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## The Absence of Laws Regulating the Proliferation of Space Debris and its Implications on Space Operations

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### Abstract

In 1957, Sputnik-1 was launched to outer space and since then, for over six decades, space fairing nations have been launching missions to different orbits in outer space. However, these activities that were meant to serve humanity through research outputs and commercial services, caused an operational satellites to remain in orbit with no purpose to serve. Eventually, this resulted in the accumulation of space debris, which kept increasing due to collisions that put operational satellites in a very critical situation and make the outer space an unsafe environment to host the current and future space activities. The threat of space debris was recognized early in time, but it was never a matter of concern. Nowadays, with the high demand to access outer space, different private companies and state governments are planning to launch large constellations of satellites to lower earth orbit to provide high speed internet services and many other activities that are also planned by developing states due to the new technologies that allowed low-cost access to space. Thus, it is important to manage the proliferation of space debris and its implications on the sustainability of space activities. The United Nations Committee on the Peaceful Use of Outer Space (UNCOPUOS) was established as a specialized agency to maintain the international peace and security of space activities, which is being now directly affected by the significance increment in the production of space debris. By its nature, Space debris constitute a threat that can cause damages to space assets it hit due its varying sizes and its very high speed that is almost 10 km/s, at this speed its threat extends to astronauts in the International Space Station (ISS). Furthermore, because space debris is not identified to whom it belongs, if it causes any damage in outer space it would be very hard to impose liability on anyone. Unfortunately, the current space legal regime that is mainly represented of the five international space treaties does not define space debris, prevent the proliferation of space debris neither imposes a responsibility on the launching states to remove it from outer space. The lack of regulatory framework relating to space debris and the negligence will result in catastrophic situations that will limit the space activities and effect the outer space sustainability. Accordingly, international organizations and space agencies conceded space debris mitigation guidelines and standards, but it remains voluntary to abide to while developing a space mission. Hence, the emergence of legally binding laws to regulate space debris and the other issues arising from it is needed to assure the safety of outer space environment. This paper will focus on the legal challenges of space debris by shedding the light on the loopholes in the current international space legal regime, as well as it will review the importance of the existing international guidelines and standards to be taken into consideration as binding regulations in the future advancement of space law.

**Keywords:** Space Debris, Space Law, Space operations

### Acronyms/Abbreviations

United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)

Inter-Agency Space Debris Coordination Committee (IADC)

European Space Agency (ESA)

### 1. Introduction

The proliferation of space debris has become a substantial concern as the number of launches and the amount of debris in orbit have increased [1]. The problem is further compounded by the fact that debris can travel at extremely high speeds, making collisions with operational satellites and other space assets a real threat [2]. The accumulation of debris in orbit can lead to a cascade effect, where collisions between debris create even more debris, increasing the risk of collisions for operational spacecraft [3]. Furthermore, the debris can stay in orbit for centuries, meaning the problem will persist for a long time [4].

The absence of laws and regulations for the generation of space debris is a major contributing factor to the proliferation of space debris. While there are international guidelines and best practices for reducing the number of debris generated during space operations, such as the guidelines developed by the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) and the Inter-Agency Space Debris Coordination Committee (IADC), these are not legally binding [5]. This means that there is currently no legal framework in place to hold countries or companies accountable for the debris they generate or to provide a mechanism for dealing with debris that becomes a problem [4].

The paper is structured as follows: Section 2 examines the identification of space debris, the removal of inactive satellites, and highlights the necessity of international cooperation. International space treaties and the importance of the existing guidelines will be discussed in Section 3. Section 4 addresses legal challenges and presents recommendations. Finally, the study's conclusion is summarized in Section 5.

## **2. International Space Activities**

### *2.1 Identify space debris*

Space debris refers to any manmade object in orbit around Earth serving no useful purpose. These objects can be anything from dead satellites, rocket stages, or fragments from collisions and explosions. While there is no exact number of how much space debris is orbiting our planet, there are several ground-based radars and optical telescopes being used to detect, track, identify, and catalogue all manmade objects in orbit. The most recent estimate from the European Space Agency (ESA) states that there are over 100 million pieces of space debris orbiting Earth, ranging in size from 1 mm to larger than 10 cm. Of these pieces, more 36,500 pieces of debris are estimated to be larger than 10 cm, and more than 7,000 are estimated to be active satellites [6].

The total mass of all known space debris is estimated to be more than 10,500 tonnes. However, this number is likely to be higher as many estimates do not consider the smaller pieces of debris. The smaller pieces of debris are created from rocket exhaust, paint chips and other small objects. And they travel around earth at a very high speed with the potential to damage ongoing missions. The accumulation of space debris is increasing, as it is not possible to remove most of the existing debris due to the enormous number of space objects. This accumulation has the potential to cause a dangerous chain reaction, known as the Kessler Syndrome. This is where an increase in the population of objects creates greater risk of collision and further fragmentation, leading to an exponential increase in the amount of space debris.

