THE PRESSING NEED FOR LEGAL CERTAINTY FOR SPACE OPERATORS TO MITIGATE AND REMOVAL SPACE DEBRIS

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ABSTRACT

The Inter-Agency Space Debris Coordination Committee (IADC) was formed to address the issue of orbital debris. The IADC Space Debris Mitigation Guidelines have been globally widely accepted (Larsen 2018, p. 498). However, the IADC's cannot enforce international space debris regulations, in particular, the removal of space debris (Larsen 2018, p. 499).

Although the IADC Space Debris Mitigation Guidelines have been widely accepted, a fundamental concern regarding these international guidelines is that it is considered "soft law" and is considered to some legal scholars as being "less binding". By enacting international hard law requirements for mitigating space debris, thus create legally binding obligations that are precise (or create more detailed regulations) and that a designated delegate authority for enforcing the law (Shaffer and Pollack 2010, p. 714-715).

1 INTRODUCTION

An inherent problem for the space powers and other states concerning space debris is the need for hard laws that encourage international cooperation and clarification on how to best address the issues of mitigating and removing the space debris. Whilst the Guidelines are the initial point for states to adopt their legislation to reduce the orbital debris, all United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) members will agree that international collaboration is required.

The adoption of the IADC's main purpose of mitigation alone cannot prevent the predictions made by the Kessler Syndrome. If forecasts projected by the Kessler Syndrome become reality, the space powers by the 2060s will see a 'runaway growth in the number of collisions and debris in' Low Earth Orbit (Bowen 2014, p. 4). In 2020, if the space powers alone remove five troublesome debris every year, it is projected by the 23rd century that the debris will be halved from 60,000 to 30,000 (Bowen 2014, p. 4).

During the cold war when tenses were high between the space powers (the former Soviet Union and the United States) they came together to make a strong commitment to the peaceful uses of outer space. Since the development of Anti-satellite technologies, tenses between countries has risen. The same discussions between the space powers must occur again.

The issues surrounding the mitigation and removal of space debris are becoming more complex and require immediate resolution. Firstly, we must define space debris and determine the risks involved to mitigate and remove it. Secondly, we must have the appropriate international standards and practices to ensure a substantial collective effort is being made by all space operators to reduce debris. Thirdly, salvage law must be acknowledged to provide an incentive for public and private operators to actively remove space debris.

2 NATIONAL INITIATIVES

In 1988, the United States (US) pioneered the introduction of a national space policy and the National Aeronautics and Space Administration (NASA) developed the world's first space debris guidelines (Ansdell 2010, p 10). Although the US lead the initiative; Art IX of the Outer Space Treaty (OST) specifies the principle of co-operation (and Articles III and X) there are no specific requirements for states to either have a duty of care to mitigate or remove space debris. Furthermore, the current Guidelines provide general principles for international cooperation, but legislation is needed to specify the type of activities, the role of the actors to remove standards required for space debris (Popova and Schaus, 2018 p. 3).

The 25-year rule US Orbital Standard Practice ensures that satellite objects do not exceed a 25-year life span but is it necessary at an international level that higher levels of authority and stricter levels of compliance are required to reduce the growth of orbital debris (Hildreth and Arnold 2014, p. 8). The United States along with NASA and the Department of Defence have extensive policies, practices and guidelines to ensure that all space operators are reducing orbital debris. Since 1994, NASA was a founding member of the IADC and has lead the discussion on this topic at the Scientific and Technical Committee (STSC) of the COPUOS. NASA pioneers in researching and developing relevant technical standards and informs the STSC of issues to be addressed with the aim to update the Guidelines (Compendium 2019, p. 63).

Russia still acknowledges that itself and other states require equal or priority access to data that is available to detect space debris. It can only be ensured if all states have a national and international system devoted to detecting, cataloguing, and processing real-time information that is centralised space debris centre before

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determining the risk of collision with space debris (Shustov et al. 2013, p. 305).

The 1986 Ariane event lead to a response by various European Space Agencies to work together to respond to the orbital debris problem. Within the European Space Agency research activities formed a multidisciplinary Space Debris Office. The Office conducts research and development to four national space agencies of ESA / EU member states such as France (CNES), Germany (DLR), the United Kingdom (UK Space Agency) and Italy. These national space agencies with ESA collaborated and formed the European Network of Competences on Space Debris (SD NoC). Since the Ariane Event, a Resolution on the Agency's policy vis-à-vis the space debris issue was required and ten years later ESA created a Space Debris Mitigation Handbook. Also, several other documents lead to the formation of the European Code of Conduct for Space Debris (Wouters et al. 2015, p. 9-11).

3 INTERNATIONAL COOPERATION WITH A COMMON INTEREST

In 1994, the United Nations General Assembly (UNGA) promoted to states not yet party to the OST the role of international cooperation for peaceful space exploration. A UNGA resolution in 1996 built on its predecessor with an emphasis on acknowledging the needs of developing countries, however these were non-binding. International law principles for instance *corpus spatialis* can be used for the 'international obligation to cooperate for the benefit of mankind' (Degrange 2019, p. 6). In 2010, the COPUOS explicitly stated that the Guidelines are not binding and it was the responsibility of nations and international organisations to adopt the appropriate measures to ensure that guidelines were being followed (McCormick 2013, p. 808).

It would be advisable to encourage the "Common Interest" principle which was originally discussed in the first three space race resolutions of the UN's General Assembly, and was later enacted into Articles I and IX of the Outer Space Treaty (Degrange 2019, p. 6). These documents have resulted in two main rules: 'first, the exploration and use of outer space must be carried out for the benefit and in the interest of all countries', and second, following the first is that it should be carried out in due regard of the corresponding interests of all States parties to the Treaty (Degrange 2019, p. 6).

