resolve the emerging environmental tragedies. As a case study, the research focused on outer space commons. This chapter initially serves to point out the key governance shortcomings within the maritime and polar commons and to compare them with the ones occurring in the outer space commons. After identifying common governance deficits, the study discusses Ostrom's design principles (2003) as potential strategies for better governance in the global commons. In the light of the discussions, it concludes with policy proposals to address the space debris problem.

5.1. Key Deficits in Global Commons Governance

First of all, continuing *non-compliance* with the provisions of the Law of the Sea and the Antarctic Treaty pose an emerging problem for global commons governance. Both in the oceans and the polar regions, states' refusal to participate in dispute resolution procedures and to comply with the legal order discredits the treaty's legitimacy and harm ongoing negotiations within various multilateral bodies. Russian refusal to attend resolution proceedings over conflicts with the Netherlands in the Pechora Sea, or the Chinese illegitimate claims over the artificial islands in the South China Sea are the examples of a consistent pattern of non-compliance with the international law provisions (Churchill, 2012).

Non-compliance is not only a challenge to effective governance but in some cases, it can also pose direct threats to ecological balance. Continuing illegal fishing and whaling within the Antarctic Treaty jurisdiction are cases where it contributes to the environmental tragedy. Similarly, in spite of the relevant provisions of the OST, China's ASAT test not only violated the already fragile validity of outer space law but also resulted in an excessive increase in space debris. In this regard, the global commons governance system is inadequate in providing effective compliance-monitoring and transparency measures and therefore requires substantial legal and institutional reform as well as instruments that can promote self-restraint and self-regulation.

Existing governance regimes and legal frameworks are not only undermined by persistent non-compliance, but they are also outdated and possess a *lack of effective regulatory and institutional arrangements* when it comes to controlling emerging activities such as Antarctic tourism, bioprospecting, seabed construction, developing oil and gas technologies, and floating structures. Similar emerging activities in outer space are yet to be officially defined and regulated, such as asteroid mining and space tourism. In some cases, such as ocean governance, the number of organisations causes proliferation of authorities but for the most part these are lacking any effective regulatory and monitoring ability due to overlapping mandates.

Gaps in regulatory regimes are furthermore affected by a *lack of clarity in defining and addressing critical terms*. Linguistic ambiguity can be found in almost every international legal framework reviewed in this research and they are often capable of causing controversies for authorities in addressing specific problems such as space debris, or contribute to disputes between states. Therefore, it is possible to argue that the global commons regimes either lack regulatory and organisational instruments, or existing instruments are ineffective in enforcement, and in legally framing and monitoring emerging activities and threats.

Establishing legally binding agreements are very critical in governing large-scale common properties. When it comes to governing global commons, this is no different. However, geopolitical interests and various conflicts between states often challenge international law makers to reach an effective and applicable consensus on a global level. Perhaps all of the global domains being reviewed throughout this paper somehow suffer from the same problem – *lack of functioning legally binding agreements*. For instance, it can be argued that

the sea regime is the most effective and applicable regime amongst the global commons governance regimes in terms of its historical and institutional development. Yet, its legal regime has been undermined by major powers.

The Arctic Council on the other hand, lacks the regulatory authority to impose legally binding measures. Therefore, past and present attempts to address problems occurring in the Arctic environment with the existing UNCLOS' provisions have been insufficient. Existing legally binding agreements of the OST regime are often ignored by the majority of the spacefaring countries. For example, the Moon Treaty has only been ratified by seven countries as of January 2018 (UN, 2018). This is partly because of the other common deficits previously mentioned, such as lack of clarity and lack of regulative and institutional arrangements within the governance regime.