### *2.2 Removing inactive satellites (enforce removal mechanism)*

Tracking and removing inactive satellites is a critical component of sustaining space exploration and preventing collisions with space debris. Satellite operations are typically managed by the space agencies that launched them, but some private companies are beginning to enter the field. To ensure the safety of our orbital environment, it is important to track and remove inactive satellites, including those that have malfunctioned or are no longer in use.

The first step in tracking and removing inactive satellites is to accurately detect them. This is done primarily through satellite tracking systems. Satellites are equipped with transmitters that broadcast their position and health status, but data from these are often incomplete or not shared. To address this, space agencies rely on dedicated tracking networks that utilize ground-based radar, optical, and radio telescopes to monitor and identify satellites. This data is then used to update satellite catalogues which contain up-to-date information on the location and status of each satellite.

After satellites have been identified, their status must be determined by the operator whether they are active or inactive. An inactive satellite can become a hazard if it is not removed from orbit, as it may eventually collide with other active spacecrafts. To ensure that they are removed, countries have enacted legislation that requires all inactive satellites to be decommissioned, disassembled, and removed from orbit. This is done by utilizing the satellites orbital control capabilities to manoeuvre or deorbit the satellite before end of life, other satellites with no such capabilities are placed in a naturally decaying orbit in line with actual duration of the mission.

As the problem is a growing it is essential that new measures are put in place to reduce the number of debris that is generated. There are several strategies proposed to manage the space debris problem. These include active removal, such as cleaning up debris using spacecrafts and capture/deorbit/disposal in Earth's atmosphere. There are currently

several efforts underway to mitigate the effects of space debris, such as the deployment of netting or tethers to deorbit the debris, or the use of lasers or harpoons to break up larger pieces. Passive strategies are also proposed, such as collision avoidance manoeuvres and debris shielding.

### *2.3 Necessity of international cooperation*

Cooperation in space is becoming an important part to address the space debris problem. As commercial space activity grows, the risk of collisions between satellites, rockets parts and other space objects increases. This increases the risk of creating even more space debris, jeopardizing all future space missions. Space collaboration has proven to be a valuable tool in solving the problem of space debris. It not only provides a forum for international cooperation and dialogue, but also a platform for exchanging information on the latest developments and technologies related to the space industry, such as software, launch services, and space security regulations. This information can be used to promote the safe operation of satellites and spacecraft, as well as to help mitigate the risk of accidents and collisions in space.

Such collaboration also allows for the creation and implementation of measures to prevent the generation of space debris. This can include designating and monitoring hazardous orbits, establishing mandatory tracking and reporting obligations for operators, and mandating the use of technologies to capture and remove debris. In addition, it provides an opportunity to further research, develop, and share best practices for detecting, tracking, and managing space debris. This information can then be used to educate operators, regulators, and citizens about the importance of reducing the risk of space debris.

## **3. Implications on Space Operations**

### *3.1 International Space treaties*

Space exploration is a relatively new endeavour, but that doesn't mean it isn't a highly regulated activity. International space treaties help further to ensure the safe use of space for all. There are five major international space treaties and agreements: the Outer Space Treaty, the Rescue Agreement, the Liability Convention, the Registration Convention, and the Moon Agreement. Each of these treaties has special provisions that help to guide the way space exploration is conducted, ensuring peaceful exploration and use of space resources.

The first international space treaty was the 1967 Outer Space Treaty, which defined the high-level principles of space exploration and use. The treaty prohibits the testing, development, or deployment of weapons of mass destruction in space and establishes a legal framework for the peaceful use of space. The treaty also prohibits nations from claiming sovereignty over space or any part of celestial bodies.

The Rescue Agreement was created in 1968 and is designed to assist in the rescue and return of astronauts and objects launched into outer space. It establishes procedures for the recovery, return, and notification of astronauts and objects needing assistance. It also requires that any nation must provide its consent if it wishes to accept the rescue of another nation's astronaut or object.

The Liability Convention, adopted in 1972, provides a comprehensive approach to determining accountability in the case of space incidents. It also mandates nations to take measures to ensure their space activities do not cause harm to other nations or the environment. Furthermore, the Registration Convention of 1976 mandates nations to register their space objects with the United Nations and established a system for notifying and disclosing the orbital elements of satellites in Earth orbits.

The Moon Agreement was adopted in 1979, applying specifically to the moon. This treaty establishes that the moon is a shared resource of all mankind, and that no nation can claim ownership of any part of the moon. Additionally, the agreement requires that any activity on the moon is done with the intent of preserving and protecting the environment and natural resources.

These international space agreements promote safe and secure space exploration and foster collaboration among nations. They provide a set of guidelines and regulations that must be followed by all nations during space activities, ensuring that the utilization of space is advantageous to all of humanity [7].

### *3.2 Importance of the existing guidelines*

The Inter-Agency Space Debris Coordination Committee (IADC) Space Debris Mitigation Guidelines provide an international framework for reducing orbital debris and protecting active missions and assets in the space environment. These guidelines are the result of a collaborative process between members of IADC. The guidelines intend to serve as a reference for legal and regulatory entities, space operators, industry, and other stakeholders involved in activities in the outer space domain.

