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SCHOOL OF GLOBAL STUDIES

Outer Space Regime and the Issue of Space Debris

An analysis on the Committee on the Peaceful Uses of Outer Space on space debris from 2006 to 2019

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Abstract

With several actors entering the space scene and the skyrocketed increase in the launches, space exploration has become more complex, so does the challenges related to the threat posed by space debris. To deal with this matter, the United Nations adopted the Space Debris Mitigation Guidelines, and later, the Long-Term Sustainability Guidelines. These international guidelines are non-binding and voluntary, and they open space for actors to behave towards their self-interest. Considering that, this research aimed to analyze the issue of space debris in the context of the discussions of the Committee on the Peaceful Uses of Outer Space (COPUOS) from 2006 to 2019, using a regime theory approach. The background provides relevant data on the space debris context and the legal framework of outer space. The theoretical framework describes the regime theory approach towards international cooperation, followed by a literature review of relevant works about space debris under the regime theory. This research applied thematic analysis to find relevant themes being discussed at the COPUOS, as well as new trends and contemporary issues. It was found that, although the guidelines were important milestones to regulate space debris, the outer space regime still needs to evolve in order to reach the end-to-end problem, as these are changes within the regime – in its rules and procedures instead of its principles and norms. While major events and new trends were being discussed, they indirectly affected the discussions and proposals of the COPUOS over the years. The dissatisfaction of some delegations on issues such as liability towards space debris and the non-binding character of the guidelines was visible, although not leading to important changes.

Keywords: *Space Debris; Regime Theory; COPUOS; Outer Space; UNOOSA; Kessler effect; Long-term Sustainability.*

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"The universe is not required to be in perfect harmony with human ambition."

(Carl Sagan, n.d.)

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List of Acronyms

ADR	Active Debris Removal
ARRA	Rescue Agreement
ASAT	Anti-satellite weapon
COPUOS	Committee on the Peaceful Uses of Outer Space
CPR	Common Pool Resources
ESA	European Space Agency
FY-1C	Fengyun-1C
GEO	Geostationary Orbit
IADC	Inter-Agency Space Debris Coordination Committee
IR	International Relations
ISS	International Space Station
LEO	Low-Earth Orbit
LIAB	Liability Convention
LTS Guidelines	Long-term sustainability of outer space Guidelines
MEO	Medium-Earth Orbit
MOON	Moon Agreement
OECD	Organization for Economic Co-operation and Development
OST	Outer Space Treaty
OST	Outer Space Treaty
PF	Payload Fragmentation

REG	Registration Agreement
SDGs	Sustainable Development Goals
SDM Guidelines	Space Debris Mitigation Guidelines
UN	United Nations
UNOOSA	United Nations Office for Outer Space Affairs
US	United States
TA	Thematic Analysis

Chapter 1

1.1 Introduction

Outer space exploration has always shone in the eyes of society. With the advent of the first space age, marked by the launch of the first satellite into orbit on October 4th, 1957 - Sputnik I - the space race would give its initial steps. While it was a time of several milestones to the two major spacefaring nations in the sphere (The United States and The Soviet Union), it was also the beginning of a problem which the consequences can be seen now: the accumulation of space debris. According to the European Space Agency (ESA 2021b, 8), since the first launch of an artificial satellite into space, there has been more space debris than functional objects into the Earth's orbits. For clarification, this thesis uses the definition of space debris as "all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional (United Nations 2017, 89)".

With the beginning of space exploration, the International Space Law emerged, focusing its efforts on regulating space activities. It was in the context of the Cold War that the main principles and treaties were created, forming the legal framework of outer space in a pacific way. However, even with the idea that Space Law refers to an avant-garde subject, it is curious to observe that the last treaty of the regime was ratified in 1979 (The Moon Agreement). Nonetheless, contemporary issues related to space activities continued to emerge, such as the space debris with the advance of space programs, number of launches and activities as well as new actors in the field - most of these not framed on the treaties from the past.

The end of the Cold War marked a period in which several emerging countries and private companies started or intensified their space programs. Taking into consideration the number of space companies established from 2000 to 2016, it is possible to observe that this number has jumped from 8 to an impressive 347 (Merhaba et. al. 2019, 2). Concomitant to that, an increase in revenue generated in the space sector can be noticed. According to the Space Foundation Annual Report (2019, 11) the space economy, in 2018 increased more than 8%, representing $414.75 billion in space activities – the first year that exceeded $400 billion. Accordingly, 21% of that was related to government activities ($85.55 billion), while 79% corresponded to commercial endeavors; $230 billion in commercial space products and services and $100 billion in commercial infrastructure and supporting industries (Space Foundation 2019, 11). This prosperous scenario and the entry of new actors into space exploration have their side effects. Even though space may seem vast, the orbits in which the rockets and satellites are launched are a limited natural resource (ESA 2021a).

Accidental collisions, explosions, and intentional destructions from the past resulted in millions of fragments of space debris that orbit uncontrolled and high velocities, posing a threat to operational satellites and manned missions that may cross their way (ESA 2021a). Even a small piece of debris that collides with a spacecraft at a high velocity could result at the end of the entire mission. Furthermore, the highest population of debris is concentrated in the Low-Earth orbit (LEO). This is due to the lower costs and easiest access to the LEO, which turned this into the most used one and answers by the highest satellite population. The crowded scenario poses a threat to eventual collisions, that would create clouds of debris that could lead to a chain reaction of collisions (or the so-called Kessler effect), turning the LEO unusable. Some analysts believe that this region has already achieved its critical density, which means that even if no other objects are launched, fragments will continue to be generated via collisions (Hall 2014, 10).

At the same time that the issue of space debris continues to grow, so does society's dependence on the services that can only be provided using space technologies. The socio-economic impact resulting from the possible loss of essential space applications such as space-based observations for weather, climate monitoring, earth-observation, and satellite communications, would be catastrophic (OECD 2020). With satellite technology becoming more and more reliable, thus the necessity of protecting the orbits that are vital for humanity (ESA 2021a).

Furthermore, the issue of space debris poses a challenge for the near and long-term sustainability of outer space. At the same time, the International Space Law is inefficient to follow and regulate the new trends and actors in the field. Concerned about the space debris issue, the Committee on the Peaceful Uses of Outer Space (COPUOS), a body from the United Nations Office for Outer Space Affairs (UNOOSA) responsible for legal issues, created a set of guidelines for Space Debris Mitigation (SDM Guidelines) adopted in 2007. In addition, the Committee adopted a set of guidelines related to the Long-Term Sustainability of Outer Space (LTS Guidelines) in 2019, which not only approaches the issue of space debris but also a variety of other space-related topics. While the guidelines provide a list of mitigation measures to preserve and guarantee the sustainability of outer space for future generations, they also have another characteristic in common. These guidelines are of a non-binding and voluntary character according to the International Space Law, lacking enforcement mechanisms that may lead actors to behave according to their self-interest.

The risk of acting "selfishly" in outer space, especially with weak or no formal rules, is the so-called "tragedy of the commons", taking into consideration that outer space is a common good that is open for all, and the Earth's orbits[1] are a common pool resource (CPR) with limited access. As stated in the Organization for Economic Co-operation and Development (OECD) report on Space Sustainability, "comprehensive national and international mitigation measures exist, but compliance is insufficient to stabilize the orbital environment (OECD 2020, 7)". The compliance rate for mitigation measures in the LEO is much lower than in the Geostationary Orbit (GEO) (OECD 2020).

Acknowledging the relevance of the topic in society and the international sphere, this study aims to analyze the COPUOS discussions related to space debris from 2006 to 2019 using the regime theory approach. For that, it draws on a background of the space exploration and space debris context, highlighting the new actors and challenges in the field. The literature review is based on bibliographies written around outer space and regimes to address what has been done in the field so far. Furthermore, it describes the regime theory approach to international relations - which explains the cooperation among the nations with a focus on the role of regimes to apply to the space regime and the issue of space debris. The documents utilized in the analysis account for reports from the annual meetings of the Committee, which contain recommendations, discussions, and decisions on - among several topics – space debris and long-term sustainability. The timeframe for the analysis aimed to cover the main milestones identified in the Committee related to space debris. In this context, it intended to understand how the topic changed over the years and which are the inflection points in the discussions.

[1] "An orbit is the curved path that an object in space (such as a star, planet, moon, asteroid or spacecraft) takes around another object due to gravity (ESA 2020)". Most satellites are placed in the Geostationary orbit (GEO), Medium Earth orbit (MEO) and Low-Earth Orbit (LEO), in which each orbit will designate different functions to the satellite.

1.2 Aim and research questions

As seen, the issue of space debris continues to grow, posing a challenge for the long-term space activities and the orbits that are essential for society. At the same time, space programs are launching as never before while new actors enter the field of space exploration with audacious plans. In this perspective, the study of the issue of space debris under a regime theory approach can be useful to understand the advances and barriers for a legal framework on the topic. Therefore, this study aims to analyze the COPOUS discussions related to space debris from 2006 to 2019 using the regime theory approach. Acknowledging the relevance of the topic in the society and the international sphere, the research questions that guide this study are:

R1. What is the politics behind the discussions about space debris at the Committee over the times analyzed?

R2. What are the correlations between the space debris events and the discussions and proposals of the COPUOS?

R3. Which new trends can be identified in the discussions of COPUOS?

1.3 Delimitations

Some delimitations need to be accounted for to achieve the objectives of this study. It is acknowledged that all the actors of space exploration account for the issue of space debris and thus should work together to revert the scenario. Given that the main theories related to regimes focus on the role that States play, and that these are the main actors that account for the international legal framework of outer space, the analysis has greater attention on them. The private exploration of space is a relatively new phenomenon and calls for a better understanding of issues of liability, but those still respond under their respective countries. Nonetheless, the critics related to the theory and the increasing role that non-State actors have in regimes are mentioned.

Furthermore, the legal framework chosen for the analysis is part of the COPUOS because it was understood that it embraces a greater number of States and International Organizations, despite the fact international regulations from other organizations also play an important role in regulating outer space. Another point is the national mitigation measures adopted by different countries that are not described. They vary significantly and shall be accounted as the results of international efforts.

1.4 Relevance to Global Studies

This section aims to reflect on which ways the proposed research is relevant to Global Studies. The field of global studies is often linked to studies of globalization that emerged in the 1980s and 1990s, shaped by events from earlier periods (Darian-Smith and McCarty 2017, 13). In this sense, space exploration – in special the first space race - helped to shape the idea of a globalized world. Among other events of a world postwar, the success of the missions Apollo - which accounted for the first man on the Moon, "reflected a remarkable period in which a new global imaginary of mankind's interconnectedness emerged and took on weight in the popular imagination, particularly in the United States (US) (Darian-Smith and McCarty 2017, 15)".

With the entry of emerging space fairings and private space companies into the space arena, as well as the intensification of space programs established in the 1950s, the way that space exploration has followed since 1957 changed. Accompanied by the escalation of space activities with the number of launches increasing year after year, the study of contemporary issues such as space debris mitigation and the sustainability of outer space is now more crucial than ever. Nonetheless, although the politics of outer space are highly linked with Global Studies, the field lacks enough studies about space in general – in special about the proposed aim. Having this in mind, this research contributes to Global Studies by offering a perspective of regime theory approach into the International Space Law with special regard to the issue of space debris. The study of regimes is a key point to understand cooperation between states (and most recent non-States) in the international system with a critical view. Furthermore, this can be associated with the debate of new institutionalism within the International Political Economy (O'Brien and Williams 2016).

In a broader perspective of Global Studies, space technologies are a key tool in providing information in real-time in humanitarian crises and natural disasters, being essential for contemporary society. In addition, the UN recognizes their importance in supporting the Sustainable Development Goals (SDGs) (UNOOSA n.d.d). Moreover, space technology is crucial for logistics, especially in a crisis in which it is necessary to "keep stuff circulating (Cowen 2011)". Here lies a wider spectrum of the importance of avoidance of a Kessler effect, as well as the guarantee of the long-term use of outer space.

In the last frontier of space exploration, Global Studies can be used to construct an analysis that is not only limited to borders. Using as an example SpaceX, the company was founded with the main mission of colonizing Mars and "making humanity multi-planetary (SpaceX n.d.)". Together with SpaceX, there are several other companies developing rockets that are (or are highly likely to be) capable of manned flight. If the first private company arrives at the Moon – and the last frontier, Mars – the International Space Law will encounter great questions, such as the appropriation of celestial bodies. While Article II of the Outer Space Treaty states that outer space is not subject to national appropriation by "claim of sovereignty, by means of use or occupation, or by any other means (United Nations 2017, 4)", it does not explicitly mention non-State actors. In this sense, a global imaginary can offer ways to think about social relations and behaviors that are not limited to sovereignty, territory, citizenship, and nationalism (Darin-Smith and Mccarty 2017, 4). A last reflection concerns *our* behavior with outer space. When we land once again on the Moon and for the first time on Mars, we will encounter several "space trashes" in these celestial bodies, remains of failed and past missions and dead rovers put there by us. Not only are we trashing our planet, but also outer space even before going there. This is a consideration to be made about *our* actions, not only towards Earth (that is the only planet that is known – so far – to harboring *our* civilization), but also towards the cosmos.

Chapter 2: Background

The following chapter aims to present a brief background on the issue of space debris, bringing the historical process that led to the current scenario. Furthermore, it explores the new actors in the space field as well as the situation of space debris in numbers. It follows with a background of the legal framework of outer space to understand the main principles and treaties that shape the Space Law. With that, it is intended to provide an overview of the issue and data to support the aim and research questions of the analysis.

2.1 Space exploration and the space debris

The issue of space debris started just about the beginning of space exploration during the first space race. For clarification, the first space age was initiated during the Cold War, and it was marked by the space race between the two main spacefaring nations of the time - the United States and the Soviet Union. Nonetheless, space debris was not understood as being a major threat by the time. With just a few countries on the game, space was perceived as an infinite field. As pointed out by Lehnert (2011, 1), outer space was treated as if it was an endless space for all human activities, marked by the neglect of policies.

Nevertheless, some indirect efforts to understand the issue of space debris in the past can be pointed out. Years before the launch of Sputnik I, some scientists, were already concerned about the possibility of the existence of natural debris that could lead to the failure of future manned missions by the threat of collision (Hall 2014, 1). With that, the astronomer Clyde Tombaugh ran a project from 1953 to 1958 funded by the US Army Office of Ordnance Research in order to identify natural satellites (Hall 2014, 1). While the final report on 1959 stated that no evidence was found, the project also stated that Sputnik I was spotted by their telescope, providing proof of the inexistence of natural satellites before the first launch into LEO (Hall 2014, 1).

Furthermore, when launched, the rocket parts of Sputnik I accounted for more debris than the active satellite per se, although all the objects of the mission returned and burned in the atmosphere after a couple of months (Hall 2014, 2). The satellite that was responsible for the beginning of space debris accumulation - and is the oldest dead artificial object in orbit - was the Vanguard 1, launched by the US in March of 1958 into the medium-Earth orbit (MEO) (Hall 2014, 2). While its mission lasted until 1964 there is an expectation that the satellite will remain in orbit for at least 200 years, showing not only the "presence" of the US but the consequences of the negligence of space programs in remediating long-lived debris. Concomitant to that, already in the 1970s some scientists were arguing that most of the objects launched into orbit would remain there for years, increasing the risks of a collision that would create thousands of fragments that could lead into a chain effect of collisions, or Kessler effect (Lehnert 2011, 1).

2.2 Kessler effect

The Kessler Syndrome – or collisional cascading – was proposed by Donald Kessler at the National Aeronautics and Space Administration (NASA) in the ’70s after abandoned Delta rockets exploded and created clouds of debris (Corbett 2016). With that, Kessler demonstrated that once the space debris achieves the critical mass in an orbit, the effect begins even if no more objects are launched until the orbit becomes unusable (Corbett 2016). Since then, the Kessler effect is a key concept in articles and books about space debris. It is used in this study to explain a scenario that would be the final consequence of a crowded orbit in which, given the number of debris orbiting in high velocities, would result in such a high risk to manned missions and space activities that the orbit could be no longer used.