Consequently, this study argues that if these key governance deficits are not addressed successfully, political and legal problems within global commons regimes are highly likely to remain unresolved. Accordingly, environmental problems such as overfishing in oceans, melting in the Arctic, and space debris in outer space are expected to become self-sustaining environmental tragedies. Yet, as Nobel award winner Elinor Ostrom argues, "the tragedy of the commons" is not inevitable (Ostrom, et al., 2003). Such that, a large number of systematic multi-disciplinary studies have proven that a variety of adaptive governance regimes have been effectively established to control commons and resources therein (Ostrom, 2010) (Stern, et al., 2010). Despite the emerging problems mentioned in the Antarctic environment, the Antarctic treaty system has shown a similar model in terms of global governance that has proven to be successful overall (Convey, et al., 2012). Therefore, it is possible to study global commons governance from a commons perspective, and that a set of design principles offered by Ostrom and her colleagues can be defined and conducted for global commons regimes in order to mitigate large-scale environmental tragedies (Stern, 2011).

5.2. [Elaborating Ostrom's General Principles for Global Commons Governance](#)

Even though principles provided by Ostrom (2003) are largely applicable to global and regional problems, some principles may not be identical to those implemented in local governance (Ostrom, 1990). Therefore, eight principles also need to be discussed in terms of their applicability to global commons, particularly to outer space.

To begin with, *clearly defining the boundaries of resources and user groups* is not a feasible practice for the majority of global commons regimes, as Stern emphasises (2011). As this research has shown previously, there have been many territorial disputes between states in global arenas. Although it is feasible to consider international jurisdictions as boundaries, only establishing certain geographical limits would not be enough to prevent conflicts between parties when it comes to governing resources. Territorial disputes in the Arctic Sea are clear examples of the impracticality of implementing boundaries for resources.

However, despite its environmental vastness, the outer space commons comprises of spatial resources which are now very limited and valuable. Developments in space traffic management show that there are certain orbital boundaries for satellites to perform certain tasks such as navigation, communication, or earth observation. In fact, as discussed earlier, the ITU allocates GEO slots for states by assessing orbital parameters (ITU, 2018). Today, more than ever, spatial commons need to be shared carefully between user groups within definite boundaries. In order to achieve this principle in outer space commons, certain governance requirements need to be met. As Ostrom identifies in key requirements for environmental governance (2003), *providing information* and *inducing rule compliance* are also very critical in governing orbital sources. Implementing effective information sharing between the ITU and satellite owners, as well as applying sanctions against those who do not act in accordance with the standards set by international law, would probably result in better governance. These requirements also apply to the principle of *applying graduated sanctions for violations*.

Devising rules that are congruent with ecological conditions was not a priority in specifying and enforcing rules until the late 20th century (Stern, 2011). This has changed with the acceleration of information sharing and communication and with the significant increase in global awareness towards the ecological conditions in global commons. The UN Fish Stock Agreement of 1995 and Paris Climate Accord of 2016 are two of the regulatory instruments developed to enforce rules that account for specific environmental conditions. Similar approaches can be made for the outer space commons when the problems therein are clearly defined and backed with effective institutional arrangements that take the space environment into account and monitor compliance accordingly. Moreover, in parallel to devising new rules, updating existing agreements to keep pace with technological developments can improve the quality of governance. This is of significant importance for

outer space governance as the emerging activities such as space tourism and asteroid mining pose new challenges to the OST regime.

Holding monitors accountable to users is an important principle for global commons governance, however, it is very problematic to implement for a number of reasons. Firstly, there is a continuing presence of conflicts of interest between major users which can negatively impact monitoring activities. This is primarily visible in Arctic waters where states are engaged in aggressive military actions in order to claim natural resources. Secondly, increasing involvement of commercial and private actors globally may affect monitoring activities. Finally, to effectively prevent non-compliance, monitoring activities should be conducted. Therefore, there is a need for an independent body to conduct monitoring activities. Due to its specific nature, land-based activities related to outer space are very limited compared to other global commons. In-orbit missions, on the other hand, require constant monitoring in order to avoid potential collisions and radio frequency interferences. Stern's (2011, p. 221) updated version of the principle, "*Establishing independent monitoring of the resource and its use that is accountable to the interested and affected parties*", is more applicable to global commons governance.

