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THE OBLIGATION OF STATES TO PREVENT AND MITIGATE SPACE DEBRIS

Bachelor's thesis

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ABSTRACT

This thesis analyses the strict liability and obligations of the States Parties of the main space law treaties to prevent and mitigate space debris, whether active or forthcoming under strict liability. As currently, 95% of the artificial objects in the Earth's orbit are debris, the near outer space is becoming like a landfill and may prevent the future use and exploration of outer space. This thesis analyses both the strict liability derived from the international environmental and customary law to held state parties liable for the space debris and the current practise. As the Outer Space Treaty, Liability Convention and The Registration Convention were ratified before the space debris problem came to present, they do not address the issue directly. Besides the property rights and the state sovereignty must be taken into consideration if a third party removes the debris. The legal obligation to remove existing and future space debris, whether resulting from the governmental or non-governmental operations may be derived indirectly from the current treaties, from environmental laws (polluter pays principle) or from the international customary law. In addition, mandatory guidelines, comparable to aviation and maritime standards and procedures, may be also implemented to prevent space debris.

Keywords: space debris, outer space treaty, liability convention, registration convention, space debris mitigation, strict liability, property rights, international environmental law

ABBREVIATIONS

ASAT - Anti-satellite weapon

COSPAR - Committee on Space Research

GEO - Geostationary orbit

IAA - International Academy of Astronautics

IADC - Inter-Agency Space Debris Coordination Committee

ICAO - International Civil Aviation Organization

ICBM - Intercontinental ballistic missile

ICJ - International Court of Justice

IMO - International Maritime Organization

LEO - Low earth orbit

MEO - Medium earth orbit

OECD - Organisation for Economic Co-Operation and Development

PAROS - Proposed Prevention of an Arms Race in Space

UNGA - United Nations General Assembly

UNOOSA - United Nations Office for Outer Space Affairs

USSR - Union of Soviet Socialists Republics

INTRODUCTION

Space debris, also defined as space garbage or the pollution of the Earth's orbit is a growing concern for the use and exploration of outer space. The origin of the debris is defunct satellites, upper-stages of launch vehicles and even tools and gloves lost during the spacewalks. Whereas losing a glove in orbit would seem trivial considering the vast amount of the space in orbit, the consequences of a glove or other debris colliding with satellite or manned vehicle with a relative speed of 30,000 km/h are hazardous. Currently, there are estimated being over 128 million particles of debris which are smaller than one centimetre and over 900,000 particles which are from one to ten centimetre.[1]

The colliding of the small particles with larger objects may lead to a phenomenon known as the Kessler syndrome in which the existing space debris results "a self-sustaining chain-reaction of collisions and fragmentation with a production of new debris".[2] The possible chain-reaction is topical, as on February 10, 2009, Cosmos 2251, defunct Russian satellite collided with U.S-based functional communication satellite Iridium 33 with a relative speed of 35,888 km per hour resulting at least 1875 pieces of debris larger than ten centimetres which are expected to remain in orbit for decades.[3]

Another threat yet to materialise is the European inoperational Earth-observing satellite Envisat which encounters with two pieces debris every year with the distance of approximately 200 metres. A potential collision would result in a large cloud of debris with a potential to escalate into the Kessler syndrome.

Besides the accidental collision of objects, part of the debris orbiting the Earth originates from the military experiments conducted in outer space. As the satellites form the critical structure for

[1] Debris by Numbers (2019, March 19). (2019).
Accessible: https://www.esa.int/Our_Activities/Operations/Space_Safety_Security/Space_Debris/Space_debris_by_the_numbers , 7 May 2019.
[2] Rendleman, J.. (2010). *Non-Cooperative Space Debris Mitigation*. Proceedings of the International Institute of Space Law 53, 303.
[3] *Ibid, p 303.*

military intelligence gathering, navigation and communication, various states have conducted anti-satellites tests which have resulted in a vast amount of debris. This thesis will provide a legal analysis of the 2007 Chinese anti-satellite missile test that severely restricted the free use and access to the outer space as it resulted in a significant amount of space debris that affects the future launches and present operational phases of spacecraft.[4]

The most commonly used geocentric orbits are a congested Low Earth Orbit (LEO), an altitude below 2,000 kilometres where the high-bandwidth-low-latency service satellites and the international space station is situated, the Medium Earth Orbit (MEO) with the most common altitude of 20,200km which is used, *inter alia*, for global positioning system - satellites (GPS). Above the MEO is Geostationary orbit (GEO) at an altitude of 35,786 kilometres above the Earth's equator which follows the planet rotation and where most communication and broadcast satellites are situated. The Geostationary orbit was categorised as a "limited natural resource" as early as in 1976 in the Bogota Declaration with little effect.[5] In addition, sun-synchronous orbits remain highly popular for the operations as Earth observation, spy or weather satellites which require high voltage supply with continuous solar panel charging.[6]

The area with most affected by the space debris is the LEO region as launching satellites in the low earth orbit is most cost-effective besides the upper-stages of the launch vehicle that deliver satellites to the MEO and GEO regions are detached at LEO orbit.[7] As the interest and the focus for the prevention and mitigation of debris lies in near earth environment, managing the debris orbiting the Moon, Mars, Lagrangian points and other traces beyond earth orbit may not be forgotten but are not in the scope of this thesis.