With that, the concept of long-term sustainability is highly linked with the idea of avoidance of a Kessler effect. Space sustainability is the ability to conduct space activities indefinitely, guaranteeing the use by future generations. As stated by COPUOS (2018, 02):

> “The long-term sustainability of outer space activities is defined as the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations (COPUOS 2018, 02)”.

While the accumulation of space debris poses a risk to the use of Earth’s orbits, there is particular attention to the LEO. This orbit has been used as never before, driven by the low costs associated with its launch and the rise of new emerging national programs and private spacefaring actors. The contemporary dilemma confronted is the dichotomy of guaranteeing sustainability in the long-term in terms of keeping it functional and yet, economically profitable.

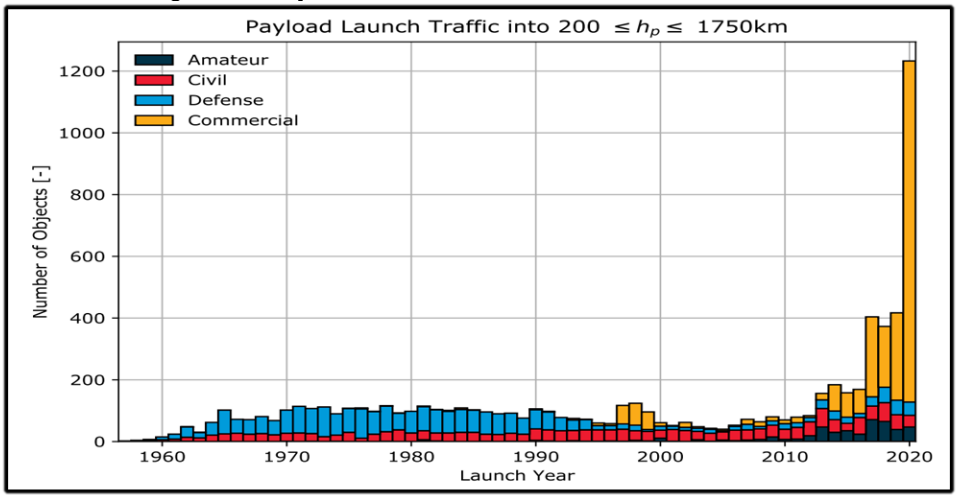
2.3 From national to commercial agencies

Despite the accumulation of space debris from the past, the scenario would see a drastic increase in its second age, marked by the entry or intensification of space programs from non-classic actors. The way of space exploration that prevailed since the early 1950s was marked by direct government involvement within the military sphere or through the creation of space agencies (Genta 2014, 480), suffering an inflection after the end of the Cold War. With the national space budgets dropping significantly, together with a “shrinking” process that started in the 1980s and 1990s, based on mergers, acquisitions, or closure of space companies, the private space sector emerged (Gomes et. al. 2013, 2).

As a result of this shift, the 21st century indicates a new phase for commercial space-fairings, in which the private space market has grown considerably (Gomes et. al. 2013, 3). Given the dynamic characteristics of the space sector, it can be argued that a new space race is emerging (Gomes et. al. 2013, 5). With the rise of space tourism and more and more powerful commercial rockets being developed, the space race confronted now is directly driven by the market. While private companies launch more and more, either to “sell” the company or for purposes of power, space exploration gives space to a phenomenon being called the “billionaire space race”.

At the same time that space exploration intensifies, and new actors enter the sphere, thus the number of objects launched into Earth´s orbits, with special attention to the LEO. When analyzing the chart below that shows the number of objects launched into LEO from 1957 until 2020, it is possible to see that the commercial payload increased considerably in the past years, with a significant jump from 2019 to 2020, accounting for way more than any other category.

Figure 1: Payload Launch Traffic into 200 - 1750km



Source: ESA 2021b, 26.

The changing point has its origins in mega-constellation projects. For clarification, satellite constellations can be understood as a group of satellites that work together in synchronized orbits complementing - instead of interfering - each other to provide ground coverage (Baudoin et. al. 2020).

2.4 The Low-Earth Orbit and the mega-constellations

The current access to the Internet is highly dependent on satellite transmission via towers and cellular cables, which results in disparities in the access to the Internet in different regions, not being such an available option in remote areas (Baudoin et. al. 2020). The mega-constellations emerged as affordable alternative broadband access, which will have global coverage through high-performance satellites. As mentioned before, what most of these projects have in common is the orbit in which they are launched, the low-Earth orbit.

Currently, there are several companies with mega-constellation projects underway. Leading in the number of launches and satellites is SpaceX's project, Starlink. It is estimated that the company had, by March 2021, about 1300 satellites in orbit, deployed through 23 launches (Duffy 2021). This is a small number when taking into consideration SpaceX's plans to launch up to 42000 satellites by 2027 (Duffy 2021). Furthermore, the global communication network, OneWeb, had 146 satellites in orbit by March 2021, with an original plan consisting of 650 satellites by 2022 (OneWeb 2021). Another mega-constellation project is the Amazon Kuiper System that is led by the company Amazon, planning on launching 3236 satellites. In addition, several other companies announced their projects to build mega-constellations, such as Facebook, Samsung, Boeing, China's Hongyan among others that were either delayed, put on hold, or have been publicly quiet (OPM Research 2021).

According to OECD (2020, 18), with the deployment of one or various mega-constellations, the number of operational satellites in orbit can double or triple in the next five years, with several tens of thousands by 2030. As stated by OECD (2020, 18), based on multiple modeling efforts, given the orbital density, it is not a question of if a dead satellite will collide with orbital debris, but when.

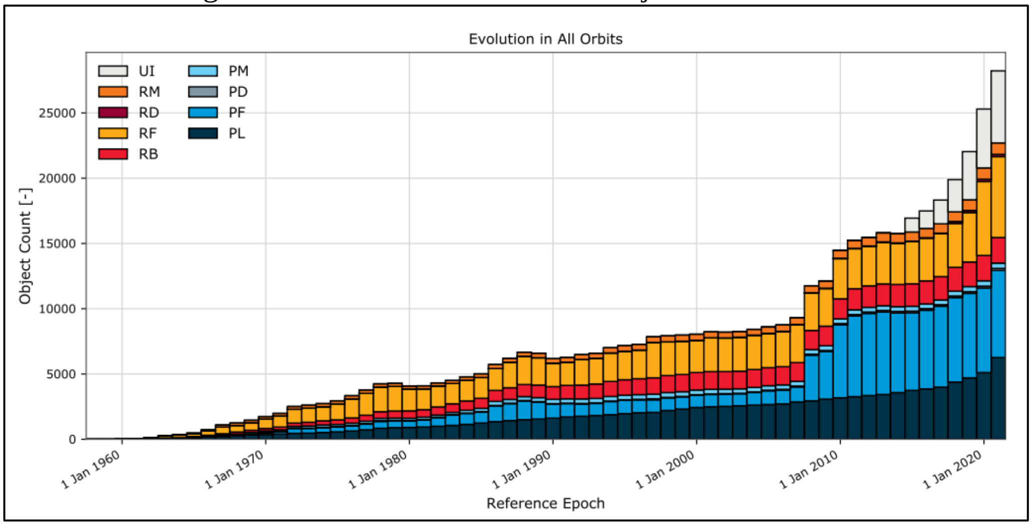
While satellites placed more than 1000km would take one to five years to de-orbit by natural decay, they are likely to fail and become hazard objects that are incapable of maneuvering in case of imminent collision (Baudoin et. al. 2020). Even with a low failure rate, when thinking about the total number of satellites, this raises concerns. McDowell (apud Duffy 2021) estimated that by November of 2020, 2.5% of the Starlink satellites launched may have failed in orbit. If this rate persists, the full deployment of the mega-constellation would result in more than 1000 dead satellites (McDowell apud Duffy 2021). While the mega-constellations affect astronomers' observations by "illuminating" the dark sky, they also pose a serious threat to the long-term sustainability of outer space. The space debris scenario already accounts for several objects and fragments from past missions, collisions, and intentional destructions, being even deeper affected by contemporary space activities.

2.5 Space Debris in numbers

Three main events are responsible for the creation of debris. The first one is by accidental means, which occur mainly from collisions and explosions. As an example, there is one of the major events in space debris, the collision between Iridium 33 - an operational communication satellite from Virginia - with the Cosmos 2251 - a Russian deactivated satellite – in February 2009. The event created more than 1,600 detectable objects, many of them still in orbit (Hall 2014, 4). Secondly, there is the intentional creation of debris, which consists of activities such as the destruction of dead satellites through the use of anti-satellite weapons (ASAT). The intentional destruction is particularly alarming, as it could be avoided. The intentional explosion of a space object through an ASAT can generate a cloud of thousands of small debris that put at risk operational satellites and even the International Space Station (ISS). In 2007, the Chinese ASAT test towards its dead satellite Fengyun 1C (FY-1C) increased the number of trackable space debris, alone, by 25% (ESA n.d.a). The last way of creating debris is by debris released intentionally, which can be associated with satellite deployment operations that release aluminum and explosives used to detach the satellite from its launch vehicle that disintegrates in smaller particles (Hall 2014, 2). With that, intentional and non-intentional events demonstrated that just a few incidents can drastically affect the issue of space debris.

The impact of these two events is visible when taking into consideration the evolution in the number of objects in all orbits, as seen in the chart below. The Payload Fragmentation (PF) from the years 2007 and 2009 suffered a visible increase. For clarification, PF refers to objects fragmented or unintentionally released from payloads by a unique event, such as payload explosions and collisions with another object (ESA 2021b, 9). Another point noted is the significant growth in objects that are still in orbit after the 2000s, marked by the entry of new space actors as seen before.

Figure 2: Evolution of number of objects in all orbits



PL: Payload; PF: Payload Fragmentation Debris; PD: Payload Debris; PM: Payload Mission Related Object; RB: Rocket Body; RF: Rocket Fragmentation Debris; RD: Rocket Debris; RM: Rocket Mission Related Object; UI: Unidentified.

Source: ESA 2021b, 4.

Furthermore, in order to have an overview of the current scenario on space debris by numbers and categories of space debris, the European Space Agency (ESA 2021d) data is presented. The total of rockets launched since 1957 (excluding failures) is around 6020, with around 10680 satellites placed into Earth's orbit. From this, about 6250 satellites are still in space, of which only 3600 are operational (ESA 2021d). The number of debris that is tracked and maintained in the catalog of Space Surveillance Networks is around 28210, representing a mass of more than 9200 tones with an estimated number of 550 break-ups, explosions, collisions, or other events that result in fragmentation (ESA 2021d). Statistical models estimate that there are 34000 objects larger than 10cm into orbit, 900000 larger than 1cm to 10cm, and 128 million greater than 1mm to 1cm (ESA 2021d). It is important to point out that only a small fraction of debris can be detected and tracked. After analyzing the current scenario of space debris and its shifts, another point is the possible measures to control and revert the issue.

2.6 Space Debris Mitigation and Remediation

There are two main ways of dealing with the issue of space debris: mitigation and remediation measures. Although the study does not discuss the techniques and technologies that are being developed for the removal of debris, the explanation of the concepts is necessary to understand the barriers accounted on the legal framework and discussions. Mitigation can be understood as "a class of actions designed to lessen the pain or reduce the severity of something (Baiocchi and Wesler 2010, 13)". With that, mitigation measures do not end unwanted behavior, but aim to reduce its frequency and consequences to prevent a problem from getting worse, usually through standards, rules, and regulations (Baiocchi and Wesler 2010, 13). Remediation, on the other hand, aims to remove existent pieces of debris within active debris removal (ADR) techniques, such as inoperative or uncontrolled objects (Popova and Shaus 2018, 8-7). While mitigation measures are applied to reduce the number of objects yet to be launched, remediation deals with the consequences of an already congested scenario by removing the debris that represents a threat to space activities (Popova and Shaus 2018, 8). The authors argue that to overcome the issue of debris into a catastrophic state, a combination of mitigation and remediation measures is needed (Popova and Shaus 2018, 4).

According to ESA (n.d.b) the most effective measure to stabilize the space debris scenario to a safe level on a short-term basis would be to reduce the space debris growth rate (preventing explosions and collisions), and in the long-term, to comply with post-mission guidelines. In addition, the removal of 5 to 10 large pieces of debris per year may be necessary to stabilize the growth of the debris population (ESA n.d.b). While space debris remediation measures were proposed at the international level, they were not adopted. To understand the regime of outer space and how it deals with the issue of space debris, as well as the legal barriers, it is necessary to contextualize the legal framework of outer space.

2.7 Outer Space Legal Framework

The following section presents a background on the legal framework of outer space, introducing the main principles and treaties that shape the regime. Furthermore, it describes the Space Debris Mitigation Guidelines (SDM Guidelines) and the Long-Term Sustainability Guidelines (LTS Guidelines) related to space debris. Given that the focus is on the United Nations, parallel agreements, although not less important, will not be explained in detail. To understand the outer space regime, first, the concept of Space Law needs to be addressed. Space Law is described by the UNOOSA (n.d.c) as:

> "...the body of law governing space-related activities. Space law, much like general international law, comprises a variety of international agreements, treaties, conventions, and United Nations General Assembly resolutions as well as rules and regulations of international organizations. (UNOOSA n.d.c)"

Therefore, Space Law is commonly associated with rules, principles, and standards of international law that are present in the five treaties and principles of outer space developed under the UN (UNOOSA n.d.c). In addition to these, states have also developed national legislation for space-related activities (UNOOSA n.d.c).

Although the space legal framework was established in the 60s, Space Law dates from earlier stages, being first mentioned in 1910 in a journal article in Paris, despite vague and just quoted as a simple concept (Doyle 2011, 1). In 1932, the first monography of the topic appeared, describing fundamental concepts, and, until the 40s, only a few comments were made, when in 1953 the first doctoral thesis was published (Doyle 2011, 1). When Sputnik was launched in 1957, the concepts from earlier years started to be seen in practice, and the need for regulations increased. Thus, the main treaties that shape the regulation of outer space were built in a world under the Cold War. When thinking about the outer space regime, it is important to take into consideration the rivalries between the major space fairs that shaped the agreements that are still the base for Space Law; as well as the main actors that were accounted for the space race – in which commercial companies did not have such an important role.

To regulate outer space, the Committee on the Peaceful Uses of Outer Space (COPUOS) was established in 1959 by the General Assembly. Since its creation, the Committee has been working on the legal framework of the space arena by reviewing international cooperation towards a peaceful environment, supporting space research programs as well as studying space activities and legal problems emerging from space exploration (UNOOSA n.d.a). The main objectives of the Committee are to “govern the exploration and use of space for the benefit of all humanity: for peace, security and development (UNOOSA n.d.a)”. With that, the Committee meets annually with its members to discuss international cooperation and space-related topics. Furthermore, it counts with two subsidiary bodies (both created in 1961), the Scientific and Technical Subcommittee and the Legal Subcommittee (UNOOSA n.d.a). The Committee then, reports to the Special Political and Decolonization Committee (Fourth Committee of the General Assembly), which is the Committee responsible for the adoption of an annual resolution in “international cooperation in the peaceful uses of outer space” (UNOOSA n.d.a). The reports from the official annual sessions are then published at the UNOOSA website, counting with information about the agenda of the meeting, the members, attendance list, as well as recommendations and decisions.

The Committee was instrumental in the creation of the five treaties and principles of outer space: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty - OST, 1967); Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Rescue Agreement - ARRA, 1968); Convention on International Liability for Damage Caused by Space Objects (Liability Convention - LIAB, 1972); Convention on Registration of Objects Launched into Outer Space (Registration Convention- REG, 1976) and Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement - MOON, 1984) (UNOOSA n.d.e).