The IADC Space Debris Mitigation Guidelines are comprised of seven fundamental principles for managing space debris. These principles require space objects' design, development, and operation to minimize debris production and be accountable for the generated debris and its potential hazards. In addition, it is crucial to take measures to mitigate the dangers of accidental explosions or collisions in space. The principles also include informing operators about the risks and mitigation methods, promoting international cooperation and information sharing, encouraging research and development towards reducing space debris, and evaluating the impact of all space activities on the environment.

The IADC Space Debris Mitigation Guidelines aim to reduce the generation, impact, and long-term accumulation of orbital debris and to foster responsible use of outer space. The guidelines provide comprehensive guidance and resources on the issues related to space debris. It is designed to support international collaboration in developing legal and technical measures to protect active missions and assets in the space environment. In addition, the guidelines act as an essential reference for all stakeholders in the space environment. They provide an international framework for reducing orbital debris and protecting active missions and assets in the space environment. The guidelines are a vital tool for international collaboration and promote the responsible use of outer space for the benefit of all [8].

## **4. Legal Challenges of space debris**

### *4.1 Legal loopholes*

Space debris and its associated legal loopholes have become a growing concern for space operators and lawmakers over the past few decades. Space debris poses a threat to existing and future spacecraft operations and has the potential to create a cascading effect of collisions, leading to an ever-increasing population of debris in Earth's orbit. One major legal loophole in space debris arises from the lack of any definitive international law governing space debris. Currently, only two main international treaties exist, the 1967 Outer Space Treaty, responsible for the general principles of international space law, and the 1972 Liability Convention, which governs the liability of space operators for damage inflicted by their activities on the Earth's surface or other objects in space. However, neither of these treaties deals explicitly with the issue of space debris. Without an international agreement, individual countries are left to address the issue on a case-by-case, leading to inconsistencies in the handling of space debris and legal vulnerabilities in the event of an accident.

A second legal loophole associated with space debris is the potential for a spacecraft operator to be held accountable for damage caused by a piece of debris for which the operator is not responsible. Liability for such indirect damage still needs to be clarified and addressed in the 1967 Outer Space Treaty or the 1972 Liability Convention. This loophole opens up the possibility of a spacecraft operator being held liable for damage caused by a piece of debris, even when the operator is not responsible for the debris. Moreover, another significant legal loophole is the difficulty in tracing the origin of debris and assigning responsibility. In many cases, it is impossible to determine who is responsible for creating space debris, making it challenging to hold those responsible accountable.

These loopholes need to be addressed to ensure the responsible management and disposal of space debris, and to minimize its impact on human space missions and active satellites. In addition, efforts should be made to ratify and implement international agreements on space debris, to develop new norms and guidelines for responsible space debris management, and to improve the monitoring and analysis of space debris [9].

### *4.2 Suggestions for the legal loopholes*

To address these legal loopholes, various proposed solutions have been put forward. One proposed solution is ratifying and implementing international agreements such as the Outer Space Treaty and the Liability Convention. These Treaties would set clear rules and standards for the responsible use of space and ensure that all countries comply with the same standards for mitigating space debris. It will also ensure consistency across the globe and clarity in an accident involving space debris.

Another proposed solution is for countries to sign up for a framework for collective responsibility for any accidental damage caused by space debris. Doing so will ensure that any damage caused by a piece of debris would be shared among all the nations responsible for its creation, regardless of whether or not the operator responsible for the debris was cognizant of the damage caused by it. In addition, an advanced space situational awareness investment could be an effective solution where these systems will provide greater visibility into the origin, trajectory, and potential impact of space debris, making it easier to trace its source and assign responsibility. This will also help to minimize the creation of space debris and to ensure that countries are held accountable for its impact.

Furthermore, international cooperation and collaboration are critical to mitigating the creation of space debris and addressing the legal loopholes in current regulations. By working together, countries can share information, resources, and their best practices to minimize the creation of space debris and to ensure its responsible management and disposal. In addition, countries could work together to develop a system of insurance to cover any damage caused by space debris. Such a system could become mandatory for all spacecraft operators, ensuring that any damage caused by space debris would be compensated promptly, thus providing financial security to operators in the event of an accident [9].

## 5. Conclusions

Space law is an ever-evolving field, but we are still in the early stages when it comes to regulating space debris. Despite the catastrophic damage and disasters that space debris can cause, the international laws and treaties are placing a limit on the increase of space debris. However, with the rapid growth in the number of space missions and the consequent increase in space debris is a growing concern which requires greater attention from space agencies, although some efforts have been made to address this problem, the amount of space debris continues to grow and more needs to be done to mitigate its impact. Without space laws and regulations, the space debris problem will continue to pose a significant threat to the sustainability of the orbital environment.

For these laws and regulations to have impact it requires international cooperation as it is an essential part of the global effort to address the issue of space debris and protect the safety of satellites and spacecraft. By exchanging information, creating, and implementing measures to prevent the generation of space debris, and researching and sharing best practices, space collaboration can help reduce the risk of collisions and protect our assets in space.

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