Article I (I) of the OST acknowledges that outer space is to be used "for the benefit and in the interests of all countries" and must recognise "the province of mankind". Although the expression of "province of all mankind" should not be confused with the "common heritage of mankind" (CHM). Although it origins are from *res communis humanitatis* which acknowledges the community interests and benefits that are favoured by humanity in outer space activities, CHM is defined in the Moon Agreement and is not subject to the outer-space environment generally (Tan 2000, p. 162). Article I (I) of the OST is not defined by the Treaty but it still acknowledges Article 3 of the United Nations Charter (Tan 2000, p. 162).

The "Common Interest" principle is still subject to controversies especially concerning the word "countries" due to no legal consistency. The United States objected to this point, but the opinion of Article I was to provide a guide to the space powers but does not set out terms or conditions regarding how they should develop and conduct their activities concerning international cooperation. Furthermore, the United States added Article I was vague and had no legal obligation, thus not self-executing (Degrange 2019, p. 6). However, others have considered that the use of the word "shall" found in Article I shows an intention that the parties have made a binding obligation to cooperate internationally with other states (Degrange 2019, p. 6). The Common Interest principle requires practical measures which may require international assistance from either a private or public actor.

An inherent problem with the common interest is that states differ on the concept. For example, each state, and space operator is charged with the identification of the common interest and each must participate in forming a view to the meaning of the common interest. It requires all space operators from diverse states whether public or private will differ with their goals either for commercial, scientific or military purposes but they will have a common interest to protect and preserve the environment by mitigating and removing space debris.

The common interest is highly relevant to determining the role of the space operator in particular whether their conduct falls within national jurisdiction. The *Res nullius* concept was recognised that no national sovereignty existed in certain areas and states have a right to assert sovereignty. The alternative is that orbits are needed for the common benefit and these resources should not be 'subject to private ownership or state sovereignty' (Tan 2000, p. 160-161).

The 1963 Declaration of Legal Principles strongly emphasised the principles of equity, fairness, and a common interest (Tan 2000, p. 161). Presently an intended orbit is considered a public good. However, with the increasing number of space debris, it may become excludable, thus space agencies may have to restrict one party access to orbit due to another person occupying it and also due to the threat of space debris (Salter 2015, p. 10). However, Article I of OST specifically claims exclusive appropriation. Each state has an equal right to access outer space and no state can be the exclusive user that excludes other states and operators from a particular orbit (Larsen 2018, p. 748).

3.1 Anti-satellite Problem and the international community's commitment towards peaceful uses of outer space

Both the USSR and the US supported the uses of the space environment for peaceful purposes. In 1958 President Dwight D. Eisenhower called States "to promote the peaceful uses of space and to utilise the new knowledge obtainable from space science and technology for the benefit of mankind" (Christol 1985, p. 195). On April 22, 1958, President Khrushchev, following President Eisenhower's proposal in correspondence with President Bulganian, wrote that his country would seriously consider American's proposal to exclusively make outer space reserved for peaceful purposes. President Khrushchev added that the Soviet Union was "prepared to conclude an agreement which would provide for the prohibition of the use of outer space for military purposes and would permit the launching of rockets into outer space only by an international program of scientific research" (Christol 1985, p. 195).

Both states were crucial to the formation of terms of Article 4 found within the 1967 Principles Treaty. Both the Article and the Treaty as a whole do not restrict the space environment to be used exclusively for peaceful purposes (refer to Article 4 paragraph 2). An inherent issue with the treaty and the Article is that without an ultimate definition of the expression of "military", states (and private operators) can use space technologies for military purposes that were not originally conceived by the drafters due to the advancement of technology concerning military purposes that would intentionally not be peaceful (Christol 1985, p. 195).

It was not until the development of anti-satellite satellites (ASATs) and ballistic missile defence (BMD) in the 1970s that occurred which could be defined as human-made space objects where military space capabilities were first developed(Christol 1985, p. 195). In the late 1970s, the US began to develop, test, deploy and use ASATs. Since the early development, there have been numerous cases of ASATs.

The United States on 20 February 2008, deployed their own ASAT creating 174 space debris (Weeden and Samson, 2019). On 27 March 2019, the Indian Government sent an ASAT creating over 400 Orbital Debris to show the world, it was a space power with defence capabilities to respond to China destroying one of its weather satellites in January 2007. On 16 December 2020, Russia conducted a direct satellite missile (Rej 2020). The United States in response to its purposeful interference or its allies which affects the national rights will be met with immediate response (Rej 2020).

Presently, there needs to be a clarification to distinguish "peaceful" and "military" but also "peaceful" and "aggressive". According to Christol (1985) p. 197 'the prevailing view, but not unanimous, the view is that aggressive conduct violates the norms of peaceful uses of outer space. To determine the issue of aggressive behaviour, we must determine the amount of force used that makes it aggressive conduct, whilst distinguishing peaceful conduct from aggressive conduct. One view, that military personnel performing peaceful operations is not military in nature or aggressive (Christol 1985, p. 197).

Another view is that all military activity is inherently military and thus aggressive. Military satellites and personnel that engage in technical verification of space objects as a military in nature are therefore aggressive. However, scholars have rejected this rationale due to military personnel and military satellites being used by the military for defence purposes only. These scholars further add that these military satellites are to preserve the peace to respond to humanitarian aid and monitoring war zones (Christol 1985, p. 197).