Involving interested parties in informed discussion of rules is a foundational principle within the system of international relations¹⁷. However, ensuring meaningful and effective participation within a highly diverse society is a major challenge. In fact, as Stern argues, the benefits and losses of degradation fall to largely different stakeholders which often result in various disputes in any specific governance setting (Stern, 2011). Moreover, the international law-making process is quite slow as participants often have entirely different interests with regards to regulatory and institutional arrangements. In general, reaching an agreement takes years of negotiations. OST treaties, for instance, were agreed upon following years of discussions within the Legal Subcommittee. At this point, a large body of research suggests that encouraging states and other stakeholders to adopt, harmonise, and change are crucial requirements for effective governance in global settings (Dietz & Stern, 2008) (Ostrom, et al., 2003). Moreover, it is widely argued that ensuring equal participation of public, commercial, and private organisations is a vital part of effective rule development processes in global

¹⁷ COPUOS Legal and Technical Subcommittees, UNCLOS committees, the Arctic Council, and various other UN bodies include numerous stakeholders from public and private institutions.

commons governance (Dietz & Stern, 2008). Establishing such a participatory system in the OST regime would enhance the legal and scientific discussions and yield long-term cooperation in confronting the space debris problem.

Allocating authority to allow for adaptive governance at multiple levels from local to global is related to overcoming the collective action problem in the provision of governance in global commons. First offered by Ostrom et al. (1961) later elaborated as the *polycentric approach* (Ostrom, 2010), this principle is aimed at preventing the chaotic system of governance resulting from high number of governments. As discussed previously, the existing governance arrangements within the sea regime indicate a similar chaotic system when dealing with the fishery, whaling, and shipping activities in the oceans where mandates and authorities cause serious legal and operational problems (GOC, 2015). It is proposed that the “polycentric system” allows participants to have more efficient task distribution and cooperation in managing natural resources (Weschler, 1968). Therefore, Ostrom’s polycentric approach (2010) represents an appropriate governance system for global regimes with multiple governing authorities at different levels, instead of having monocentric units. A polycentric model for outer space governance can be established when national, regional, and international space legislation and agents are sufficiently integrated and have substantial regulatory and organisational harmony. Moreover, other public and private organisations need to be engaged in different levels of governance.

Employing mixtures of institutional types refers to having complex, redundant, and nested institutional variety in global governance (Ostrom, et al., 2003). Single-level centralised strategies for governing large resources have shown to cause environmental degradation (Berkes, et al., 2000). Having institutional variety as a part of a global governance, to increase information sharing, monitoring, induce compliance, and dispute resolution, is fundamental for global governance. The challenge of establishing such “institutional combinations” as Stern describes (2011), is finding an appropriate organisational structure that can effectively implement the other design principles previously discussed. As such, the last principle of *establishing low-cost mechanisms for conflict resolution* is directly embedded within this principle. In fact, although all of these principles are inter-related, institutional and regulatory arrangements comprise the two fundamental aspects of every governance system. Moreover, such a functioning institutional system must be integrated and adopted within regional,

national, and local institutions (Stern, 2011). Establishing polycentric institutional variety is a huge challenge for outer space governance considering the current diverse state of space cooperation. However, it is necessary in successfully confronting the space debris issue.

To conclude, Ostrom's principles for global resource governance present profound shifts for the global commons regimes. Previously identified key governance deficits can be dealt with by utilising her principles. At the same time, it is necessary to take into account emerging technological and scientific developments in the implementation of these principles. As Ostrom stresses (2003, p. 1910), "as the human footprint on the Earth enlarges, humanity is challenged to develop and deploy understanding of large scale commons governance quickly enough to avoid the large-scale tragedies that will otherwise ensue". Space debris is one of these tragedies that are created as a result of rapid human expansion in space that took place over the last five decades. Today, the consequences of this irregular and unnatural expansion are threatening global welfare. This research has attempted to review this tragedy based on the foundation of the overall state of global commons regimes and similar environmental tragedies occurring therein. In light of the discussed principles, it concludes with a number of policy proposals aimed at addressing the tragedy of outer space commons.