These treaties deal with several issues such as the non-appropriation of celestial bodies by any nation; arms control; freedom of exploration; liability for damage caused by space objects; rescue of astronauts and spacecraft; notification and registration of space activities; prevention of harmful interference; scientific investigation and exploitation of resources in space and disputes (UNOOSA n.d.c). The treaties serve as pillars for the development of Space Law, in which all the additions to the regime must be in accordance with them.

The number of States, areas, or organizations that have accepted, signed and ratified these treaties can be seen in the chart below. It is notable the ratification rate on the first (and most important) treaty, accounting for 111 members. The OST contains the basic principles that regulate space activities, serving as the foundation for the following treaties, which makes it often mentioned as the "Constitution" of Space Law (Popova and Schaus 2018, 4). On the other hand, the Moon Agreement has the lowest ratification rate (18) in which none of the major spacefaring nations ratified. One of the main reasons for that lies in the Article XII of the treaty, which states that the benefits derived from the exploitation of the Moon resources shall be shared by State Parties in equal parts, with special consideration to developing countries and those that contributed directly or indirectly for the exploration of the Moon (United Nations 2017, 36).

Table 1: Status of the five international agreements related to outer space

	United Nations Treaties				
	(1) 1967 OST	**(2) 1968 ARRA**	**(3) 1972 LIAB**	**(4) 1975 REG**	**(5) 1979 MOON**
Total R (ratification, acceptance, approval accession or succession)	111	98	98	70	18
Total S (signature)	23	23	19	3	4
Total D (declaration of acceptance of rights and obligations)	0	3	4	4	0

Source: Adapted from UNOOSA 2021

Furthermore, the international law designates the outer space (as well as celestial bodies), as a common global, which means that they are above any national jurisdiction and are understood to belong to all of those that aim to use it for peaceful purposes (Popova and Schaus 2018, 4). After describing the main bodies and treaties, the topic of space debris needs to be addressed.

It is noted that none of these treaties explicitly mention or deal with the issue of space debris. In addition, Tallis (2015, 89), argues that until 2006 there was no mention or definition of "space debris" within international agreements or United Nations documents, in which the author argues, turns unfeasible to address a problem that has not yet been identified and institutionally acknowledged. This can be attributed to the years in which the treaties were adopted and the timeframe in which the UN recognized the issue. While the Moon Agreement (the last to be adopted) dates from 1979, the gravity of space debris would only be addressed by the UN years later.

COPUOS had recognized and reported the issue in 1999 when published its first Technical Report on Space Debris (United Nations 2017). Nonetheless, it would only be in 2007 that, through the work of the Technical Subcommittee, the first Space Debris Mitigation Guidelines would be adopted and endorsed by the General Assembly on the 62/217 resolution (United Nations 2017). The UN guidelines consist of a set of seven voluntary and non-binding measures that were based on the Inter-Agency Space Debris Coordination Committee [2](IADC) Space Debris Mitigation Guidelines from 2002 and should be considered in all phases of a mission (see in appendix). Some of the main aspects dealt with within these guidelines are the limitation of debris released during operations, the limitation of the probability of accidental collisions, the limitation of the long-term presence in LEO after the end of a mission, the limitation of the long-term interference in GEO after the end of a mission, the avoidance of intentional destruction and harmful activities and the minimization of potential break-ups during and post-mission (United Nations 2017, 90-93). Another important point is that they call for action of its members stating that the measures should be adopted by "national mechanisms or through their applicable mechanisms (United Nations 2017, 90)". Since then, several national mechanisms related to mitigation have been increasingly adopted by different member states. These national mechanisms vary considerably given the domestic law of the countries, which results in diverse measures among states.

In 2019, COPUOS adopted a set of 21 Long-Term Sustainability Guidelines. The LTS Guidelines were the result of eight years of work by the Working Group on the Long-Term Sustainability of Outer Space Activities, established in 2010 by the Subcommittee, and the effort of 92 member states (UNOOSA 2019; COPUOS 2010, 26). Among several topics of space exploration dealt with a long-term sustainability perspective - that are indirectly linked with space debris - the guidelines explicitly touch on debris mitigation, stating the need for implementation of debris guidelines such as the Space Debris Mitigation Guidelines (COPUOS 2018, 5). These guidelines are of a voluntary and non-binding character according to international law and should not be interpreted as a new obligation to the members, just as the previous guidelines on mitigation. According to UNOOSA (n.d.b), the guidelines aim to "provide guidance on the policy and regulatory framework for space activities; safety of space

[2] The IADC was stablished in 1993 by the United States, Russia, Japan, and ESA in order to exchange information about debris, facilitate the cooperation in research and identify mitigation options for the issue of debris (Li 2015, 302; IADC n.d.).

operations; international cooperation, capacity-building and awareness; and scientific and technical research and development". Special attention on space debris is found on guidelines 8 and 21. While the first deals with the space debris monitoring information, the last goes further in the debate of long-term sustainability within space debris, focusing on the investigation and consideration of new measures to manage the space debris population in the long term (COPUOS 2019, 60;69). Furthermore, the overview of the guidelines also tackles some of the aspects present in the Space Debris Mitigation Guidelines, such as the disposal of objects in LEO and GEO to limit their long-term presence in the orbits. Going further in the debate of non-governmental actors, the document recognizes the role that those actors play and the importance of States monitoring their activities. Although voluntary, they represent a great effort towards the international regime in order to deal with space debris, showing that the new trends and threats in space exploration are being considered and discussed by the Committee.

Chapter 3: Theoretical framework and literature review

The following section aims to present the main theories and the key concepts that are used in the analysis to help to understand the issue of space debris as proposed. With that, it explains the regime theory approach within International Relations and its main paradigms to further apply to the issue of space debris in the discussions of the COPUOS over the years analyzed.

3.1 Regime theory

Regimes started to get popularity in the 20th century when states were increasingly getting involved in international agreements and rules in order to facilitate interstate relations and create a framework for actors to follow the same norms and rules (Stoyanov 2012, 1). The rising of institutions to govern certain areas, together with the decline of the United States hegemony in the 70s and the rise of technologies and information, the power of ideas, values, and identity created uncertainties for orthodox explanations that did not anticipate cooperation to overcome the chaos in an anarchic system, which led to the creation of a new analytical device to study the development of international institutions (Meiches and Hopkins 2012, 3). The anarchy in the international system corresponds to the absence of central governance to rule the world, in which the actors act to maximize their gains, guarantee the security and sovereignty of their territory. So, when states started to cooperate and create international institutions, some classic views of International Relations that had the chaos under anarchy as central, failed to predict and explain regimes.

According to Bradford (2007, 1) regime theory (or theory of international regimes as proposed by Peterson [2012]) is an approach to International Relations (IR) theory that aims to explain the cooperation among States by focusing on the role that regimes play to mitigate the effects of the anarchy in the international system and overcome collective action problems. Furthermore, international regimes are not to be understood as quasi-governments to govern the politics of the world, but institutions involving States (and increasingly non-State actors) to achieve their long-term goals, structuring and stabilizing relations in favor of all its members (Bradford 2007, 1). Regime theory helps to understand cooperation and collaboration among states even when there is no clear benefit to a single hegemonic actor, given the rise of the complex interaction between countries, organizations, and other institutions (Meiches and Hopkins 2012, 2). Thus, regime theory is a tool in international relations to analyze the role of regimes instead of constituting a theory per se.

Pfaltzgraff (2011, 45) points out that the theories within IR still do not account for space, an inflection that would emerge once more knowledge about this environment is developed. The author proposes to think of space with the existent theories about Earth-bound political relationships as a starting point for the analysis (Pfaltzgraff 2011). Accordingly, if the emphasis is on regimes to codify and regulate the Earth-bound relationships, the same would be extended to space by undertaking efforts to regulate operations in space (Pfaltzgraff 2011, 52). The norms already established about space and how the actors should behave in space could then be understood within an approach of international regimes.

Given that, it is necessary to define the international regime and its characteristics. Although there are several definitions for the regime, Krasner's (1982, 185) concept is convergent with different views and is frequently adopted in regime articles, explaining regimes as "sets of implicit or explicit principles, norms, rules, and decision-making procedures around which actor's expectations converge in a given area of international relations". Krasner´s definition is intentionally vague in order to accommodate different variables to explain the creation and persistence of a regime, which is also the crucial point in its critics (Meiches and Hopkins 2012, 4). The critics argue that this definition leads to an imprecise instrument for the analysis of the potency of international organizations (Meiches and Hopkins 2012, 4). Nonetheless, it is a beneficial concept by providing the tools to analyze a variety of interactions, from explicit actions of formal organizations (such as the UN) to semi-formal (such as the G8) and day-to-day interactions between banks and financial institutions (Meiches and Hopkins 2012, 4).

Principles and norms are the base of a regime, providing its characteristics that are unaltered and giving some sense of general obligation, or reciprocity (Krasner 1982). In accepting such terms, the actors would abdicate their short-term goals with the expectation that others will encompass the given principles. Rules and decision-making procedures, in this sense, should be consistent with the principles and norms. Krasner (1982, 187) points out that changes in the rules and decision-making processes are changes within the regime, given that the base is unaltered. The current International Space Law provides treaties that are the basis for the following additions, so the following rules are in accordance with the main laws. In this sense, the Space Debris Guidelines, as well as the LTS do not represent a change in the regime, but a change within the regime, in its rules and procedures, since they still have as the main principles, the space treaties.

Regimes can change internally (procedures) and not lose consistency, or they can weaken and disappear despite the continuity of practices (change in norms) (Meiches and Hopkins 2012, 4). Meiches and Hopkins (2012, 4) point out that regime theorists diverge considerably on the perception of regime concept and place attention on different variables to explain in what conditions a regime exists, as well as its effectiveness. The authors argue that regime theory often reflects the assumptions of specific paradigms within international relations. The main paradigms to be accounted for are realism, neoliberalism, and a cognitivist/constructivist approach.

Krasner (1982) offers three orientations on regime significance that are the core for the study of regimes, debating various works of authors on the issue and serving as a starting point for the understanding of regime development. The first one, conventional structural, views the concept of the regime as useless (Krasner 1982, 190), and is associated with realist or structuralist interpretations (Meiches and Hopkins 2012, 5; see also Strange 1982). Different strands of realism all share the notion of the international system as anarchic, in which states would act to maximize their power. Here, the concept of regime obfuscates and obscures the real interests and power relationships of states, having no impact on the behavior of actors, so they are merely epiphenomenal (Krasner 1982). The behavior would be the result of power distribution and is altered once the power distribution changes. The realists offer the most conservative interpretation of regime since it lays on regime effectiveness by hegemonic power, giving a secondary role for non-State actors (Meiches and Hopkins 2012, 5). Although this is a great orientation to explain why regimes emerge, it falls into providing an explanation for their continuity and evolution, in special in the space sphere with new actors and issues. Even if the main treaties created in the Cold War can be understood as epiphenomenal, the approach fails to explain their evolution and new rules developed, as well as its continuity with the fall of the Soviet Union.

The second orientation to the regime is the modified structural (Krasner 1982, 191), (or neoliberal perspective as pointed by Meiches and Hopkins 2012, 6), that also shares the concept of anarchy in the international system but differs on the overcome responses for uncertainties, highlighting the role of cooperation. Keohane and Stein (apud Krasner 1982, 191) argue that regimes have a great impact in situations in which Pareto-optimal[3] outcomes would not be achieved by uncoordinated individual calculations of self-interest, a view that is present in game-theoretical examples. Furthermore, regimes cannot be relevant in zero-sum situations, in which the gain of one state means the loss of the other. As proposed by Krasner (1982, 192), there are two paths: most of the situations have a direct link between basic causal variables and related behavior and outcomes (a); but under situations that are not purely conflictual and that individual decisions would lead to a suboptimal outcome, regimes can be useful to generate different behavior and outcomes (b).

Taking the orbits of Earth into consideration, path b is useful if applied in international Space Law and especially the issue of space debris, given that space is not necessarily a conflictual arena, plus uncoordinated actions lead to suboptimal outcomes to all the actors involved. It is specifically applied to the orbits as it is difficult to exclude actors from its use but the space that a satellite or debris occupies subtracts the available space for all (no other object can occupy the same space and the electromagnetic interference of one satellite can affect others). The uncontrolled use of orbits, in special LEO, is a typical example of a "tragedy of the commons". Lam (2011, 02) defines tragedy of the commons as "a concept that denotes a specific type of social dilemma in which interdependent individuals face incentives to choose

[3] "In economic theory, an alteration in the allocation of resources is said to be Pareto efficient when it leaves at least one person better off and nobody worse off ("Pareto Efficiency" n.d.)".

independent actions that maximize their individual benefit but generate a suboptimal aggregate outcome". Figure 2 shows four types of goods as proposed by Ostrom (2009, 413), according to its substractability degree and difficulty of excluding potential beneficiaries. Outer space is a common good and the orbits of each celestial body are common-pool resources in their own right, so a total regime of outer space would have to deal with its infinity and thus is not applicable (Weeden and Chow 2012, 166-172). The analysis focus on near-Earth orbits and their governance framework.

Table 2: Four types of goods

		Subtractability of Use	
		High	Low
Difficulty of Excluding Potential Beneficiaries	High	Common-pool resources: groundwater basins, lakes, irrigation systems, fisheries, forests, etc.	Public goods: peace and security of a community, national defense, knowledge, fire protection, weather forecasts, etc.
	Low	Private goods: food, clothing, automobiles, etc.	Toll goods: theaters, private clubs, daycare centers

Source: Ostrom 2009, 413

Nonetheless, some critics need to be accounted for the neoliberal approach. Although is a great perspective to elucidate why certain regimes emerge, it is unable to explain how or why actors desire norms, cooperation, and reciprocity, as well as providing a historical evolution of the regime and explaining how some regimes that do not provide absolute gains to all the parties involved still emerge (Meiches and Hopkins 2012, 8).

Furthermore, the Grotian [cognitivist or later constructivist (Meiches and Hopkins 2012, 9)] approach is the one that most differ from the previous orientations, seeing regimes as more pervasive and inherent of any persistent pattern of human behavior, including the international system (Krasner 1982, 190). This perspective views regimes present in all areas of international relations, even in situations of clear power rivalry (Krasner 1982, 192). Young (apud Krasner 1982, 192) points out that patterned behavior inevitably generates expectations, leading to conventionalized behavior that would generate recognized norms. Taking into consideration the basic causal variables, the related patterned behavior would necessarily generate regimes and regimes then reinforce the behavior. The critics within this approach lie in methodological moves, as well as imprecision and variability of beliefs among scholars (Meiches and Hopkins

2012, 10). Furthermore, by focusing on the ideational aspects, the material context and economic incentives may be neglected (Meiches and Hopkins 2012, 10). While this is a great approach to understand regimes as something pervasive to international politics, it may not emphasize the aspects under which the space regime emerged. To understand the space regime, it is necessary to account for the material context and power interests of countries that shaped the main treaties of international Space Law in the past.

Rather than focusing on the substance of the regime, an approach to regime theory allows one to analyze its form. Since the aim of this study is rather analytical than prescriptive, understanding the current regime and its cooperation and compliance instead of providing a solution for the problem, this is a framework that offers great insight. After summarizing the main approaches to international regimes, it was understood that although each of them is valid in its own way, offering different insights to regimes as well as behavior and outcomes, none is capable of encompassing the aspects of a regime altogether, having distinct outcomes and critics. Given the hostile environment of outer space and the importance of regimes to guarantee the peaceful use of the cosmos, and that the orbits are understood in this analysis as CPRs, the approach that was found to be the most beneficial to understand the process of regimes of outer space and space debris is the modified structuralism proposed by Krasner (1982) and convergent to Keohane and Stein (apud Krasner 1982, 191) ideas.