The original intention of the Principles Declaration 1962 which is found in paragraph 1 was that the peaceful uses of outer space be "for the benefit and in the interests of all" humanity, with the aim from its inception to have the international community incorporate an outer space arms control regime. Within the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS), Brazil, India, Japan and Lebanon proposed that any outer space treaty "Principles Declaration" should include a genuine operative paragraph that unequivocally ensures that outer space is used only for peaceful purposes. The Principles Declaration was included in the OST (Wolter, 2005 p. 13).

The OST paragraph 4 affirms that all space activities be conducted "in the interest of maintaining international peace and security and promoting international cooperation and understanding" and paragraph 6 ensures that State must consult the possible harmful interference to other states and seek appropriate international consultation regarding possible harmful interference with the peaceful use of outer space (Wolter 2005, p. 13).

The Current Space Debris legislation requires similar provisions to the Antarctic Treaty. The Antarctic Treaty ensured to prevent the militarization of the Antarctic and required the area to be a complete demilitarised zone. Article 1 prevents any measure of a military nature which included the military manoeuvers and testing of weapons. The United Nations General Assembly to protect the international seabed they made a resolution entitled the "Declaration of Principles Governing the Sea-bed and the Ocean Floor, and the Subsoil Thereof, beyond the Limits of National Jurisdiction" which states the following at paragraph 8 "the area shall be reserved exclusively for peaceful purposes" (Wolter 2005, p. 16).

The term "peaceful" regarding the OST much like the Seabed Treaty, lacks a definition and still remains controversial, even though a majority of states consider the concept to be complete demilitarisation. Although military satellites can provide humanitarian aid and be used to preserve and protect their people this type of military activity should not be prohibited. However, ASATs and BMDs that create more space debris that is intentionally aggressive in nature that affects the peaceful purposes of outer space and endangers the lives of astronauts are hostile acts that could potentially start a war if not provoked. If more states develop their ASATs and BMDs it will create a space environment that is extremely hostile and difficult for space operators to complete their missions or endanger the lives of astronauts, which could create a diplomatic problem. A problem in relations to this issue, whether a private operator will be accountable for their actions and the state they have launched or will they alone be accountable for the actions?

Presently, traditionally the lines between public and private or between civilian and military have become obscured due to governments heavy reliance on private operators capacity to provide a range of services (Koplow 2014, p. 742). For example, private operators can provide civilian, military and intelligence operations to various stakeholders (Koplow 2014, p. 743).

The EU has made several drafts of the Code of Conduct for Outer Space Activities (Lukaszcyk 2012, p. 16). The code called upon member states to establish policies and procedures to ensure that all space actors reduce their space debris without interfering with the peaceful uses of outer space for all space operators (EU 2014). In 2014, the latest draft of the International Code of Conduct was originally intended to be subject to negotiations at the United Nations in New York from July 27 to 31, 2015. Although the code focuses on orbital debris and acknowledges the UN General Assembly Resolution 62/217 in 2007, with inviting over 100 countries Russia and China have rejected it (Listner 2015). Also, while the UNCOPUOS Guidelines for Long-term Sustainability of Outer Space emphasise the need for member states regarding accurate, update and sharing of information on space debris monitoring and encouraging space operators to develop assessments to reduce their space debris. Both these legal documents are non-binding, but a majority of states including Russia and the US have national legislation to reduce their space debris (Compendium 2019). However international cooperation is needed to address this issue.

4 PRESENT LEGAL DIFFICULTIES FACING SPACE DEBRIS

A difficulty facing the scientific and legal community is addressing the problem of space debris which before the formation of the IADC and the Guidelines is that it was 'neither identified nor institutionally acknowledged' (Tallis 2015, p. 89). Article IX of the Outer Space Treaty prohibits harmful contamination of space, but it lacks the appropriate framework to enforce or provide a clear understanding of contamination means (Tallis 2015, p. 89). Another problem is that Article IX only prohibits this activity, in a general unenforceable way due to it lacking specific mechanisms for dispute resolution. Also, as the Article applies to unusually hazardous activities, it does not focus on the threat that the usual accepted space activities can affect the environment (Taylor 2006, p. 76).

In the past, as evident by the space treaties there was little or no concern for having any binding obligations for the environmental protection of Earth from space debris. However, Article IX of the OST provides some limitations concerning environmental protection which is 'due regard', 'harmful contamination' and consultations. From the states adopting a common practice that formed the 'due regard' principle (Su 2016, p. 404).

Although space debris became a newly recognised form of 'harmful contamination of outer space, States Practices are only obliged to 'avoid' it and adopt 'appropriate' measures 'where necessary'. These words are open to interpretation (Su 2016, p. 404). States will refer to Article VI and VII for discussing the concept of contamination to conceptualise the liability to determine what state is liable for the material it launches which includes private space orbital devices launches within the particular states domestic boundaries (Tallis 2015, p. 89).

The main problem in Article VI and VII is that it places a heavy burden regarding the liability of states, but with little focus on the growing private space operators (Tallis 2015, p. 89). The 1972 Liability Convention attempts to provide a framework for the international community to prevent negligent behaviour in space. However, the agreement in addressing debris remediation must have a pragmatic approach that is legally enforceable to all actors (private or public) (Tallis 2015, p. 89). According to Taylor, 'the Liability Convention cannot be used as a mechanism for enforcing Article IX of the Outer Space Treaty' (Taylor 2006, p. 76). Also, the Liability Convention does not focus on damage in space with protecting the space environment and thus does not restrict or prohibit the build-up of orbital debris (Taylor

2006, p. 77). Two rationales below that will explain this in-depth.