5.3. Cleaning up the Junk: Policy Proposals for Space Debris

It can be argued that governing the space debris problem poses fundamental challenges of legal, economic, and scientific dimensions. First, there is a lack of binding international agreement on the space debris issue (Imburgia, 2011). Second, remediation and mitigation processes of space debris are extremely costly (Wiedmann, et al., 2004). Third, substantial scientific advancements are required in active debris removal methods in order to prevent debris collisions from cascading (Castronuovo, 2011). In addition, a lack of institutional and regulative arrangements amongst these dimensions is prevailing within the entire international space debris regime (Pusey, 2010). In the light of aforementioned, this research recommends that (1) a binding agreement concerning the issue of space debris should be established; (2) access to space should be taxed and a dedicated fund for orbital preservation should be established; and (3) an international space agency under the auspices of the UN should be established.

5.3.1. The Space Debris Treaty

As discussed previously, the existing UN treaties on outer space are incapable of dealing with the problem of space debris. Although some argue that the liability and registration conventions should be reformed and updated (Roberts, 1992) (Lamperitus, 1991) (Pusey, 2010) and that a new treaty would be an impractical option for addressing the orbital debris issue (Mirmina, 2005), this study argues that the first and most important method to confront the tragedy is to establish a legal regime that clearly defines, effectively regulates, and strictly obliges the mitigation and removal of orbital debris. In doing so, the Legal Subcommittee of COPUOS must engage in extensive dialogues with various stakeholders including state representatives, non-governmental organisations, national and regional space agencies, commercial and private space firms, and scientific and technological institutions in establishing the treaty. The Committee should also emphasise and prioritise the ecological conditions when devising rules as encouraged by Ostrom's principles.

The definition of the term space debris is of great significance in dealing with the tragedy. Therefore, the treaty should define the term space debris in order to clarify the issue of liability and to resolve the disputes that emerge due to the absence of an applicable term. Colonel Imburgia's definition on the term can be utilised as it encompasses all forms of space debris present in the orbital environment (2011, p. 621):

“all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional, regardless of whether the debris is created accidentally or intentionally; the term includes, but is not limited to, fragments of older satellites and rocket boosters resulting from explosions or collisions, as well as any non-functional space object, such as dead satellites, spent rocket stages or other launch vehicles, or component parts thereof”.

Existing non-binding space debris mitigation guidelines¹⁸ should be utilised when implementing the provisions of the new treaty, this includes the limitation of debris production from new launches, the issue of compensation for damages caused by space debris, removal of space debris created, information sharing, and other measures. Moreover,

¹⁸ IADC Space Debris Mitigation Guidelines of 2007 and Space Debris Mitigation Guidelines of the COPUOS of 2010

the new treaty should address the inadequacies within the 1972 Liability Convention and the 1975 Registration Convention. For instance, it should require parties to exchange tracking data related to space debris, a provision which the existing legal framework failed to provide.

The treaty should have necessary provisions and mechanisms with respect to enforcement and dispute resolution. Similar to the Maritime and Antarctic regime, the Space Debris Treaty should require state parties to enforce provisions and resolve disputes peacefully in compliance with the UN Charter and through international courts (Imburgia, 2011). The treaty should limit the military activities in the orbital environment and categorise, regulate, and control existing and emerging space activities in space such as asteroid mining and space tourism. Finally, the treaty should establish necessary provisions for the taxation of space activities and for the establishment of a dedicated fund for outer space maintenance, as well as the international space agency and its organisational structure and activities.

5.3.2. Taxing Access to Outer Space and the Orbital Conservation Fund

Similar proposals have been made within the literature to tax access to outer space (Pusey, 2010) and to establish a fund in order to conduct scientific experiments and remediation activities to clean up the orbital environment from space debris (Williamson, 2006) (Sundahl, 2000). As the current debris situation poses great financial and technical challenges, it is widely argued that applying tax and creating a fund for scientific research and debris removal missions would be considered less burdensome for states (Imburgia, 2011). The system would operate similar to how highways and other public transport services are maintained. Users would be taxed for benefiting from the services and the collected funds would be used to maintain the environment and the infrastructure therein. Accordingly, for every launch, depending on the quality and quantity of the mission, states and private companies should be taxed by the International Space Agency.