3.2 Literature Review

The following section aims to present some of the previous research within space debris and regimes, highlighting key texts to explore the main ideas and literature developed about the topic. Although there are several reports on space debris, Liou and Johnson (2006), presented an important study on the orbital debris environment and its possible evolution throughout statistical models. The authors also pointed out some alternatives to avoid and revert the increase in the issue of debris. This specific study was chosen for the literature review given its relevance and that, although written in 2006, recognizes that the problem was already present and would only worsen in the next years. The authors argue that in some regions of LEO, the density is above the critical point, which means that the production of space debris through collisions exceeds the natural decay of objects (Liou and Johnson 2006, 1). The article discusses this scenario in a context before the events of 2007 and 2009. Furthermore, Liou and Johnson (2006, 1) argue that only remediation measures would prevent future problems at LEO and that the development of the necessary technology for ADR will require cooperation between states and the private sector. Furthermore, the wide implementation of mitigation policies and guidelines is needed (Liou and Johnson 2006). In accordance with this view, Salter (2016) also points out that a combination of mitigation and remediation is the key to keeping trajectories uncluttered, in which international cooperation and clear rules play an important role in guaranteeing a long-term solution.

Salter (2016) provides an analysis of the issue of debris from an economic perspective focusing on public and private actors, respectively. The author draws on the concept of commons to address the costs to be considered when dealing with mitigation and removal challenges (Salter 2016). Salter (2016) argues that the fact that there is no regime of private property rights for orbital access seems to be responsible for the debris problem since “nobody owns, nobody cares”, but that this view has its limitations. There are costs associated with debris removal, and the pieces could be used for future missions (within a private-public partnership for example) since the materials are expensive and costly to send to orbit (Salter 2016). Given the characteristics of the orbits to be a CPR, a property rights solution, although providing great insight, would be hard to achieve. Drawing on the concept of commons but with a different perspective, Weeden and Chow (2012) apply the dilemma into near-Earth orbits and the eight principles of management of a CPR proposed by Ostrom to sustainable governance of the orbits. Some of the finds are the need to account for new actors in the rules and mechanisms, as well as monitor the behavior of space actors.

As seen before, Pfaltzgraff (2011) debates the main approaches to IR and applies to space given the absence of a clear theory. Thus, if the emphasis is on cooperation on Earth-bounded relationships, the same can be extended to think about space. Although regime theory is considerably discussed within international relations, just a few papers that applied the approach to outer space were found.

One example is Stuart (2013), that points out that the notion of regimes is relevant in understanding how the politics of outer space are shaped and evolve over time. Given the characteristic of common global of outer space and the absence of governance, actors pursue coordination in the field to establish a “governance without government”. This has been the case for the politics of outer space for the past 60 years, in which space activities are constrained by a set of regimes (Stuart 2013). In the process of formulation of regimes, the author argues that geopolitics plays an important role, as some actors have more influence in what type of governance is established due to power asymmetries and technological capability (Stuart 2013). Furthermore, the author argues that the concept of epiphenomenon or intervening regime can be useful to understand why and how the regime was established (Stuart 2013). Additionally, some treaties may be codified but never internalized, or never be formalized but still influential over actors (Stuart 2013). The author brings up that an area that should evolve in regime theory and space is the role of non-actors as full players in outer space regime, as the commercial companies (Stuart 2013). The lack in the literature and the studies, thus, relies on the participation of commercial actors in the process of outer space politics, although Stuart (2013) does not describe how to overcome the gap.

Another work on regime theory is from Medvedeva (2015), which applies regime theory on space debris remediation, given the absence of a regime in the specific problem. Furthermore, the author argues that many of the states have not ratified any of the international instruments that tackle the issue of space debris, such as the UN Space Debris Mitigation Guidelines (Medvedeva 2015). The success of a regime in remediation, according to Medvedeva (2015) depends on the effort of actors to create an intergovernmental regime legally binding, so the signed and ratified parts would follow through.

With that, this research contributes to the literature gap regarding regime theory and space, with a special emphasis on space debris. The literature on CPRs and space was also beneficial to draw on the concept and its applications into orbits and space debris. Although the available literature is not so extensive, it provided some insights into how to apply the theory to the proposed aim.

Chapter 4: Methodology

The following section describes the methodological approach chosen to collect and analyze the data that was found the most beneficial to the aim of this study. For that, it first discusses the research design as a case study and the choice of method. Furthermore, it presents the data collection process and the data analysis through thematic analysis. The ethical considerations, reliability, and validity of the process are also discussed.

4.1 Research Design

While space debris legislation and discussion can be found on several levels, such as national and international, and in different organizations, it would be impractical to study and analyze the vastness of the issue in all its complexity. Therefore, the focus on the UN Committee and the treaties and guidelines was chosen because they were found to be the most relevant and often associated with the topic of Space Law. Considering its origins, the treaties have a high adherence rate among the actors involved in space exploration and serve as the base for further aggregations in the regime. Given that the focus was on the outer space regime from the UNOOSA, the data analyzed had to be related to the delimitations, with that, the discussion in the annual meetings from the COPUOS was chosen. Furthermore, considering the extensive technical aspects of the field, in this thesis, the focus lies on the governance and other political aspects of how space is viewed understood, and regulated by international actors. After choosing the case, the next step was to plan a research design that would be adequate for the outcomes proposed.

With that in mind, the research strategy chosen for the study was qualitative, given that this approach allows formulating - instead of testing - hypotheses, exploring, and understanding ideas along with the processes. Bryman (2012, 380) points out that qualitative research stresses words instead of quantifying in the collection and analysis of the data, being a broad inductivist, constructivist and interpretivist approach - although not always accounting for all those three. The aim of understanding the issue of space debris under a regime theory approach is qualitative since the characteristics of the study are to explore and understand, as well as explain how the issue is being dealt with in the Committee. Another point that justifies the qualitative approach is that the analysis was conducted through documents already consolidated instead of collecting samples and testing them.

Furthermore, the basic case study design was chosen for this research due to the fact that it is a method that offers a detailed and intensive analysis of a particular case (Bryman 2012, 66). Gerring (2004, 342) defines a case study as “an intensive study of a single unit for the purpose of understanding a larger class of (similar) units". The unit proposed by the author refers to a spatially bounded phenomenon - a state, revolution, political party, election, or a person - that is observed at a specific point in time or a delimited period (Gerring 2004, 342). Given that space debris (in particular the guidelines) within the Committee discussions were the main focus, this type of design was found to be the most adequate. The unit in the study is the COPUOS, and the timeline period was 2006-2019. This is because the first Space Debris Mitigation Guidelines were adopted in 2007, followed by the LTS in 2019. With that, it was intended to explore the main discussions and shifts in paradigms regarding space debris in the reports, taking into consideration the timeline from the guidelines.

4.2 Data collection

The selection of data accounted for documents available at the UNOOSA official website that are the reports from annual meetings of the Committee on the Peaceful Uses of Outer Space. Given the extensive amount of material since 1963 - the first report available on the website -, and the fact that the discussion of space debris is somewhat a new trend, the analysis of all the reports would be unnecessary. Another point is the timeframe of this study, which rather short would turn the complete analysis of all reports unpractical. With that in mind, the choice of data was made taking into consideration the adoption of the first guidelines related to space debris within the Committee, embracing also the latest guidelines linked not only to the topic but to other concerns regarding the long-term sustainability of outer space as studied previously.

The documents chosen were 14 reports, from 2006 to 2019, taking into consideration that the last meeting (2020) was canceled due to the COVID-19 outbreak. The 2021 session is still scheduled to happen, so is not included in the analysis. Reports are among the most common documents of the UN and can be found in the most diverse topics, sometimes only published on the website of the respective body (United Nations n.d.). According to the United Nations (n.d.), most of the bodies such as committees, commissions, boards, and councils report their work through reports that account for a summary of their work for a given period of time or session. These reports include: “dates of sessions and meetings, membership during the sessions covered, summaries of discussions held, the full text of resolutions or decisions adopted by the body and recommended actions to be taken by parent organ, including draft resolutions for consideration (United Nations n.d.)”. Therefore, the reports from the COPUOS sessions were chosen since they have recommendations and decisions - among other relevant topics - on the issue of space debris.

Nonetheless, official documents have their limitations. It is common to assume that such documents would reveal or underline the reality of the organization, however, there is some skepticism with this view (Bryman 2012, 555). Atkinson and Coffey (2011, apud Bryman 2012, 555) suggest that documents should be viewed as a distinct level of "reality" in their own right, examined by the context that they were produced and the implied readership. Documents, then, have a distinct ontological status and form a different reality, or "document reality", and are not to be taken as transparent (Bryman 2012, 555). With that, documents should be recognized for what they are, texts that were written with a focus in mind and not to reveal the entire reality (Bryman 2012, 555). Since the focus of the analysis was to understand the changes within the regime through the Committee discussion over the years, instead of revealing or debating the reality of the organization, these types of documents were found to be beneficial for this study despite their limitations as official documents.

Furthermore, it is important to point out the data collection used in other sections of this research to formulate a critical perspective on the proposed questions. For the collection of articles and reports, the author used tools such as Google Scholar to find relevant secondary data to provide the background and statistics on space debris. This characteristic is beneficial for the study given the extensive work and technical aspects that would be needed in formulating primary data about space debris. Nonetheless, secondary data has its downsides, in which the primary process behind the collection of data is lost and accounts for aspects of positionality from other authors. The sources are mainly in English and are from international organizations and major actors in space exploration, as well as academics that write about the issue. Thus, cannot be accounted as the general view of all the states and agencies in the field. After choosing the material, the next step was to explain the process of data analysis, which is discussed in the following subsection.

4.3 Data analysis

To analyze the reports selected, a thematic analysis (TA) was applied. This method is among the most common approaches when analyzing qualitative data, and it works by identifying and analyzing patterns of meaning (themes) (Braun and Clarke 2014, 1948). TA is a very flexible approach that can be used to address most of the research questions, allowing the analysis of most types of qualitative data, from secondary sources to textual data and interactive and naturalistic data (Braun and Clarke 2014, 1948). Given that the focus of this research was to identify patterns of topics discussed on the Committee over the years to find repetitions and inflections, the author opted for this method of analysis. Since the reports follow more or less the same structure, it was possible to generate main themes with the topics discussed, approved, and pointed by the COPUOS and its members, as well as seeing inflections on new items and proposals.

Braun and Clarke (2014, 1948) point out that themes are constructed having in consideration the codes applied and the data set, capturing broader patterns of meaning. Having this in mind, the main initial themes applied to the report were: Space Debris Mitigation Guidelines; Long-Term Sustainability Guidelines; Issue of space debris; and Contemporary issues and inflections.

On the process of analysis, the author reflected on the six-phase process proposed by Braun and Clarke (2014, 1950-1951) when applying TA to qualitative data: familiarization of data; generating initial codes; searching for themes; reviewing themes; defining and naming themes and producing the report. On the first step, the data was thoroughly read to acquire initial ideas to start the process of coding. For the next step, the documents were uploaded on the ATLAS.ti software, which allowed the researcher to consolidate the material by applying initial codes: space debris; long-term; sustainability; collision; threat and removal. With that, extracted paragraphs related to the initial codes appeared and were further condensed in meaning units. It was then possible to identify the recurrence of themes on the topics. After reviewing the initial themes and reviewing them, the author proceeded to the presentation of the results.

Although thematic analysis is a flexible approach that can be applied to a range of qualitative data, some critics need to be accounted for when using this method. According to Bryman (2012, 548), TA often lacks a clear and specified series of procedures. This can turn the process of identification and employment of themes unclear. Nonetheless, it showed to be adequate for the purpose of this research.

4.4 Ethical considerations

Given that the data were analyzed through thematic analysis and that the reports from the Committee are of public domain, there were no extensive ethical considerations found to be accounted for. Reflecting on the four points suggested by Pace and Livingston (2005, 39 apud Bryman 2012, 149) regarding ethical considerations of content available on the Internet: "the information is publicly archived and readily available; no password is required to access the information; the material is not sensitive in nature; no stated site policy prohibits the use of the material", the reports were found to fill all the aspects.

Nonetheless, doing research is not a neutral process and it is not conducted in a moral vacuum (Bryman 2012, 149). No ethical issues regarding interviewees occurred, however, there are ethical implications, as the results were influenced by how space was conceptualized as a common good, which may vary according to other conceptual frameworks. Furthermore, the researcher is influenced by a variety of presumptions and values that affect all steps of research (from the choice of the research area until the conclusions) (Bryman 2012, 149). The study of outer space regime, in special space debris, is a highly political subject and it is important to posit that, even though not intended, the research is not neutral and may be influenced by the beliefs of the author. Although the author has some previous knowledge in the topic of space politics, it is her first time studying the issue of space debris and UN legislation in-depth. Furthermore, the author is not involved in any investment scheme, commercial interest, or otherwise implied in the commercial use of space. The author also posits herself as an outsider from space education, given that is not part of any space-related organization, which gives the character of the research as an independent. Another important point to discuss is the quality of results that are described below.

4.5 Reliability and validity

The question of reliability and validity in qualitative research has a different meaning from quantitative research. Bryman (2012, 389) points out that validity connotes an idea of measurement that is usually present in quantitative research in contrast with qualitative research and thus calls for adaptations (Bryman 2012, 389). While reliability represents the degree to which the research can be repeatable, validity means the integrity of the conclusions that were generated (Bryman 2012, 46-47). Guba and Lincoln (apud Bryman 2012, 390) propose an alternative in assessing the quality of qualitative research by considering its trustworthiness by its credibility, transferability, dependability, and confirmability (Bryman 2012, 390). Given the characteristics of this research previously described, with documents already consolidated, some of the aspects that would be relevant in other research designs may not be applicable in such extensive details here. Qualitative research has a subjective aspect and is influenced by presumptions and values from the author as discussed before, which generates diverse conclusions according to the researcher's positionality. Furthermore, to access the criteria of the quality of the documents, the author reflected on the points proposed by Scott (1990, 6, apud Bryman 2012, 544): authenticity, credibility, representativeness, and meaning, in which the reports from the COPUOS were found to be a relevant source, considering its limitations as well as an official public document.

Chapter 5: Results

The following section presents the results from the thematic analysis of the Committee reports selected. The reports are named by their years instead of their numbers, so the first is document 2006, and the last one is document 2019, for a better understanding of the timeframe. As mentioned before, the main codes to start the analysis were: Space Debris; Threat; Sustainability; Long-term; Collision and Removal. Although there are parallel codes applied to space debris, the results were excluded when not linked with the aim and research questions. Nonetheless, they were used to guarantee the accuracy of the results collected in the rest of the documents, and not only under the subsection on space debris and long-term sustainability – despite the emphasis of the analysis being on these. It was found that some of the discussions had duplicated meaning under different subsections from the Subcommittees, which were considered by the author only once. The similarity in the structure of the reports allowed to collect results under the same categories over the years, which turned into the themes and subthemes proposed. The results are presented by the following themes:

Table 3: Themes and Subthemes from thematic analysis

Themes	**Subthemes**
Space Debris Mitigation Guidelines	development; adoption; national mechanisms; cooperation; legal aspects; updates
Long-Term Sustainability Guidelines	development; adoption; national mechanisms; legal aspects;
The Issue of Space Debris	liability; cooperation; nuclear power sources
Contemporary issues and inflections	ADR; intentional destruction; weapons; new item; event; LEO; mega-constellations

Source: own construction

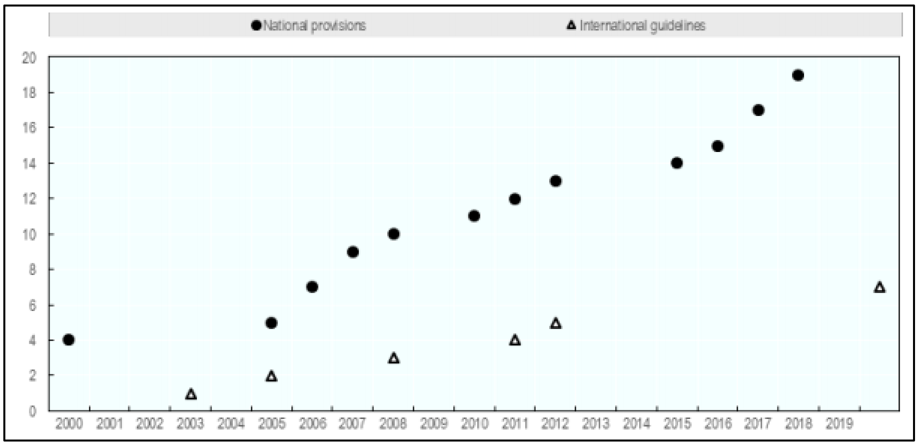
The themes are not strictly fixed discussions, and some of the subthemes may be recurrent in the topics with emphasis according to their main division. The frequency of the topics in the discussions made it possible to perceive when there were changes in the debate and the proposal and/or adoption of new items in the agenda. The background of this research supported the detection of the events, contemporary issues, and debates on space debris that were the driving forces on the change of speech and focus by the delegations and the Committee. For the full view on the thematic analysis of the documents see appendix.