Firstly, the problem is identifying the cause of damage is difficult with space debris so small that it is difficult to track. Second, following the ‘first is the claimant State must prove negligence on the part of the other State’ (Taylor 2006, p. 77). An inherent problem, that the satellite has been placed in a particular orbit does not construe as negligence. For example, the satellite has been in the same orbit for decades and a collision occurs, difficultly will arise concerning the claimant State to make a case for a negligent act.

4.1 Issues of liability concerning space debris

Professor Frank von der Dunk raised an important issue how does a claimant be compensated for damage caused by orbital debris (von der Dunk 2001, p. 867). A problem with the Liability Convention is that it requires proof of the fault for damages in outer space, but does not define fault and neither has a standard of care for determining the fault (Lampertius 1992, p. 453). The drafters of the Convention had left this unresolved issue for several reasons.

Firstly, it was not believed at the time that damage could occur in outer space. Furthermore, the drafters acknowledged that appropriate changes would need to take place once space became more frequent and numerous. Secondly, the drafts feared that a defined standard of care in outer space would result in a fault-based liability that would prevent the Convention in its entirety from operating (Lampertius 1992, p. 454).

In the Cosmos 954 incident, both the USSR and Canada had conflicting views regarding the fault of the failed satellite. The interpretation of providing information to all endangered states to forewarn the danger of the satellite was different. Canada wanted extensive information regarding the incident. Russia interpreted the obligation of disclosure as to provide minimal information. Shortly after the incident, the scientific and technical sub-committee of the UNCOPUOS announced that if a satellite causes damage to another State the launching state must compensate for damage including the recovery of debris. The Canadian Government consider the norm as that they were entitled to full compensation for repairing the injured satellite (Cohen 1984, p. 82- 85).

5 RECOMMENDED LEGISLATIVE CHANGES

The space debris guidelines are non-binding and most state practices follow; however, there is a lack of a clear definition of “orbital space debris”. Both the Liability Convention and the Registration Convention only define “space objects, but nowhere in the treaties mention space debris nor have a treaty devoted to dealing with space debris. Presently, there is no global agreement on the term itself. Another concern is no accepted space debris removal technology exists within the scientific community that can remove orbital space debris. The Space Debris Mitigation Guidelines are the first step towards the mitigation and removal of space debris; however, there is a ‘lack of technical, legal, financial, business, and institutional arrangements’ to make an international collective effort to actively removal space debris (Pelton 2015, p. 6).

5.1 Defining Space Debris

To define space debris we must not only define what space debris is but determine the sources of space debris and what is the best way to observe and track to mitigate and remove space debris (Ansdell 2010, p. 9-11). Presently, Space Debris Guidelines do not provide an expressed definition of what is Space Debris. However, the guidelines do mention that there are primary sources of space debris 1) accidental breakups and 2) ‘debris released intentionally during the operation of launch vehicle orbital stages and spacecraft’(United Nations Office for Outer Space Affairs, 2010 p. 1). To add to the 2nd source should be whether it is intended for military or non-military purposes of disrupting or creating more debris to satellites and other identifiable space objects. Although, Guideline 4 does restrict the intentional destruction to create space debris. Space was originally intended and is expressed in paragraph 2, Article IV of Outer Space Treaty for “peaceful purposes” which does apply to anti-satellite testing and other military activities that create debris (Popova and Schaus 2018, p.5).

Space Debris can include satellites, derelict spacecraft mission objects (which may be fragmented), tools and other astronaut equipment that has become space debris. According to Megan Ansdell ‘fragmentation debris is the largest source of space debris’ and of the 95 percent, China is the largest (42 percent), followed by the United States (27.5 percent) and the third-largest is Russia (25.5 percent) (Ansdell 2010, p. 10). A key issue facing these countries and the international space community as a whole is to form an accepted standard of practice for the common good of reducing the space debris to ensure that all actors (states, and private operators) make a firm commitment to this practice. To best observe and track, mitigate and remove space debris it will be necessary for legislation to define Low Earth Orbit (altitude between 200 and 2000 km), Medium Earth Orbit (altitude between 2000 and 36,000 km) and Geostationary Earth Orbit (36,000 km and above) (Popova and Volker 2018, p.2). Different orbits have different space debris and will require different mitigation and removal practices.

The definition of space debris is found within the Guidelines which is classified as 'soft law'. However, soft law cannot create enforceable rights and obligations but has legal effects (Chatterjee, 2014 p. 3). The Guidelines assist in providing an international established norm for international cooperation (Chatterjee, 2014 p. 4). As the definition found within the Guidelines does not provide strict compliance within the international community it does however provide a basis to develop harder laws in this growing area of concern (Chatterjee 2014, p. 4).

On 8 April 2012, ESA lost contact with Envisat, the largest non-military earth observation satellite in orbit (Chatterjee 2014, p. 4). As of March 2012, Envisat was 10 years in orbit that doubled its expected five-year lifespan (Kramer 2021). ESA made several attempts to regain control of the satellite and ceased having control on 9 May 2012. As of 2012, the US Joint Space Operations Centre tracked the satellite that was drifting uncontrollably in a sun-synchronous polar orbit. Its size is ten metres in length and five meters in width, with a larger solar array which weighed 8 tons being a high collision to all space vehicles and satellites. Given its orbital and area-to-mass ratio, it has been estimated that it will take 150 years to naturally decay from atmospheric drag (Chatterjee 2014, p. 4).