As Pusey suggests (2010), by means of creating inducements for environmentally conscious design and engineering, the tax would change based on mitigation procedures implemented and applied after the launch by the responsible satellite operator. For instance, satellite operators that comply with the Space Debris Law might receive a reduced tax expense, otherwise the operators and responsible state would receive higher tax liability. In this way, the tax system would establish a fair setting in collecting tax revenue and would encourage

and eventually increase responsible conduct in space affairs. The International Space Agency, created by the Space Debris Treaty, would be responsible for collecting and maintaining tax revenues. Collected revenues would be redistributed into scientific research, education programmes for space situational awareness, and development processes, eventually contributing to mitigation and ADR projects. Moreover, with the unprecedented growth of commercial space firms, such as SpaceX and Boeing, the increasing number of activities can create more funds to enhance efforts to achieve long-term sustainability of outer space by utilising and improving space traffic management activities and information exchange programmes.

5.3.3. International Space Agency

There are various studies conducted on the creation of environmental regimes which point out the necessity of a global mechanism to unify existing separated instruments and experimental knowledge in order to achieve sustainable development and environmental protection (Young & Osherenko, 1990) (Haas, 1989). As the organisational body of the Space Debris Treaty, an International Space Agency (ISA) would be of great importance for not only achieving safe, secure, and sustainable access to outer space but also for global welfare and development. Such an important organisational body should be established under the auspices of the UN and should be comprised of national and regional space agency representatives, UN officials as well as representatives from other commercial and international space organisations and institutions. A great example of such cooperation is the International Space Station which has been operating for almost two decades. The same level of dedication and ambition should be ensured when establishing the ISA in order to offer credible protection and cooperation in the outer space environment.

The presence of such a unified international agency to coordinate and guide international negotiations, compliance monitoring, and dispute resolution processes is crucial for a successful space debris governing regime. Moreover, the agency would provide a polycentric governance system that can benefit national and regional space agencies and also provide critical lessons to the agency from local experiences when dealing with space affairs. As David Tan suggests (2000), the agency should have a truly inter-disciplinary approach that includes expertise from the fields of science, technology, health, economics, international security, law, and other areas. The contributions from these fields would play a profound role in

shaping the space regime formation, particularly in developing and implementing global policy actions. In addition to having the financial responsibility for collecting and redistributing tax revenues, the agency would be responsible for making recommendations to the UN to adopt additional binding rules and enforcement mechanisms to the proposed space debris treaty.

Finally, a similar agency model proposed by David Tan suggests a number of guidelines that can be utilised in order to increase the effectiveness of the ISA (2000, p. 214):

“(1) the formulation of a clear mission objective, agreed to by the signatories of space debris treaty; (2) the acceptance of the role of the ISA in an organisational structure that reflects the interest, power, and capabilities of member states; (3) the minimisation of bureaucratic inefficiency through the establishment of an able and professional Secretariat within ISA to coordinate transnational scientific, technical, technological, and legal matters maintaining at all times an apolitical agenda; (4) the authority to engage in research on the effects of all space activities on the outer space environment; (5) the authority to recommend, from time to time and without need to achieve consensus, relevant principles to be included in a protocol of the space debris treaty.”

5.4. Conclusion

Achieving the long-term sustainability of outer space depends on the international community's reaction to the many challenges confronting it and reflecting on the lessons from the global commons on Earth, so as to avoid making the same mistakes, as detailed in this research. The tragedies occurring in global environments require effective global responses. The proposed policy recommendations are aimed at resolving the key governance challenges in the legal, economic, and scientific fields by emphasising the significance of international organisational and regulatory arrangements. These recommendations are utilised with the lessons derived from Ostrom's principles discussed in this paper. In this regard, an international treaty on space environment protection, a financial programme in managing the cost of debris removal programmes and maintenance of spatial resources, and an international space agency to coordinate these fields and provide substantial cooperation between space actors, are offered as fundamental steps. On the basis of these

recommendations, a course of action can be plotted to, at the very least, further mitigate the tragedy in outer space and thus preserve the common heritage of mankind.

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