5.1 Space Debris Mitigation Guidelines

The Space Debris Mitigation (SDM) Guidelines emerged as a theme because it is a great part of the discussions under the subsection of the reports on “space debris”, as well as the milestone from the Committee in dealing with the issue on an international level. The main theme was then divided into five subthemes: development; adoption; national mechanisms; cooperation and legal aspects. In document 2006, the Committee noted “with satisfaction” that the final draft of the SDM Guidelines was ready one year ahead of the scheduled plan. Furthermore, the document stated that these guidelines were based on the IADC Guidelines (as presented previously), but instead of containing technical aspects as these, it contains general recommendations. Document 2006 states that these guidelines would remain voluntary and not legally binding under International Law.

The guidelines were adopted in 2007, as reflected in the document from the same year. These guidelines should be implemented through national mechanisms, and since the first document, the Committee states that some members have already adopted space debris mitigation measures on a national level, consistent or based with the IADC Guidelines of 2006, and further on, also consistent with the SDM Guidelines. From 2009 onwards, it is noted that some members were also using the European Code of Conduct for Space Debris mitigation as a reference point. In 2018, the Committee noted that some States were using the International Organization for Standardization standard and ITU recommendations as reference points. Furthermore, the Committee also urges those that had not yet adopted mitigation mechanisms to do so. In 2009, the Legal Subcommittee added a new item on its agenda entitled “general exchange of information on national mechanisms relating to space debris mitigation measures” that would allow not only the Committee to be informed on different approaches but also those states that were still in the process of initiating their national measures. In 2013, the view was expressed that a document compiling national practices in mitigation would encourage the development of new national measures. With that, in 2014, Canada, the Czech Republic, and Germany developed a “compendium of Space Debris Mitigation Standards” that was adopted by the Committee and requested the Secretariat to maintain a website page on the UNOOSA, that according to COPUOS, would contribute to improving knowledge on mitigation standards and regulations. As shown in the figure below through the cumulative number of national and international measures by year, when considering the number of countries that adopted national provisions, it is possible to see that the number jumped from 4 in 2000 to 19 in 2019 and that the number of international guidelines increased from 1 in 2003 to 7 in 2019 (OECD 2020, 30).

Figure 3: Number of international guidelines and national provisions for space debris



Source: OECD 2020, 30 (Adapted from UNOOSA 2019)

As a result of the measures adopted by members, the guidelines should also open access to data and information regarding debris of all types. The Committee also expressed the sense of cooperation that the adoption of the guidelines brings. In document 2007, COPUOS agreed that the voluntary guidelines would increase “mutual understanding on acceptable activities”, thus reflecting on the stability and the decrease of friction and conflict.

The political side is also a current topic among the delegations at the COPUOS. Regarding the legal aspects from the SDM Guidelines, from 2006 onwards some delegations expressed that although the guidelines represent a significant advance, they would not cover all debris-producing situations. Once adopted in 2007, the view of some delegations was that the SDM Guidelines were not sufficient and should be considered on a binding framework by the Legal Subcommittee and that they would pose a disadvantage for developing space fairing countries. Document 2010 states that the view was expressed that the SDM should be reviewed and considered into a set of principles by the Subcommittees. In 2011, the critics of some delegations regarding the guidelines were relating to the lack of requirements, as seen by the following:

> “105. Some delegations were of the view that it was necessary to continue improving the Space Debris Mitigation Guidelines of the Committee. The lack of clear requirements and the use of phrases such as “to the extent possible” provided a form of protection for those countries that had traditionally used technology without any restrictions or controls and, in some cases, without regard for human life or the environment (COPUOS 2011, 16).”

While the document does not state which delegation said what, the discomfort of some members with the guidelines and the lack of clarity continued to give a sense of “protection” towards the major space fairings that were responsible for the vastness of space debris is visible. The discussion goes further when in document 2013, some delegations expressed the view that solutions to space debris mitigations should not impose undue costs on developing space fairing nations. In document 2014, some delegations expressed that the countries that were largely responsible for the space debris situation should assist emerging space fairings into implementing SDM Guidelines and related, while in document 2016 the same discussion repeated, adding that the most responsible had a “moral international responsibility” to assist them. Nonetheless, nothing concrete changed that would enquire those views and complaints to the actual guidelines.

Regarding updates, in 2012 Czech Republic proposed an item on “Review of the legal aspects of SDM with a view of transforming the guidelines into a set of principles to be adopted by the General Assembly”, but the proposal did not go further in the next years. In the last document, in 2019, the report pointed that the IADC Guidelines (which served as the basis for the SDM Guidelines). This update on mitigation standards states that:

> “[…] the post-mission lifetime of a satellite in orbit should not exceed 25 years, included the requirement of achieving a 90 per cent probability of the successful post-mission disposal of satellites, and addressed the topic of large constellations (COPUOS 2019, 17).”

While the recommendations pose a time requirement of 25-years for satellites after their post-mission, also addressing the topic of large constellations, it remains unknown how the update will affect the SDM Guidelines, which would require a further analysis over the next years, in special giving the fact that the last update on the Committee guidelines occurred in 2010.

5.2 Long-Term Sustainability Guidelines

The adoption of the Long-Term Sustainability Guidelines was a long process - from 2008 until its adoption in 2019 - and for that, it was divided into the subthemes: development; adoption; legal aspects; national mechanisms, and space debris. In document 2008, France presented for the first time the proposal of a new item on “Long-term sustainability of space activities”, under a multi-year work plan for 2009-2011, but the presentation was postponed for 2009. In the next year, the Committee agreed on the new item under a work plan from 2010-2013, in which a Working Group would be established in order to prepare a report with the best practices to be finalized by 2012/2013. In document 2010, the Working Group was officially created. Nonetheless, the original years for the work plan changed from 2011 to 2011-2014.

In 2013 the Working Group presented the first draft for the guidelines. Nonetheless, in document 2014 the Committee agreed that the final draft should be ready for approval by 2016. By 2015, the Working Group had not confirmed that it could meet its work plan fully, at the same time that some delegations emphasized the importance of the “timely finalization” of the guidelines given the proliferation of space debris and the increasing risk of collisions, which threatens the long-term space activities. Document 2016 showed that, although there was substantial progress in developing the LTS, the draft of each guideline was in different stages, so the plan to have them ready by 2016 was not reached. In the next year, the Committee noted that it was important to have the LTS completed and ready to be adopted in 2018 to coincide with the UNISPACE +50[4]. By 2018, the Working Group reached a consensus on a set of 21 guidelines, which were adopted by the Committee in 2019. The Committee then encouraged the delegations to take voluntary measures to "ensure that the guidelines were implemented to the greatest extent feasible and practicable (COPUOS 2019, 22)".

Regarding the issue of space debris, the view on the need to include ways to deal with the LTS Guidelines was always present, not only on the sense of adoption of mitigation measures but also removal, although taking into consideration the historical responsibilities of spacefaring nations (COPUOS 2015, 27). Furthermore, the view was expressed that all States should consider the fact that space debris affects the sustainability of the use of outer space (COPUOS 2017, 16) and the guidelines should not contain such simplified language that would not offer practical solutions (COPUOS 2014, 26).

The political aspects from the part of some delegations regarding the work on the long-term sustainability are present since 2010, being a recurrent topic over the years. On the legal aspects, the discourse of some delegations was on that these:

> "[…] should not be limited to the safety and security interest of States with advanced space activities but should also focus on ensuring equitable and rational access to outer space, which was a limited resource at risk of saturation (COPUOS 2010, 22)."

In 2014, the view was also expressed that emerging space fairings should not "bear the burden" that was imposed by the major space programs established back in the '50s. Furthermore, some delegations expressed that the considerations on the item should not be used to promote the commercial activities over the State's interest. In 2013, the view on the private companies by some delegations goes even further, when expressed that the Working Group should go "beyond the status quo" to promote long-term sustainability, shifting the interest of the private sector to "the people".

The LTS Guidelines came a long way with shifts and turns as the result of ten years of work by the Working Group. Since they were officially adopted in 2019 and the 2020 annual meeting

[4] The UNISPACE +50 celebrated the 50th anniversary of the first United Nations Conference on the Exploration and Peaceful Uses of Outer Space, providing a platform to consider the future of global space cooperation and the benefits of space (UNOOSA 2018).

of the COPUOS was canceled due to the COVID-19 outbreak, it is still too early to see the impacts on the discussions and the adherence of the guidelines by the members as the SDM Guidelines. Nonetheless, the adoption represents a greater effort towards sustainable use of outer space.

5.3 The Issue of Space Debris

The theme on the issue of space debris is related to the subthemes of liability on who should be responsible for dealing with space debris from a general perspective, as well as the role that cooperation plays to control the scenario. There were also the legal aspects related to the new challenges imposed by the threat of space debris.

While in 2006 some delegations see space debris as the prime threat to space operations in the future, international cooperation is mentioned as a way to develop more appropriate strategies to deal with the issue. Going further in the sense of cooperation, document 2008 points out that transparency was indispensable and that the States that still do not share information on space debris should do so. In 2009, the importance of making information available goes even further when it is said that this would help to avoid collisions and to protect people on the re-entry stage. Another point mentioned is the necessity of sharing measures to reduce the situation. The awareness about the need for transparency and exchange of information is recurrent through the documents analyzed.

The liability issue from the part of some delegations lies on the sense of, just like seen in the other themes, the major spacefaring nations being the ones to take a greater part of the actions to revert the scenario, given that they are the most responsible for the creation of space debris. Furthermore, the issue of space debris should not be addressed in a way that jeopardizes the development of new space actors. Document 2008 makes it clear when states that:

> "124. The view was expressed that the States most responsible for the creation of space debris and the States having the capability to take action on space debris mitigation should make a greater contribution to space debris mitigation efforts than other States (COPUOS 2008, 18)."

In document 2014, the liability of largely responsible for debris is also extended to the view of some delegations that these should assist developing spacefaring nations on the issue of space debris by transferring technological and scientific support without "undue costs". Another recurrent subtheme detected is the attention towards nuclear power sources in outer space and the threat that it poses to collisions and re-entry.

5.4 Contemporary issues and inflections

The theme on contemporary issues and inflections deals with two main things. While contemporary issues are related to the new trends identified in the discussions of the meetings that threaten the space debris scenario as well as major events, the inflections are the perceived shifts in the attention dedicated by some delegations on specific topics over the years.

The topic of removal of debris is recurrent over the years, being noted in the first document analyzed (2006). It was classified as a contemporary issue in the sense that there is no legal framework on ADR, even though the discussions came a long way and there are several studies (as seen before) mentioning that is the only alternative to control the population of debris in the long-term. As some delegations expressed:

> "130. […] Efforts should continue to be made to devise the technical ability to begin removing existing space debris from their orbits in order to halt the decline in the space environment. Those delegations also expressed the view that the proliferation of space debris was undermining the future of space programmes and the respective benefits deriving from space activities, as well as the safety of crews on space missions (COPUOS 2006, 18)."

While some delegations expressed that mitigation and limitation of space debris should be among the priorities of the Committee and its bodies (COPUOS 2012), the legal barriers are also mentioned in a perspective that is concomitant with the treaties from the International Law. As article VIII[5] from the OST (1967) forbids any lateral activities by other parties that are not

[5] "A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found

the State registry towards a space object (regardless of its operational status), the removal of an object would require an agreement with the States involved in the mission. In document 2012, some delegations expressed the view that, during removal activities, no unilateral action should happen by any state with respect to a space object from another State – unless previous consultation and agreement with the State of the registry. Given the complexity of such activity, and that the technology of ADR could be used not only for peaceful purposes but also military, the regime of outer space would need to advance to promote such measure. This view is expressed in document 2016, when mentioning the "potential conflict" and militarization that a unilateral removal activity could bring, also the negative impacts to the GEO. While document 2015 shows the view on creating a new item regarding ADR, this would only appear in 2017, when an amendment of "space debris remediation measures" was adopted to the general exchange of information and views on legal mechanisms that before only contained mitigation measures, being first present on the report in 2018. Furthermore, an interesting point emerged in the discussions regarding ADR in 2019, when the view was expressed that commercial development of removal technology should be "encouraged" (COPUOS 2019, 17).

Still, in regards to the commercial activities, a concern on the topic of mega-constellations emerged in 2016 onwards, noting that the new trends were part of the discussions of the Committee. In that sense, some delegations expressed that the challenges posed by large and mega-constellations should be addressed by the Committee, as well as to analyze the possible impacts of their deployment in the LEO (COPUOS 2016, 15; COPUOS 2019, 16). The concern regarding the crowded scenario of LEO is mentioned years before when in document 2009 some delegations noted the increasing density of the debris population on that specific orbit and that it threatened the use of space in the short and long-term.

Furthermore, some major events on space debris marked the discussions and presented changes in the discourse. In 2007, there was an inflection on the concern on the part of some delegations regarding the risk to space activities from long-lived space debris from "intentional destruction", as well as the introduction of weapons. This concern does not come alone when taking into consideration the intentional ASAT test from China in the same year. In regards to the intentional destruction of the USA 193 satellite from the United States that had a

beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return (UNOOSA 2017, 6)".

malfunction in 2008, the Committee only stated that received the information (COPUOS 2008, 4). The Iridium 33 / Cosmos 2251 collision in 2009 received greater attention, demonstrating an increased risk of space debris towards space activities, in special at the LEO (COPUOS 2009, 17). In the same year, Italy and Germany proposed a platform of data and information on objects in outer space that did not go further on the following reports.

After presenting the results of the thematic analysis on the reports previously selected, the next step is to relate and analyze the findings towards the research questions proposed. For that, the following section aims to present the discussions on the three questions of this study.

Chapter 6: Analysis and discussion

The reports from the COPUOS provided a relevant background on the politics behind the resolution, as well as contemporary issues that emerged outside of the Committee and how they affected the endogenous discussions. When analyzing only the adopted guidelines, the process of discussions, views of delegations, and working through the years would be absent. This study aimed to analyze the COPUOS discussions related to space debris from 2006 to 2019 using the regime theory approach. The following section presents the analysis and discussions on the proposed research questions. For that, the results from the thematic analysis of the previous section are linked with the main debates, as well as the background and theoretical framework when applicable.

6.1 Politics and the issue of space debris

As the R1 focused on the politics behind the discussions about space debris at the Committee over the time analyzed, the themes identified were proven beneficial with special attention to the “Issues of Space Debris” that tackled some important points on politics. While the analysis of the reports did not reveal which delegations were responsible for the view of each topic, as predicted in the methodology, there were some hints that the major critics directed to the form of the guidelines and liability on who should be responsible for space debris were addressed by non-classic space nations.