Also, hard laws must recognise the four human-made types of space debris 1) inactive payloads, 2)operational debris, 3) fragmentation debris and 4) microparticulate debris (Bird 2002, p.638). Inactive payloads are considered earth-orbiting satellites that are no longer under the control of their owners (Bird 2002, p. 638). It has been reported that since 1961, over 140 satellites have been broken up spreading space debris (Bird 2002, p. 638).

<u>Definition of Space Debris Sources</u>

Inactive payloads: The launched space objects over time become derelict and the space operator has lost the ability to control the object location or to re-enter Earth.

Operational debris: refers to all associated materials and components of all sizes used to perform the space objective set by the space operator that remains in orbit. This can include paint chips, bolts and discarded upper rocket stages that all played a direct or indirect role in the space objects that are located in space.

Fragmentation debris: Similar to operational debris, however, this occurs when the space object (civilian or military) breaks apart from either an explosion, collision or from some other cause that was imperative to fulfilling its space objective. Specific fragmentation debris includes accidental collisions, battery explosions, fuel leaks, failures of attitude control systems, failures during orbital injection manoeuvres and other related debris (United States Committee on Science and Technology, 2009).

Microparticulate Matter: Generally consists of biological, chemical particles, human-made or naturally occurring from the earth that has been inserted into space, nuclear particles and space electronic discharges. These types of debris occur include solid-propellant rocket motors, hybrid rocket motors and propulsion systems, scientific and military experiments in space that occur in orbit, surfaces of in-orbit objects and manned spacecraft (Ajit 2012, p. 354).

The definitions should recognise the causes which can be collisions intention or non-intentional in their mission, but also the quantum of damage.

To address this issue, an international organisation must specify the orbit and body size. A draft concept for a space debris mitigation system concerning observation and data processing instruments and methods is as follows:

1. 'Specific requirements for space debris detection instruments.
2. The same for surveying (monitoring).
3. Data collection, storage, and usage' (Shustov et al. 2013, p. 307).

To best determine the level of risk we must define an averaged risk and a specific collision risk. To assess risk we must solve the following problems:

- Calculate the probability of collision with a space debris object
- Estimate the consequences (task of geophysics, explosion physics, and sciences and technologies used by the original space debris object and spacecraft that has collided with space debris)
- The creation and coordination of a space debris decision making process (Shustov et al. 2013, p. 313).

6 SOFT LAWS V HARD LAWS

To best determine the appropriate source of international law, litigators must refer to the International Court Justice (ICJ) statute Article 38. A problem for space litigants is that it only regulates the applicable law not space law and is restricted to State parties. The ICJ is an institutional legal body used to resolve disputes for the United Nations. We must not confuse the ICJ as being a world or Global Supreme International Court of Justice. Article

38 is not to be solely relied upon by space litigants and thus is should not be able universally to determine international law (Castaneda 2012, p. 358-359).

Soft law instruments much like the Guidelines are recognised as soft obligations ("legal soft law"), thus being non-binding which includes voluntary resolutions and codes of conduct that are commonly accepted within the international community ("non-legal soft law"), to statements prepared by international and regional organisations that are either private or public with a degree of government capacity to form a set of international principles (Chinkin 1989, p. 851).

The use of the Guidelines itself does not create a hard binding obligation, unlike the OST. The Vienna Convention on the Law of Treaties does not require soft international laws made between states to create any identifiable rights and obligations. However, the Guidelines are still subject to international law. As demonstrated in early discussions in my paper with the OST, that hard laws provide specific and precise words that must be followed with rights, duties and obligations (Chinkin 1989, p. 851).

Soft Law plays an integral part in the principle of common interest and peaceful uses of outer space. Both principles provide that a State must be willing to consult with other States with genuine intentions to ensure that Outer Space activities were to be for the common interest without the deployment of military weapons that would not interfere with the peaceful use of other states. The Guidelines have provided non-binding additional duties concerning these principles which are found with the OST that are highly relevant to maintaining peaceful uses of outer space concerning reducing break-ups and avoiding intentional destruction (Dupuy 1990, p.425).

It would be advisable for UN state members to remove space debris similarly to the international standard set by the ICAO (Haroun et al. 2021, p. 66). The International Maritime Organisation (IMO) is vital to preventing marine and atmospheric pollution by ships (International Maritime Organisation 2019). Before the Paris Agreement, the IMO made important initiatives to reduce the sectors greenhouse gas emissions, which reported that all ships contributed 1.8 % of the world's total CO2 emissions (International Maritime Organisation 2019). Although the Guidelines, provide soft norms, history has demonstrated that they will provide standards of good behaviour to create a hard norm. The Guidelines provide standards of good behaviour and due diligence to mitigate space debris which still acknowledges the OST (Dupuy 1990, p. 434). Soft law lacks an independent judiciary and supporting enforcement powers, thus some may consider it as only a window dressing. International lawyers such as Prosper Weil argue that the increasing use of soft law "might destabilise the whole international normative system and turn it into an instrument that can no longer serve its purpose" (Abbott and Snidal 2000, p. 422). However, others, much as demonstrated by the formation of the OST argue that soft laws are the initial step to developing harder and more satisfactory laws (Abbott and Snidal 2000, p. 422-423). An inherent problem for UN non-binding documents is that scholars are divided on which some recognise it or others not (Chernykh 2017, p. 437).

A concern international litigants is that UN Resolutions although binding on UN Member-states is that they are not a source of international law. Soft law documents in comparison to hard law documents do not imply unlawful violations but rather provide a best practice with peer pressure amongst the international community. The Guidelines have demonstrated that some states have made national legal and some of the space agencies have developed their standards and guides to mitigate space debris (Chernykh 2017, p. 437-438).

If hard laws addressed the space debris remediation, it would provide enhance international cooperation as evident within the OST and ensure that the state makes genuine commitments to following and enforcing hard laws. The hard laws can once be signed and ratified by states require them to implement domestic laws to be enforced on all space actors who launch in that state. The stages of creating hard laws will ensure that international cooperation is best obtained through creating legal commitments to reducing space debris. Also, hard laws will ensure that states can monitor and enforce their own or other state commitments and create an appropriate space court to resolve such disputes (Schaffer and Pollack 2010, p. 717-718).

6.1 The inherent problems with the IADC

Although the guidelines are non-binding they were authored by the IADC. The IADC consists of national space agencies of Italy, France, China, Germany, India, Japan, the United States, Russia, Ukraine, and the ESA. Although the IADC formed the guidelines as a separate entity to the COPUOS, however, the members of its state are also active members of the COPUOS both the Legal and Scientific and Technical Committee. The guidelines and the OST regarding this issue do not update and best address the problem of mitigation and removal of space debris (Larsen 2018, p. 479).

It should be noted strong commitments have been made by Russia and the United States, however not all states have made the same level of commitments or have a common practice for mitigating and removing space debris (Compendium 2019). In 1995, the United States National Space Agency (NASA) issued a set of procedures for limiting space debris via guidelines and were later expanded in 1997, with NASA and the Department of Defence, forming the Debris Mitigation Standard Practices (Salter 2015, p. 9). Much like the IADC, both the International Civil Aviation Organisation (ICAO) and the International Maritime Organisation (IMO) have standards and procedures (Larsen 2018, p. 480).

7 CURRENT INTERNATIONAL STANDARDS AND PRACTICES

The ICAO is funded and supported by 193 national governments concerning the Chicago Convention, but it is not an international regulator (ICAO, 2021). However, Article 38 of the Convention on International Civil Aviation requires states to comply with international standards and procedures (including the ICAO standards and ISO 9001) (Convention on International Civil Aviation, 1944). Currently, the ISO 9001 which is also applicable to the space sector requires space operators to have sound quality and environmental management systems in place (Pratama et al. 2018).

It would be advisable for UN state members to remove space debris similarly to the international standard set by the ICAO (Haroun et al. 2021, p. 66). The IMO is vital to preventing marine and atmospheric pollution by ships (International Maritime Organisation 2019). Before the Paris Agreement, the IMO made important initiatives to reduce the sectors greenhouse gas emissions, which reported that all ships contributed 1.8 % of the world's total CO2 emissions (International Maritime Organisation, 2019).

A great example to address the mitigation and removal of space debris can be found within the Convention on the Intergovernmental Maritime Consultative Organisation. Article 12 of the Convention provides that the IMO consists of an Assembly, a Council, and a Maritime Safety Committee as well empowering the IMO to have other Committees if necessary. A similar provision to be included in the hard space laws. Articles 28-32 provide that members must maintain maritime safety and report to the Assembly on the existing regulations, and make commentary and recommendations. A great series of provisions required, to ensure that Member states are working on addressing these issues with a sufficient dispute resolution (United Nations, 1948).

7.1 The need for Internationally Accepted Practices and Standards concerning Space Debris

The European space agencies and NASA have design and operational practices that limit the production of space debris whilst ensuring the compliance of operational phase requirements and safety. All these agencies unanimously agree and recommend that every space vehicle whether launching from these nations or others should either orbit or intended to orbit the Earth follow or adopt their practices and standards to reduce space debris. For example, a space vehicle would be re-entered safely within an agreed specified time and specified operational requirements that are accepted by a national or international organisation (Alby et al. 2004, p. 1261).

A re-entry requirement complies with the ethos of the Space Treaties, but it neither practicable nor reasonable due to the lack of the following technological capacities:

1. The propulsion requirement (and fuel budget) is demanding, and could increasingly become less advantageous for re-entries to be performed from high altitude orbits (geosynchronous orbit).
2. Modifications in the design and operational stages of the space vehicle to perform re-entry will be difficult for present operators.
3. Presently, some objects lack the technical and financial resources to conduct manoeuvre capabilities (Alby et al. 2004 p. 1261).

Presently, the re-entry requirements are noteworthy to reducing space debris, but it will require international cooperation and in the foreseeable future become mandatory. Alternatively, similar practices will need to be agreed upon by others (Alby et al. 2004, p. 1261).

What is necessary is an accepted international standard that all space actors must demonstrate and meet the requirements throughout the project to ensure compliance with the standard. A space debris plan should consist of a National Space Debris Manager (or company) whose duties are to enforce the standard, a management plan for the SDM to be sent and approved by the national space agency and measures for minimising debris generation with appropriate organisational measures (Alby et al. 2004, p. 1261).

The UNCOPUOS Working Group should in future discussions regarding the long-term sustainability of earth orbits to place the foundations of hard laws regarding accepted standards (Brachet 2012, p. 165). The two leading developers of international space standards are the International Standards Organisation (ISO) and the Consultative Committee for Space Data Standards (CCSDS). Both these standards developed to maintain the commercial contractual legal mechanisms being closely aligned to IADC, UN COPUOS and ITU guidelines (Oltrogee and Christensen 2019, p. 4). ISO is the key international standards organisation with operational standards to ensure the best commercial practices and norms for space mitigation (ISO 2021).