This was due to the use of certain terms as shown in the results. An example is present in document 2011 when some delegations expressed that the SDM Guidelines lack clear requirements and provide “a form of protection” to the “traditional countries” that used space without any restrictions and sometimes without “regard for human life or the environment” (COPUOS 2011, 16). Furthermore, some delegations expressed that the most responsible for creating debris should take greater actions in mitigation efforts than other States, as well as transferring technology without “undue costs” to emerging spacefaring nations. In addition, as document 2012 showed, it was expressed that the issue of debris should not be addressed in a way that jeopardizes developing space-fairings.

The emerging space programs confront a crowded scenario with the same degree of liability that the classic actors, which explains the critics found in the reports. As the past of space exploration was marked by negligence towards space debris (explained in the background), and that the major space-fairings responsible for the proliferation of debris in the past, host the top private companies (that are increasingly launching), the pattern repeats. The emerging space programs that are still in the process of developing satellite technologies are highly likely to encounter a crowded and risky scenario in the future.

Furthermore, it can be argued that, given the anarchic characteristics of outer space, and that, according to document 2010, is “a limited resource at risk of saturation (COPUOS 2010, 22)”, the regime in this sphere plays an important role to guarantee equitability of use and avoidance of conflict among its members. Nonetheless, the adoption of the Space Debris Mitigation Guidelines, as well as the Long-Term Sustainability Guidelines by the Committee, did not change the regime but represented a change within the regime (Krasner 1982). Recapturing the two paths of behavior outcomes proposed by Krasner (1982, 192) under a modified structural approach, while the outer space is not a pure conflictual arena and is marked by an extensive history of cooperation, regimes offer a different outcome to basic causal variables than the absence of them would do. While the guidelines provide norms to be followed and thus lead to a different outcome than with their absence, these are still of a voluntary and non-binding character. This results in costs, not only political but also regarding sustainability. Even with a gradual increase in the satellite disposable compliance rate in the LEO, this is not fast enough to revert the scenario (ESA 2021c).

The fact that the guidelines are still voluntary and non-binding is a concerning topic steadily criticized by some delegations over all the years analyzed. Since document 2006, some delegations pointed out that, although a great achievement, the guidelines would not cover all debris-production situations. Nonetheless, while the view on the creation of binding rules was identified since the first document, regarding the SDM Guidelines, the Committee maintained the characteristics unaltered throughout the year. These critics were also directed to the development and adoption of the LTS Guidelines. Furthermore, as noted in document 2013, some delegations expressed the view that, for the Working Group to develop proper guidelines towards long-term sustainability, they should break the “status quo” to promote the interest of the “people”, instead of the “private sector”.

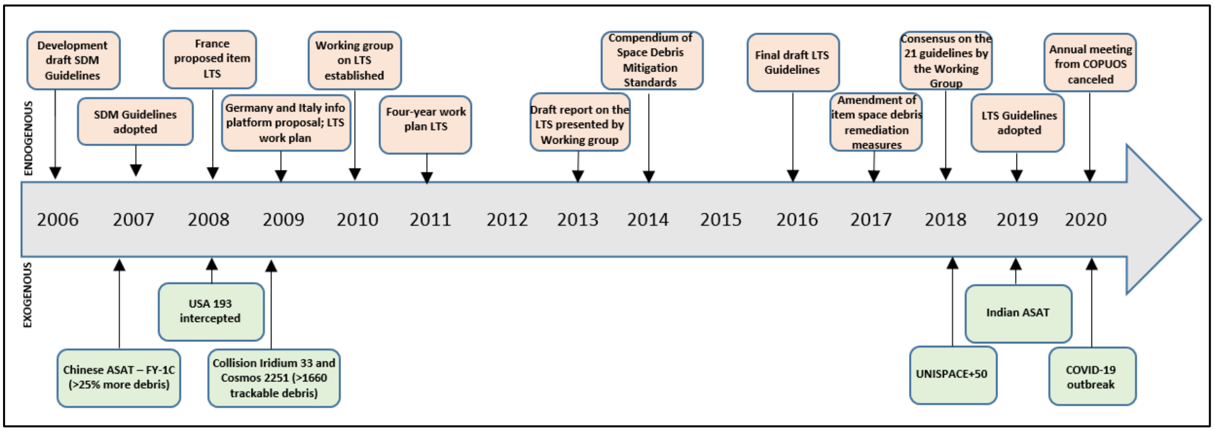
The last consideration is regarding international cooperation and its role in the discussions on the issue of space debris. The Committee stretches the importance of transparency and exchange of information to promote strategies that deal with the issue of space debris. Nonetheless, the interests of members are shown to play an important role in the development (or the status quo) of the regime.

As the main body of the regime remains unaltered, the interest of the major space fairings is perpetuated, posing a threat to the access of space by emerging space programs and, in the space debris scenario in the long term. Although much of the critics expressed by some delegations did not end up in concrete measures, such as the legally binding discourse, it was interesting to see that they were indeed happening and are a continuing part of the ongoing discussions. Such analysis would not be possible only with the study of the guidelines.

6.2 Space debris events and proposals

To answer R2 on the correlations between the space debris events and the discussions and proposals of the Committee, the timeline bellow was constructed to pinpoint the major items adopted or proposed at the COPUOS over the years, together with the biggest events on space debris. The reason is to see if there is any correlation between these two that can be identified. For that, it separated events into two categories: endogenous, which are related to changes inside the Committee; and exogenous, which correspond to outside incidents or events.

Figure 4: Endogenous and exogenous events on space debris



Source: own construction based on the reports from COPUOS (2006-2019)

The first document showed that the final draft for the SDM Guidelines was ready one year ahead of schedule. The process of adoption was even faster if taking the LTS Guidelines process in comparison. Nonetheless, this fast process does not come alone when looking at one of the major space debris-producing events. The Chinese ASAT test towards its deactivated satellite FY-1C just a few months before the adoption of the guidelines in 2007, as seen before, created alone, more than 25% space debris. As the concern increased, the discussions of the Committee suffered an inflection, in which some delegations argued about the risk that long-lived debris from "intentional destruction" present to space activities, as well as the weaponization of space. In 2008, the delegation of France proposed an item on long-term sustainability that would later lead to the LTS Guidelines. One fact is that France is one of the only countries that have mandatory technical requirements for debris mitigation (OECD 2020, 30). In the same year, the US deployed an ASAT towards its uncontrolled satellite USA 193, but the Committee was informed, and no major issues emerged in the discussions.

The work on long-term sustainability did not emerge in a vacuum context, as it coincided with two of the biggest events on space debris. In 2009, the collision with the Iridium 33 – Cosmos 2251 resulted in more than 1660 trackable debris. In the same year, the Committee agreed on the new agenda item on LTS, that would be developed through a multi-year work plan from 2010-2013. Another point was the proposal from Germany and Italy on the establishment of an international platform of data and information of space objects, which did not continue through the following documents. Some delegations also expressed concern about the risks of debris into the LEO.

In 2010 the Working Group was established, and in 2011 the work plan was updated to 2011-2014. The first draft report was presented by the Working Group in 2013. In 2014 the Committee agreed to have the final draft for the guidelines ready for approval by 2016. In the same year, the Committee welcomed the development of a Compendium of Space Debris Mitigations by the delegations of Canada, the Czech Republic, and Germany. As the plan was to have the final draft guidelines ready by 2016, in 2015 the Working Group informed that it could not fully proceed with the work plan. By 2016, the Committee noted that various draft guidelines were at different stages. In the following year, the COPUOS agreed that the LTS Guidelines should be ready for adoption in 2018, to coincide with the UNISPACE+50 event happening in the same year. In 2017, the Committee also adopted an amendment on remediation measures followed by an increase in the discussions regarding ADR, as seen before. By 2018 the Working Group finally reached a consensus on 21 guidelines, adopted in 2019. The year marked the ASAT test from the Indian space program, which raised concerns by several delegations, such as the US.

With that, it can be argued that no major events happened during the years that the LTS was developed by the Working Group, which slowed down the process. The fact that it is possible to observe the increasing discussions on the Committee when there are exogenous events shows that the body has a more passive approach, in which when an event happens, there are inflections on the discussion on the Committee. Maybe, if these discussions would take place beforehand, bigger events on space debris could be avoided. For that, the Committee would have to take a more active role in the discussions.

Furthermore, the 2020 meeting was canceled due to the COVID-19 outbreak coinciding with the year that private companies had by far the most launches ever registered into LEO as seen in the background. While the delegations did not want to approve new rules via online platforms, it can also be argued that the States most responsible for the biggest private companies under the law benefited from the postponed discussions on the topic of mega-constellations, regardless of the Pareto-optimal decrease that it could generate to the following spacefaring nations – in special the emerging ones - in the near and long future.

6.3 New trends in the discussions

Regarding the R3 on new trends that can be identified in the discussions of the Committee, the theme on contemporary issues and inflections provided some important points. As contemporary topics related to space debris in space exploration emerged or intensified along the years analyzed, it was noted that the discussions on the Committee incorporated them either proposing new items on the agenda or stretching their importance or concern.

Recapturing the solutions to avoid a catastrophe from space debris in the orbits, a combination of mitigation and remediation measures was pointed out as necessary, together with the removal of 5 to 10 large pieces per year to stabilize the debris production (Popova and Shaus 2018; ESA n.n.b.). Nonetheless, ADR measures still encounter great legal barriers, as mentioned previously. It was noted that the topic of removal is recurrent throughout all the years analyzed. While some delegations expressed that remediation should be among the priorities of the Committee and efforts need to be done to overcome the legal issues, others were on the view that no unilateral action should be taken by any State towards a space object that does not belong to them without previous consultation and agreement with the State registry. This last view is concomitant with the international space law and the OST articles, which demonstrated that the regime needs to evolve in order to overcome the legal barriers to remediation. With that, the adoption of the addendum on remediation measures by the Committee in 2017 can be understood as a result of the increasing discussions on ADR by some delegations, as well as an effort to share information to overcome the issues related to remediation. Nonetheless, the path is still long to promote effective ADR measures. The commercial development of ADR technology is highly likely to play an important role in the future, as noted in document 2019 that these should be "encouraged". For that, the dilemma confronted is to turn remediation profitably encouraging for the private companies, which would come as the liability turns into a stricter requirement, increasing the compliance of end-of-life disposal of space objects.

Another point is the concern over the low-Earth orbit as noted in document 2009 and the new trend on mega-constellation projects that challenge the sustainability of this orbit. The crowded scenario of the LEO, in special in 2009, was drastically affected by the space debris events before mentioned. While the launches on LEO increased, with special attention to the commercial launches, it was noted that this new trend was also being more discussed in the discussions from the COPUOS, especially in the years after 2016. This does not come alone when taking into consideration the number of debris that the malfunction of these satellites could generate. Even with a low-rate failure, it is concerning when applied to thousands of satellites. Nonetheless, although the discussion by some delegations was present, no concrete measure was identified in the Committee in order to tackle the mega-constellations in the years analyzed.

With new trends emerging from the shift of space exploration, the contemporary issues related to space debris (in special ADR, LEO, and mega-constellations), were noted to be present and part of the ongoing discussions in the Committee. Even so, the characteristics of the current outer space regime are still shaped and changed by State's interests, in which the private companies have a secondary role and responsibilities under their national jurisdiction. As space activities become more complex, accounting for more and more actors, so does the politics related to them. While the regime of outer space only accounts for the State actors, the regime theory approach was proven to be beneficial in this research. Nonetheless, this approach failed to provide a proper analysis of the role that non-state actors play towards regimes, as previously mentioned. With the new space race, marked by the intensification of commercial activities – or as some call "billionaire space race", the outer space regime will need to find a way to recognize the private actors as players, making them accountable for issues such as space debris, as well as part of the decision-making process.

Chapter 7: Conclusions

This research aimed to analyze the COPUOS discussions related to space debris from 2006 to 2019 using the regime theory approach. For that, it applied a thematic analysis on the fourteen reports from the annual meetings of the Committee to find recurrent themes under space debris, identifying patterns and changes according to the timeframe proposed. Followed to the presentation of the results, the main findings related to the research questions were debated, together with the theoretical framework and the background when applied. As the research questions lay on the politics behind the discussions; the correlations between outside events and the discussions of the Committee; and the new trends identified at the meetings, the themes (as well as the subthemes) identified provided great insights.

As a result, this thesis has shown that although the adoption of the Space Debris Mitigation Guidelines in 2007, as well as the Long-term Sustainability Guidelines in 2019, represent an important step towards guiding to revert the issue of space debris, these are still of a non-binging and voluntary character. Through the discussions on the Committee, it was possible to identify that some delegations steadily criticized the form of the guidelines over the years, arguing that these would not impede all debris production and asking for the Subcommittees to consider binding rules. Furthermore, it was also implied that the major critics regarding the issue of liability on space debris were from emerging spacefaring programs. This was due to statements - among others - that the major space actors responsible for space debris in the past should have a higher level of liability in resolving the situation and helping develop space programs to implement mitigation measures without undue costs. Nonetheless, the guidelines maintained their character regardless of the complaints on the part of some delegations and the politics of the interest of the bigger space nations, that are also responsible for the top private companies seems to perpetuate.

Going further in the discussion, the thesis also showed a correlation between outside events to the proposed and adopted items of the COPUOS agenda. It can be argued that the adoption of the SDM Guidelines was sped up in the context of the ASAT test of 2007, while the LTS guidelines were proposed, and the Working Group was created in the middle of the circumstances of the collision from 2009. Nonetheless, the draft and adoption of the LTS was a long way, which coincided with a period without greater outside events. With that, it was understood that the COPUOS has a more passive approach as inflections in the discussions occurred after exogenous events.

This thesis also showed the main new trends identified over the discussions of COPUOS in space debris. As the issue of remediation was a recurring topic, the addendum on remediation measures adopted in 2017 was understood to be the result of an increasing discussion on ADR. The legal barriers to adopting remediation measures are still high and the regime would need to evolve to aggregate these. The concern over LEO and the mega-constellation projects were also noted, although not resulting in major changes on the Committee. The mega-constellations had special attention when analyzing the payload launched into LEO in 2020 - the majority from commercial actors, which represented a cosmic increase in comparison to the previous years. This coincided with the canceled meeting of the COPUOS in 2020 due to the COVID-19 outbreak. In a context in which States did not want to approve new items via online platforms, the States most responsible for the top private companies benefited from the postponed discussions.

While this research illustrated the patterns and changes of the discussions on space debris on the Committee, highlighting the role of States in the regime, it also raised questions regarding the role of private companies. As these actors are increasingly part of the new space age, the challenge is to integrate them in the decision-making process, as well as make them accountable for the issue of space debris. With that, Krasner's (1982) regime theory approach has shown to be adequate to construct the analysis and answer the aim of this research.

7.1 Future research

Although many topics are related to the issue of space debris, for this thesis, the focus was on the more explicitly ones debated on the reports from the COPUOS, concomitant with the findings on the background of this research. For future studies, perhaps, another theoretical framework and different documents analyzed could lead to the study of non-State actors and liability issues related to space debris and regimes.

With a non-stop rising of objects launched in space, either for tourism or for mega-constellations projects, several questions appeared regarding how to make the new space actors accountable for the issue of space debris. As the “billionaire space race” emerges, a new pattern of space exploration is being shaped, different from the past where the scenario was marked by hegemonies with a more scientific and technological purpose. This turns relevant when thinking about the regime of outer space and its near future, such as how to frame the new actors into making part of it, not just responding under their country’s responsibility.

Further research on space debris and international regimes could be developed on a sense of sustainability and tragedy of the commons. From a broader perspective, focusing on the long-term sustainability of outer space, the challenge of overcoming the issue of space debris is just one amongst other topics that need to be addressed. A suggestion is to have greater attention on nuclear power sources and the concern about it regarding the safety of outer space, in special LEO and GEO orbits.