The ISO 24113 is the most crucial document for commercial space operators to meet space debris mitigation in all elements of developing and launching a space object which includes launching into or passing through near-Earth space, including launch vehicles orbital stages, operating spacecraft and any objects released during normal operations of launch vehicles. As you can see from the figure below the ISO 24113 is the highest in the hierarchy of documents whilst the lowest levels are technical reports that are to guide system engineers on how to apply the standards (Stokes 2019, p.3).

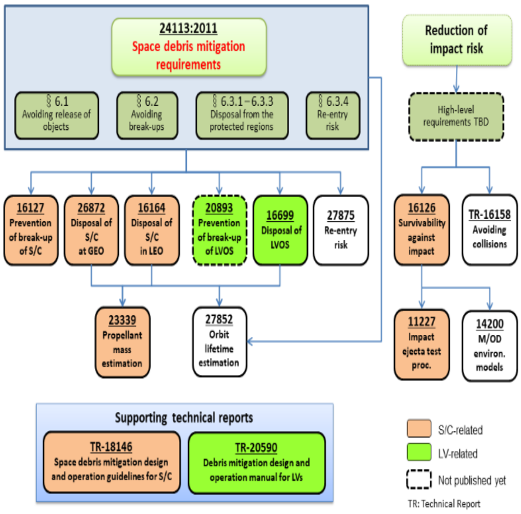

Figure 1: 2010 Original framework of the ISO space debris mitigation standards (Stokes et al. 2019, p. 3)

The CCSDS is a government or quasi-government organisation that was formed to develop standardised solutions concerning space information and data. Also, the CCSDS liaison with other key space organisations including but not excluding the American Institute for Aeronautics and Astronautics and European Committee for Space Standardisation (ECSS) with over 100 scientific and industrial entities that influence the technical development of CCSDS (Pilgram 2010, p. 516-518).

In 2019, CCSDS allows all these entities to exchange and work together regarding space navigation and communications data. In 2019, CCSDS oversees 150 active standards and 1,094 missions. The most successful is the Orbital Data Message and well used by the 150 active standards. The Conjunction Data Message and others CCSDS mechanisms provide ongoing assistance to prevent collisions (Oltrogee and Christensen 2019, p. 4).

7.2 Technical considerations and suggested best practices for all space operators

The US, Europe and Russia are best equipped at monitoring debris and forming strategies to best monitor it. However, their efforts to reduce debris are passive. The passive responses from all states must be backed up with active removal of debris (Emanuelli 2014, et al. p. 179).

NASA's standard for limiting debris is to the following: 1) limit the generation of debris; 2) limit the probability of impact with other space objects; 3) Limit the consequences of an impact with existing orbital debris; 4) to use tethers to avoid debris hazards; 5) Once mission lifetime has been near-complete it must move to a disposal orbit and limit human casualties due to orbital debris. NASA has six issues that are required to be addressed before a launch:

1. 'Debris released during normal operations;
2. Debris generated by explosions and intentional breakups;
3. Debris generated by on-orbit collisions during mission operations;
4. Reliable disposal of spacecraft and launch vehicle orbital stages after mission completion;
5. Structural components impacting the Earth following post-mission disposal by atmospheric re-entry;
6. Debris generated by on-orbit collisions with a tether system' (NASA 2019, p. 16-17).

Also, NASA adopts the following Mitigation Measures, which other agencies should adopt:

- Releasing debris in lower perigee altitude orbits to reduce orbital lifetime;
- Designing debris with a larger area-to-mass ratio to reduce orbital lifetime;
- Moving debris into favourable conditions of lunar and solar perturbations that will reduce lifetime;
- Space object designed to ensure that operationally and in their design that the release of debris is limited (NASA 2019, p. 28).

NASA's Handbook for limiting Orbital Debris provides clear definitions regarding space debris (NASA 2008, p. 20-22). NASA has provided a list of technical considerations that must be acknowledged and followed by other states to adopt a best practice to mitigating space debris:

- Orbital fragmentations can result from accidental or intentional explosions as part of their mission that are either incidental or intentional collisions that interfere with other space operators peaceful uses of outer space.

- Some space objects will have an unplanned separation whilst the payload remains intact. However, space operators must plan for both an unplanned or planned separation. Also, space operators must acknowledge that paint will flake on their spacecraft due to the change of atmosphere.
- The generation of the solid rocket motor that generates 100 um causing great contributions to the debris environment. Sodium-potassium droplets occurred during Soviet spacecraft launched between 1971 and 1988. Also, nuclear reactors onboard these spacecraft released much coolant into the orbital environment (NASA 2008, p. 26-28).

NASA has predicted even an immediate cease of all launch activities will increase orbital debris. NASA and the Defence Advanced Research Projects Agency (DARPA) held the first International Conference on Orbital Debris Removal which highlighted the need for service, vehicle to adequately manoeuver and dock and collect space debris (Barbee et al. 2011, p. 95).

8 REMOVING SPACE DEBRIS

Without a collective or shared responsibility towards removing space debris, it makes the job of cleaning the space debris much more difficult. In this section, I have provided three actions that are required to 1) mitigate and remove space debris; 2) suggested improvements to the 25-year rule and 3) the introduction of salvage law. All states have a common interest in what new laws are required to remove space debris.