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1 Appendix: Space debris mitigation guidelines

Guideline 1: Limit debris released during normal operations

Space systems should be designed not to release debris during normal operations. If this is not feasible, the effect of any release of debris on the outer space environment should be minimized. During the early decades of the space age, launch vehicle and spacecraft designers permitted the intentional release of numerous mission-related objects into Earth orbit, including, among other things, sensor covers, separation mechanisms and deployment articles. Dedicated design efforts, prompted by the recognition of the threat posed by such objects, have proved effective in reducing this source of space debris.

Guideline 2: Minimize the potential for break-ups during operational phases
Spacecraft and launch vehicle orbital stages should be designed to avoid failure modes which may lead to accidental break-ups. In cases where a condition leading to such a failure is detected, disposal and passivation measures should be planned and executed to avoid break-ups. Historically, some break-ups have been caused by space system malfunctions, such as catastrophic failures of propulsion and power systems. By incorporating potential break-up scenarios in failure mode analysis, the probability of these catastrophic events can be reduced.

Guideline 3: Limit the probability of accidental collision in orbit
In developing the design and mission profile of spacecraft and launch vehicle stages, the probability of accidental collision with known objects during the system’s launch phase and orbital lifetime should be estimated and limited. If available orbital data indicate a potential collision, adjustment of the launch time or an on-orbit avoidance manoeuvre should be considered. Some accidental collisions have already been identified. Numerous studies indicate that, as the number and mass of space debris increase, the primary source of new space debris

is likely to be from collisions. Collision avoidance procedures have already been adopted by some member States and international organizations.

Guideline 4: Avoid intentional destruction and other harmful activities
Recognizing that an increased risk of collision could pose a threat to space operations, the intentional destruction of any on-orbit spacecraft and launch vehicle orbital stages or other harmful activities that generate long-lived debris should be avoided. When intentional break-ups are necessary, they should be conducted at sufficiently low altitudes to limit the orbital lifetime of resulting fragments.

Guideline 5: Minimize potential for post-mission break-ups resulting from stored energy
In order to limit the risk to other spacecraft and launch vehicle orbital stages from accidental break-ups, all on-board sources of stored energy should be depleted or made safe when they are no longer required for mission operations or post-mission disposal. By far the largest percentage of the catalogued space debris population originated from the fragmentation of spacecraft and launch vehicle orbital stages. The majority of those break-ups were unintentional, many arising from the abandonment of spacecraft and launch vehicle orbital stages with significant amounts of stored energy. The most effective mitigation measures have been the passivation of spacecraft and launch vehicle orbital stages at the end of their mission. Passivation requires the removal of all forms of stored energy, including residual propellants and compressed fluids and the discharge of electrical storage devices.

Guideline 6: Limit the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission
Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the LEO region should be removed from orbit in a controlled fashion. If this is not possible, they should be disposed of in orbits that avoid their long-term presence in the LEO region. When making determinations regarding potential solutions for removing objects from LEO, due consideration should be given to ensuring that debris that survives to reach the surface of the Earth does not pose an undue risk to people or property, including through environmental pollution caused by hazardous substances.

Guideline 7: Limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission
Spacecraft and launch vehicle orbital stages that have terminated their operational phases in orbits that pass through the GEO region should be left in orbits that avoid their long-term interference with the GEO region. For space objects in or near the GEO region, the potential for future collisions can be reduced by leaving objects at the end of their mission in an orbit above the GEO region such that they will not interfere with, or return to, the GEO region.

Source: United Nations 2017, 90-93

2 Appendix: Tables from documents 2006-2019 of the thematic analysis

Table 4: Thematic analysis on document 2006

Document	Condensed Unit	Themes	Subthemes
2006	The view was also expressed that it was probable that the debris population would continue to grow[...], thus the need to begin removing existing space debris.	Contemporary issues and inflections	ADR
2006	Some delegations shared the view that future use of outer space depended on keeping space debris to manageable levels and that debris were a prime threat to operation of functional satellites the global community to the benefits of outer space.	Issue of Space Debris	
2006	International cooperation needed to develop more appropriate and affordable strategies to minimize the potential impact of space debris on future space missions. States should pay more attention on the problem of collisions, including those with nuclear power sources on board and the re-entry into the atmosphere.		Nuclear power sources
2006	One year ahead, the Working Group on Space Debris developed the draft space debris mitigation guidelines based on the IADC Space Debris Mitigation Guidelines. The IADC Guidelines were referred as a technical nature, while the space debris mitigation guidelines would contain general recommendations.	SDM Guidelines	Development
2006	After circulating on national level, the draft should be modified according to comments of member States.		
2006	If adopted in 2007, submission to the General Assembly would be more appropriate.		Adoption
2006	The draft of the guidelines was circulating at national level to secure consent for approval in 2007. They would remain voluntary, implemented through national mechanisms and not legally binding under international law.		Legal aspects
2006	Some delegations expressed that, if the voluntary guidelines would be adopted, they would represent a significant advance, but they would not cover all debris-producing situation.		
2006	Committee noted that some States had already implemented space debris mitigation measures on a voluntary basis, through national mechanisms consistent with the IADC Guidelines.		National mechanisms

Source: own construction based on the report from COPUOS (2006)

Table 5: Thematic analysis on document 2007

Document	Condensed Unit	Theme	Subtheme
2007	Some delegations expressed concern about risk to space activities from long-lived debris from intentional destruction.	Contemporary issues and inflections	Intentional Destruction
2007	Other delegations expressed concern that introduction of weapons might pose a greater risk than did space debris to space activities.		Weapons
2007	The Committee noted with great satisfaction that the Space Debris Mitigation Guidelines had been adopted.	SDM Guidelines	Adoption

2007	Some delegations expressed the view that the Committee should submit the draft of resolutions to the General Assembly on its 62 session to stress the importance.		
2007	Committee agreed that the approval of voluntary guidelines would increase mutual understanding on acceptable activities in space and enhance stability, decreasing likelihood of friction and conflict.		Cooperation
2007	Approval of guidelines should open access to data and information on all types of debris.		
2007	Some delegations expressed that the creation of debris – either intentional or not - could be avoided by the implementation of the guidelines.		National mechanisms
2007	Committee noted with appreciation that some delegations had already implemented national mechanisms on mitigation consistent with the IADC Guidelines.		
2007	Some delegations expressed that legally non-binding guidelines were not sufficient and would disadvantage developing countries, having the view that the issue of debris should be considered by the Legal Subcommittee with on a binding legal framework.		Legal aspects
2007	Some delegations expressed that the guidelines would not cover all debris-producing situation, thus the need to develop the technical ability to begin removing existing space debris.		

Source: own construction based on the report from COPUOS (2007)

Table 6: Thematic analysis on document 2008

Document	**Condensed Unit**	**Theme**	**Subtheme**
2008	Committee was informed about the ASAT from the US in the USA 193.	Contemporary issues and inflections	Event
2008	The Committee welcomed the agreement by the Subcommittee to include on the agenda the item "general exchange of information on national mechanisms relating to space debris mitigation measures".		New item
2008	International cooperation needed to develop more appropriate and affordable strategies to minimize the potential impact of space debris on future space missions. The Committee agreed that Member States should pay more attention on the problem of collisions, including those with nuclear power sources on board and the re-entry into the atmosphere.	Issue of Space Debris	Nuclear power sources, Cooperation
2008	The view was expressed that transparency was indispensable, and spacefaring's were urged to share information on their debris.		Cooperation
2008	The view was expressed that the States most responsible for debris and those with a greater capability to act should make a greater contribution on mitigation than other States.		Liability
2008	Committee noted that France had informed the Scientific and Technical Subcommittee that would propose a new item: "Long-term sustainability of space activities" under a multi-year workplan for 2009-2011.	LTS Guidelines	Development
2008	Subcommittee wished to be informed by the IADC of any revisions of the IADC guidelines in evolving technologies and practices of mitigation and that the SDM might be amended in accordance.	SDM Guidelines	Adoption
2008	Committee noted that some States had already implemented space debris mitigation measures on a voluntary basis, through national mechanisms consistent with the IADC Guidelines and the SDM.		National Mechanisms

2008	Committee agreed that the approval of voluntary guidelines would increase mutual understanding on acceptable activities in space and enhance stability, decreasing likelihood of friction and conflict.		Cooperation
2008	Some delegations expressed that the SDM were the first important step towards a comprehensive solution to the problem of safety of space traffic, looking forward to further discussions.		Legal aspects
2008	The view was expressed that space debris should considered by the Legal Subcommittee on a view to developing binding legal framework.		

Source: own construction based on the report from COPUOS (2008)

Table 7: Thematic analysis on document 2009

Document	Condensed Unit	Theme	Subtheme
2009	Some delegations noted that the increasing density of debris - in particular LEO - threatened the access and use of outer space in short and long term.	Contemporary issues and inflections	LEO
2009	Some delegations expressed the view that the collision with the active commercial Iridium 33 satellite and the inactive Cosmos-2251 satellite in LEO in 2009 demonstrated the increasing risk of debris to space activities.		Event
2009	Committee took note on the proposal of Germany and Italy for the establishment of an international platform of data and information on objects in outer space with the supplied data of voluntary basis and freely accessible to Member States.		New item
2009	Thorough assessment should be carried out of the resources to establish such platform.		
2009	The view was expressed that the current available information would not be sufficient for analyzing possible collisions, the delegation also pointed out the need to consider financial implications and liability that could be incurred by the UN should it become the sponsor.		
2009	The Committee agreed on inviting member States of IADC to prompt the body to advise the Scientific and Technical Subcommittee on the proposal of the platform.		
2009	Some delegations were on the view that the provisions of international space law had to be improved to respond to contemporary space activities and the threat of space debris.		Legal aspects
2009	The Committee agreed that the Scientific and Technical Subcommittee should include a new agenda item "Long-term sustainability of outer space activities" under a multi-year workplan from 2010-2013, in which 2010 a working group would be established, 2011 a preparation of a report and in 2012/2013 continuation and finalization of the report with the best practices.	LTS Guidelines	Adoption
2009	Committee noted that some States had already implemented space debris mitigation measures on a voluntary basis, through national mechanisms consistent with the IADC Guidelines, SDM Guidelines and the European Code of Conduct for Space Debris mitigation.	SDM Guidelines	National mechanisms
2009	The view was expressed that the States most responsible for debris and those with a greater capability to act should inform the Committee on their actions to reduce the creation of debris.	Issue of Space Debris	Liability
2009	Some delegations were on the view that it was important to make available information on existing debris to avoid collisions and to protect people on the re-entry, requiring concrete measures to make the existing information available and of free access.		Cooperation

Source: own construction based on the report from COPUOS (2009)

Table 8: Thematic analysis on document 2010

Document	Condensed Unit	Theme	Subtheme
2010	The view was expressed that space debris posed a serios threat to countries located along the equator.	Contemporary issues and inflections	
2010	The view was expressed that transparency in the information on debris and space activities, particularly activities that presented a risk of doing harm, was important and would enhance awareness and capability on monitoring.	Issue of Space Debris	International Cooperation
2010	The view was expressed that the States most responsible for debris and those with a greater capability to act should inform the Committee on their actions to reduce the creation of debris.		Liability
2010	The view was expressed that since the adoption of the UN treaties, many space-related issues emerged that were not envisaged in the treaties, such as space debris, expressing that the Subcommittee should explore the possibility of developing appropriate new rules, including soft laws.		Legal aspects
2010	The Committee welcomed the establishment of the Working Group on the LTS.	LTS Guidelines	Working group
2010	Some delegations were on the view that the LTS should also focus on ensuring equitable and rational access to space, which was a limited resource and at risk of saturation.		Legal aspects
2010	Committee noted that some States had already implemented space debris mitigation measures on a voluntary basis, through national mechanisms consistent with the IADC Guidelines, SDM Guidelines and the European Code of Conduct for Space Debris mitigation.	SDM Guidelines	National mechanisms
2010	Committee agreed that more states should implement the SDM.		Adoption
2010	The view was expressed that States without capability and expertise to implement the SDM should benefit from best practices and training by States with relevant experience.		Legal aspects
2010	Some delegations were on the view that the SDM should be further developed and that the Subcommittees should cooperate to develop legally binding rules on space debris.		
2010	The view was expressed that the SDM required legal review and analysis.		
2010	The view was expressed that an item on reviewing the SDM with a view of transforming them into a set of principles should be included in the agenda of the Legal Subcommittee.		

Source: own construction based on the report from COPUOS (2010)

Table 9: Thematic analysis on document 2011

Document	Condensed Unit	Theme	Subtheme
2011	Some delegations expressed concern over the fragility of the space environment and the challenges related to the long-term sustainability, to the increasing number of space actors, spacecraft, and space debris.	Contemporary issues and inflections	
2011	Some delegations called on the Scientific and Technical Subcommittee to continue its thorough consideration of the issue of debris mitigation with a greater attention on debris coming from nuclear power sources and collisions, as well as the improve of monitoring.	Issue of Space Debris	nuclear power sources
2011	Some delegations were of the view that reports on national research on debris, safety of space objects with nuclear power sources on-board and collision did not contain replies from States that were largely responsible for creating debris, including those from platforms with nuclear power sources.		Liability

2011	Some delegations were on the view that the exchange of information on measures to reduce creation and proliferation of debris would be beneficial for member states.		Cooperation
2011	The view was expressed that, to meet the challenges from mitigation from the current intensification and diversification of space activities, the Legal Subcommittee should explore developing appropriate rules, including soft laws.		Legal aspects
2011	The Working Group on the LTS should consider but not duplicate or reopen, activities and recommendations of the Subcommittees and the IADC Committee on orbital debris mitigation.	LTS Guidelines	Legal aspects
2011	LTS Workplan 2011-2014		Development
2011	Committee noted that some States had already implemented space debris mitigation measures on a voluntary basis, through national mechanisms consistent with the IADC Guidelines, SDM Guidelines and the European Code of Conduct for Space Debris mitigation.		National mechanisms
2011	Committee agreed that more states should implement the SDM.		Adoption
2011	Some delegations were on the view that further studies and research should be carried out to enhance the Guidelines and keep them up to date with new techniques and capabilities of detection and reduction of debris.		Updates
2011	Some delegations were on the view that it was necessary to improve SDM. The lack of clear requirements and use of phrases such as "to the extent possible" provided a form of protection to those countries that traditionally used technology without any restrictions or controls, in cases, without regard for human life or environment.	SDM Guidelines	
2011	Some delegations were on the view that space debris mitigation should not lead to overly high standards that might hinder the enhancement of capacity-building in developing countries.		Legal aspects
2011	Some delegations were on the view that the Legal Subcommittee should consider the SDM Guidelines to transform into a set of principles adopted by the General Assembly.		

Source: own construction based on the report from COPUOS (2011)

Table 10: Thematic analysis on document 2012

Document	Condensed Unit	Theme	Subtheme
2012	Some delegations expressed that mitigation and limitation of debris should be among priorities of the Committee and its bodies.		ADR
2012	The view was expressed that, during removal of debris, no unilateral action should happen by any State with respect to space object of another State unless consultation and agreement of the State of registry.	Contemporary issues and inflections	ADR
2012	The view was expressed that the Committee should establish means to eliminate debris, and more consideration to GEO and LEO should be given, as well as ASAT prohibited.		
2012	Some delegations were on the view that the issue of debris should be addressed without jeopardizing developing countries development.		Liability
2012	Some delegations called on the Scientific and Technical Subcommittee to continue its thorough consideration of the issue of debris mitigation with a greater attention on debris coming from nuclear power sources and collisions, as well as the improve of monitoring.	Issue of debris	nuclear power sources
2012	Committee noted that some States had already implemented space debris mitigation measures on a voluntary basis, through national mechanisms consistent with the IADC Guidelines, SDM Guidelines and the European Code of Conduct for Space Debris mitigation.	SDM Guidelines	National mechanisms
2012	Some delegations expressed that voluntary mitigation measures should be encouraged, and the efforts should be intensified in national and international mechanisms to reduce proliferation.		Cooperation

2012	Some delegations expressed that it would be beneficial to exchange information on measures to reduce space debris.		
2012	The Committee expressed concern over the increasing amount of space debris and that its SDM were a key step in providing all spacefaring nations with guidance on mitigation.		
2012	Some delegations expressed that the Subcommittee should include an item for the review of the legal aspects of SDM to transform the guidelines on a set of principles.		Legal aspects
2012	The view was expressed that turning the SDM guidelines into legally binding instrument was not warranted because of the absence of legal definition of fundamental concepts of outer space and that the Guidelines did not contain technical or specification norms. The delegation also noted that it was expected more technical details and the aspect of removal to be considered by the Scientific and Technical Subcommittee under the LTS.		
2012	The view that the Legal Subcommittee should develop appropriate rules, including principles, guidelines and non-binding frameworks on mitigating space debris was expressed.		Updates
2012	Czech Republic proposal on the item "Review of the legal aspects of SDM with a view of transforming the Guidelines into a set of principles to be adopted by the General Assembly".		

Source: own construction based on the report from COPUOS (2012)

Table 11: Thematic analysis on document 2013

Document	**Condensed Unit**	**Theme**	**Subtheme**
2013	The Committee welcomed the symposium on the theme "Overview of studies and concepts for active orbital debris removal".	Contemporary issues and inflections	ADR
2013	The view was expressed that, during the removal of space debris, no unilateral action should be taken by any State with respect to a space object of another State.		
2013	The view that more consideration should be given to GEO and LEO.		GEO, LEO
2013	Some delegations called on the Scientific and Technical Subcommittee to continue its thorough consideration of the issue of debris mitigation with a greater attention on debris coming from nuclear power sources and collisions, as well as the improve of monitoring.	Issues of Space Debris	Nuclear power sources
2013	Some delegations expressed that the States most responsible for debris and those with a greater capability of taking actions should disseminate information on actions taken to reduce the generation of debris.		Liability
2013	Some delegations expressed that the issue of debris should be addressed without jeopardizing developing countries.		
2013	The view was expressed that States that have objects should follow up and monitor continuously.		
2013	The view was expressed that spacefaring nations should provide information to the countries that might be affected by re-entry to allow assessment of risks.		
2013	Some delegations expressed the view that national and international efforts were necessary to reduce creation and proliferation of debris.		Cooperation
2013	Some delegations expressed that it would be beneficial to exchange information on measures to reduce space debris.		
2013	The view was expressed on raising the level of thrust through mutual exchange of information.		
2013	Draft guidelines of the Working Group on the LTS by groups A to D.	LTS Guidelines	Development
2013	Some delegations expressed that Legal Subcommittee should develop legal mechanisms to deal with debris and consequences arising from collisions with debris or their re-entry.		

2013	The view was expressed that the LTS should be shifted from the interest of private sector to the interests of people, and that the Working Group should go beyond the status quo to promote long-term sustainability.		Legal aspects
2013	Committee noted that some States had already implemented space debris mitigation measures on a voluntary basis, through national mechanisms consistent with the IADC Guidelines, SDM Guidelines and the European Code of Conduct for Space Debris mitigation.	SDM Guidelines	National mechanisms
2013	Committee agreed that more states should implement the SDM and/or IADC Guidelines.		
2013	The view was expressed that a document compiling national practices and legislation would encourage the development of new national measures and practices.		Cooperation

Source: own construction based on the report from COPUOS (2013)

Table 12: Thematic analysis on document 2014

Document	Condensed Unit	Theme	Subtheme
2014	Some delegations called on the Subcommittee to continue its thorough consideration of the issue of debris mitigation with a greater attention on debris coming from nuclear power sources and collisions, as well as the improve of monitoring.	Issue of Space Debris	Nuclear power sources
2014	Some delegations expressed the view that national and international efforts should be intensified to reduce debris scenario.		Cooperation
2014	Some delegations expressed the view that it would be beneficial the exchange of information on measures to reduce the debris scenario.		
2014	Some delegations expressed that the issue of debris should be addressed without jeopardizing developing countries.		Liability
2014	Some delegations expressed that the States most responsible for debris and those with a greater capability of taking actions should disseminate information on actions taken to reduce the generation of debris.		
2014	The view was expressed that those largely responsible should assist developing countries by providing scientific and technological support.		
2014	The Committee noted with appreciation the proposal by the Working Group for the consolidation of the set of draft guidelines.	LTS Guidelines	Development
2014	Some delegations expressed that the set of draft guidelines should not create barriers for new space fairs and actors by the burden imposed by the activities of established spacefaring nations from 50's.		Legal aspects
2014	The view was expressed that the guidelines should not contain such simplified language that would not offer practical solutions.		
2014	The view was expressed that elements such space debris mitigation and ADR should be considered by the Subcommittee on the LTS.		ADR
2014	Committee agreed to have the final draft guidelines ready for approval by 2016.		Adoption
2014	The Committee noted with satisfaction the dedicated research efforts among States to mitigate the effects of space debris.	SDM Guidelines	Cooperation
2014	Some delegations expressed that the Subcommittees should cooperate to develop binging rules.		Legal aspects
2014	Some delegations expressed that the information and communication-related issues needed to be addressed for SDM: establishment of a common international practice of information exchange and a single space debris monitoring center, database with all the known objects and a universally accepted standard for collision risk calculation.		
2014	The view was expressed that those largely responsible for the situation should assist emerging countries in implementing SDM or standards through the provision of conjunction assessment risk analysis and space situational awareness systems.		

2014	The view was expressed that the SDM guidelines needed to be perfected to eliminate ambiguity that might allow countries to continue creating debris.		
2014	The Committee noted that the compendium of space debris mitigation standards would contribute to improving the knowledge on space debris mitigation standards and regulatory framework.		National mechanisms
2014	The Committee expressed its appreciation to Canada, Czech Republic, and Germany for the development of the compendium and the Secretariat to maintain the compendium on a dedicated page of the OOSA website.		

Source: own construction based on the report from COPUOS (2014)

Table 13: Thematic analysis on document 2015

Document	Condensed Unit	Theme	Subtheme
2015	The Committee noted with appreciation the establishment of a space debris observation and operation center by the CNSA in 2015.	Contemporary issues and inflections	
2015	The view was expressed that space debris mitigation were possible even for small and very small satellites.		
2015	Some delegations expressed the view that the future of space activities largely depended on space debris mitigation and removal, and that the issue of mitigation should continue to be treated as a priority.		ADR
2015	Some delegations expressed the view that the complexity of issues such ADR required consideration from both technical and legal perspectives.		
2015	The view was expressed that the issue of ADR could become a new item on the agenda of the Subcommittee.		New item
2015	Some delegations expressed the view that it was necessary to continue thorough consideration on debris mitigation, paying greater attention to the problem of debris coming from platforms with nuclear power sources.	Issue of Space Debris	Nuclear power sources
2015	Some delegations expressed that the States most responsible for debris and those with a greater capability of taking actions should disseminate information on actions taken to reduce the generation of debris.		Liability
2015	The view was expressed that it was important to address the proliferation of debris without hampering emerging space fairings.		
2015	The view was expressed that those largely responsible should assist developing countries by providing scientific and technological support and without imposing undue costs.		
2015	Some delegations expressed the view that it was of the utmost importance to continue treating the legal issues related to mitigation and removal, and that measures should not lead to the adoption of overly high standards for developing countries.		
2015	The Committee noted that the Working Group had not affirmed that it could fully proceed with its workplan.	LTS Guidelines	Development
2015	Some delegations expressed the view that timely finalization of the guidelines was important given the proliferation of debris and increased risk of collisions, which posed a serious threat to the safety of space operations and the long-term sustainability.		
2015	The view was expressed that the investigation and consideration of new measures to manage space debris in the long term were indispensable to ensuring the LTS activities.		Legal aspects
2015	The view was expressed that in finalizing the draft guidelines, the adoption of space debris mitigation and removal measures must consider the historical responsibilities of spacefaring nations, and emerging spacefaring nations should not be obliged to bear the burden or share the costs of space debris removal.		

Source: own construction based on the report from COPUOS (2015)

Table 14: Thematic analysis on document 2016

Document	Condensed Unit	Theme	Subtheme
2016	The view was expressed that the principle of common but differentiated responsibility should be applied on debris and that States that created space debris had exclusive responsibility for its removal.	Contemporary issues and inflections	ADR
2016	The view was expressed that international efforts were necessary on ADR and not that removal efforts should be taken in isolation, in view of potential negative impact on the GEO and the potential lead to conflict between States and to the militarization of outer space.		
2016	The view was expressed that the development of the SDM into binding instrument or the development of guidelines for ADR would be premature given the technology was not at an advanced enough stage.		
2016	The view was expressed that it was necessary to analyze the possible impacts of deployment of large constellations in LEO and to investigate the end-of-life disposal of constellation members.		Megaconstellations
2016	Some delegations called on the Subcommittee to continue its thorough consideration of the issue of debris mitigation with a greater attention on debris coming from nuclear power sources and collisions, as well as the improve of monitoring.	Issue of Space Debris	Nuclear power sources
2016	Some delegations expressed that the issue of debris should be addressed without jeopardizing developing countries.		Liability
2016	Some delegations expressed that the States most responsible for debris and those with a greater capability of taking actions should disseminate information on actions taken to reduce the generation of debris.		
2016	The Committee noted that the Working Group had made substantial progress in developing set of guidelines for the LTS but noted that the various draft guidelines were at different stages. It was noted the substantial progress in developing background information and the definition of LTS.	LTS Guidelines	Development
2016	The Committee noted that an increasing number of States were adopting concrete actions to mitigate debris, such as improvement of design, deorbiting, passivation among others.	SDM Guidelines	National mechanisms
2016	Some delegations expressed that the future depended on mitigation and removal and that the issue of mitigation should continue to be treated as priority.		Updates
2016	The view was expressed that since much of the debris was a result of the past from major spacefaring countries, there was a moral international responsibility on their part to assist emerging spacefaring countries in implementing mitigation guidelines.		Legal aspects
2016	Some delegations expressed that the SDM should be presented for legal analysis regarding compliance with principles on outer space.		
2016	The view was expressed that OOSA should spearhead efforts to address space debris mitigation by setting up a global holistic program, defining guidelines, scheduling activities, and producing periodic reports.		Cooperation

Source: own construction based on the report from COPUOS (2016)

Table 15: Thematic analysis on document 2017

Document	Condensed Unit	Theme	Subtheme
2017	Some delegations expressed the view that there was a need for the detection, tracking, monitoring and reduction of debris and for elimination of debris according to a known timetable.	Contemporary issues and inflections	ADR
2017	The view was expressed that the absence of international regulation on ADR influenced the safety and security of space activities.		

2017	Some delegations expressed satisfaction with the amendment of the agenda item to include space debris remediation measures.		New item; ADR
2017	Some delegations expressed that the issue of debris should be addressed without jeopardizing developing countries.	Issue of Space Debris	Liability
2017	The view was expressed that it was necessary to ensure that policies and procedures to minimize risks of accidents did not result in long-term disadvantages for emerging spacefaring countries.		
2017	The view was expressed that international efforts were required to reach a common view and establish common rules and pool efforts on the increasing amount of space debris.		Cooperation
2017	The view was expressed that the increased number of debris and a growing gap between technological progress and regulations increased the relevance of the work of the Committee.		
2017	Some delegations expressed the view that it was important to establish, by 2018, clear, practicable and proven LTS guidelines.	LTS Guidelines	Development
2017	The view was expressed that all States should consider that debris affect the sustainability of use of outer space.		Space debris
2017	The Committee agreed on the importance of completing the LTS to be adopted by the Committee and transmitted to the General Assembly in 2018 to coincide with UNISPACE+50		Adoption
2017	Committee noted that some States had already implemented space debris mitigation measures, through national mechanisms consistent with the IADC Guidelines and the SDM, and some developed their own space debris mitigation standards.	SDM Guidelines	National mechanisms
2017	In addition, the Committee noted that some States were using the European Code of Conduct for Space Debris, International Organization for Standardization standard and ITU recommendation as reference points.		
2017	The Committee noted that an increasing number of States were adopting concrete actions to mitigate debris, such as improvement of design, deorbiting, passivation among others.		
2017	The view was expressed that there was a moral international responsibility on the major spacefaring countries to assist emerging spacefaring countries on the implementation of SDM.		Legal aspects

Table 16: Thematic analysis on document 2018

Document	Condensed Unit	Theme	Subtheme
2018	The view was expressed that criteria and procedures for ADR or intentional destruction needed to be thoroughly deliberated under the UN.	Contemporary issues and inflections	ADR
2018	Some delegations expressed the view that mitigation and limitation of debris should be among priorities of the Committee.	Issue of Space Debris	
2018	Some delegations expressed the view that there was a need for differentiated responsibility in cleaning debris according to each member.		Liability
2018	Some delegations expressed that the issue of debris should be addressed without jeopardizing developing countries.		
2018	The view was expressed that the debris issue should be addressed without passing costs to emerging space fairings.		
2018	Some delegations expressed the view that the registration of space objects and their parts was particularly important for LTS.	LTS Guidelines	Legal aspects
2018	Working group reached consensus on a preamble and 21 guidelines for LTS.		Adoption

2018	The Committee encouraged members to consider implementing the LTS and share their experiences.		National mechanisms
2018	The Committee noted that members may develop further proposals to continue the work on the LTS.		Development
2018	In addition, the Committee noted that some States were using the European Code of Conduct for Space Debris, International Organization for Standardization standard and ITU recommendation as reference points.	SDM Guidelines	National mechanisms
2018	The Committee noted that an increasing number of States were adopting concrete actions to mitigate debris, such as improvement of design, deorbiting, passivation among others.		

Source: own construction based on the report from COPUOS (2018)

Table 17: Thematic analysis on document 2019

Document	**Condensed Unit**	**Theme**	**Subtheme**
2019	The view was expressed that the commercial development of technology to enable on-orbit servicing and orbital debris removal should be encouraged.	Contemporary issues and inflections	ADR
2019	Some delegations expressed concern at the lack of international regulation of active debris removal activities.		
2019	The view was expressed that access to space debris mitigation and removal technologies should be facilitated because a cleaner space environment would be beneficial to all.		
2019	The view was expressed that criteria and procedures for ADR or intentional destruction of space objects, either functioning or non-functioning, needed to be thoroughly deliberated under the auspices of the United Nations to guarantee the effectiveness of the measures and ensure that they were accepted by stakeholders.		
2019	Addressing the challenges posed by the placement in space of large constellations and mega constellations should be made a priority in the work of the Committee.		Megaconstellations
2019	Some delegations expressed that the issue of debris should be addressed without jeopardizing developing countries.	Issue of Space Debris	Liability
2019	Some delegations expressed the view that it was important that new space actors were not burdened because of the historical activities of established space actors.		
2019	The view was expressed that it was important to raise awareness and build political support to discourage activities that resulted in the uncontrolled generation of space debris.		Cooperation
2019	Committee adopted the preamble and 21 guidelines for the LTS, encouraging States and organizations to take voluntary measures to ensure that the guidelines were implemented to the greatest extent feasible and practicable.	LTS Guidelines	Adoption
2019	In addition, the Committee noted that some States were using the European Code of Conduct for Space Debris, International Organization for Standardization standard and ITU recommendation as reference.	SDM Guidelines	National mechanisms
2019	IADC, whose initial work had served as the basis for the Space Debris Mitigation Guidelines of the Committee, had updated its own Space Debris Mitigation Guidelines, which now stated that the post-mission lifetime of a satellite in orbit should not exceed 25 years, included the requirement of achieving a 90 per cent probability of the successful post-mission disposal of satellites, and addressed the topic of large constellations.		Updates

Source: own construction based on the report from COPUOS (2019)