8.1 Categorisation of three actions to mitigate and remove the growth of debris

The 1993 International Astronautique Academie (IAA) Position Paper recommended the following three actions that should be done to mitigate and remove the growth of debris:

- Category 1: requires immediate action: Standards and procedures to make space objects have no deliberate breakup. The objective of this category is to minimize operational debris. Minimizing Geostationary transfer orbits, currently, the orbit is set to 25 years. Some have argued that 5 years or even 1 year is recommended, but as McKnight argued that changing from 25 years to 5 years will only lead to another 10 % reduction over 200 years without drastically change (McKnight 2010, p. 2). Separating kick motors into super-synchronous orbit (SSO) is preferred over a Geostationary orbit to reduce orbital debris. Also, ensure that GEO rocket bodies that still have fuel after separation and during their life span have enough fuel to move to SSO.

- Category 2: requires technology development, knowledge sharing and international cooperation and cost. All space objects must not exceed a 10-year life span in particular with GTO. After lifespan and as soon as practically possible deorbit space objects into earth oceans.
- Category 3: A long term technology capacity-building strategy. Space objects develop propulsive deorbit capabilities similar to Elon's Musk space rocket. Develop less resist drag for natural removal. Develop safe return tugging systems that can bring back historic satellites. Develop a clean sweeper that can collect, destroy orbit debris (McKnight 2014, p. 4).

8.2 Suggested improvements to the 25-year rule

The United States, Russia and ESA have made firm commitments to reducing space debris, the international legal mechanisms still reconsidered. One alternative is for UN member states to adopt similar principles found within the UN Framework Convention on Climate Change. States will ratify and comply with environmental treaties for either one or more of the following three reasons:

a) Signatory states have a genuine concern would like 1) influence and 2) are concerned with regulations;
b) Cost of compliance is lowered than non-compliance;
c) They fear the consequences of non-compliance (Tan 2000, p. 155).

Also agreed common international norm must be made the following suggestions on how to improve the 25-year rule (Nagendra et al. 2015, pg 13):

- 'Agreement on a comprehensive definition of space debris;
- Unanimous agreement for all states to adopt national debris mitigation regulations; (Nagendra et al. 2015, pg 13)'
- Mandatory registration for all space vehicles including satellites, launchers;
- Mandatory licence to perform space activities

on the condition that an extensive mitigation plan must be approved by the national regulator and compliant with national and international laws and norms;
- Mandatory hazard assessment that recognises the potential harms to the space environment regarding contamination and avoids the peaceful interference with others in the use of space;
- Mandatory extensive mitigation plan for every component, project mission objectives and project timelines to ensure that at all times throughout the life-span of the space object;
- Development of a uniform international catalogue for all space operators standards and guidelines that ensures that space operators have a role in the mitigation and removal process of space debris (different roles will be determined if a private operator is used to either salvage or remove space debris in some form);
- Definition of special requirements which include the type of space vehicle, mission, private or public operator (quasi-military) mission parameters and mission objectives,
- Define a specific point of contact for the national and international Space Debris Authority Office;
- Concerning ITU-R S. 1003-2, a Satellite operator in GEO must submit a deorbit plan once objectives, functions and goals have been achieved before 25-year life-span per industry best practices and must discharge stored energy sources at end-of-mission;
- The "25-year rule" must include smallsats (Nagendra et al. 2015, pg 13).

8.3 The place for salvage law as an incentive to remove space debris

Since the ratification of law governing the high seas, the main goal was to establish a common heritage for humanity whilst ensuring the global commons. Since the space treaties have been formed, no single 'country has jurisdiction over outer space' (Drago 2019, p. 418).

To salvage a spacecraft 1) collect historically significant space objects eg Sputnik; 2) re-use existing components to build other space infrastructure; 3) sweep, collect and destroy space debris 4) extract raw materials or propellants for either material processing or use as a reusable fuel source; and 5) recover valuable space objects with important data (White 1992, p. 2413).

United States admiralty law will be provided compensation to salvor if they can save in whole or part from being a shipwreck, derelict or recapture. To make a valid salvage claim: 1) must be a marine peril for the ship to be rescued 2) the salvor volunteered their own time and resources to rescue the property and 3) crucially the salvor must be successful in saving the property or some part of it from impending peril (White 1992, p. 2413).

The courts will determine the following factors in awarding damages: 1) the labour and hours used by the salvors; 2) technical skill and expertise used to retrieve the property; 3) value of technology utilised by the salvor; 4) risks and potential losses that have occurred by the salvage operation; 5) value of the property saved; and 6) degree of danger that was employed to rescue the property (White 1992, p. 2414). To ensure that all operators will require either by States or specialised private operators to provide these services. However, in addition to these criteria, international law and standardisation must have ways to grant private operators grants to be salvors. For Space salvors, we must acknowledge the cost of de-orbiting the space object and whether it has cultural and historic significance eg Sputnik 5.

9 CONCLUSION

The early Space Treaties provided great discussions between the super powers to make hard laws that would prevent military activities in space and ensure peaceful purposes of outer space. However, as demonstrated throughout this document they did not address the issues of space debris.

The Guidelines provided an initial step towards an internationally agreed approach to handling the issue of space debris, yet enough has not been done. Once again, the international community must be united to tackle the issue to make strong commitments towards reducing space debris with hard laws. The hard laws combined with international standards and practices to make a collaborative effort to reduce space debris for future generations.

As the private sector begins to become more mature with the aims of space tourism, it will be imperative for the international community to work together to remove the debris. If private operators are required to remove debris the salvage laws will need to be considered.

Also, new laws will need to whether an individual will be liable in space. As Russia, China, US and other states will differ on the best approach, they will agree that immediate action must be taken. The ultimate questions are when will it happen and will it be enough.

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