As mentioned above, the space debris poses a significant concern preciously in the congested LEO region and its satellite infrastructure. Essentially the satellite infrastructure provides a critical framework for global commerce, communication, navigation and military activity. Therefore

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[4] Koplow, D. (2009). Asat-isfaction: Customary international law and the regulation of anti-satellite weapons. *Michigan Journal of International Law30(4),* 1211.

[5] Nyman-Metcalf, K. (2009). Space for the Benefit of Mankind. *Annals of Air and Space Law*. McGill. See also Belviso, L. (2007). Applicability of Space Debris Mitigation Guidelines. *Proceedings on the Law of Outer Space 50*, 267-272.

[6] Von der dunk, F. (2011). National Space Legislation in Europe - Issues of Authosisation of Private Space Activities in the Light of Developments in European Space Cooperation. Volume 6. The Netherlands: Martinus Nijhoff Publishers. pp 180-188.

[7] Plantz, M. R. (2012). Orbital debris: Out of space. *Georgia Journal of International and Comparative Law 40(2)*, pp 590-592.

collapse, or disruption of the infrastructure by a collision with the space debris would create far-reaching consequences on the surface.

Until recently, the space debris remained a minor concern in the light of the public. Recent notable occurred incidents, the Chinese anti-satellite test on January 2007 and Iridium-Cosmos collision on February 2009, not to mention the 2013 science fiction film Gravity made the public aware of the issue and decision-makers to establish collision avoidance activity for existing operational satellites and mitigation protocols required for the launch of forthcoming rockets.

Also if there is no particular risk of the collision, the defunct satellites hinder the right of other States to pursue their use of the outer space. As the orbits are global commons, they may not be claimed or occupied.[8] As of 2017, there are 3,200 objects orbiting in LEO region and 8,000 satellites are planned to be launched into LEO and MEO regions as increasing number states, and their private entities have capabilities to launch, and interest to exploit the Earth's orbit. Therefore sustainable use of the orbits requires no reservation by defunct satellites waiting to be replaced by the functioning ones.

The legal question of space debris may be categorised both as a matter of space law and environmental law. To use outer space and yet to access orbit, the prevention and mitigation of the current and forthcoming space debris remain crucial.

The orbits are not be considered merely routes but rather resources and part of the global commons. The previous mindset of treating the outer space as an environment for *laissez-faire* activity has shifted towards sustainable use of global commons. This approach represents the space debris as an issue of pollution and therefore is a matter of international environmental law. [9]

The operational phases of the current satellites have to comply with existing space laws, and as there are no unauthorised launches into outer space, the model of mandating guidelines by the competent organisation may prove to be sufficient method to mitigate accidental break-ups and the debris from future launches. Whereas mandatory guidelines prevent the forthcoming launches as the states are required to authorise the launching of a spacecraft, soft-law does not offer a viable

[8] Mey, J. (2012). *Space debris remediation*. Zeitschrift fur Luft- und Weltraumrecht German Journal of Air and Space Law61(2), 251-272.
[9] *Ibid., 258*

solution for the liability as the results are global and are comparable to the activities regulated in the international environmental law.

The main international treaties which established the legal framework for the space law, do not address the issue directly as the space debris as a phenomenon was not known at the time of the drafting and ratification given that the UN first recognised the space debris issue in 1989. The heritage of "fire and forget" - an era in the dawn of the space age yet orbits the Earth.[10]

This thesis will outline the applicability of strict liability to prevent and mitigate space debris according to international environmental law. When a state authorises inherently dangerous, 'ultra-hazardous' activity, a prime example being when a state authorises the operations of a nuclear power plant, in which the possible damages are utmost, transnational and may affect the whole habitat of the Earth. The comparable global hazardous outcome will result if a state authorises outer space activity which creates space debris which restricts the use of outer space.

Research question is as follows:
May strict liability be derived from the public international law, namely environmental law applicable to the current and forthcoming space debris as the debris may be categorised both as pollution and depletion of natural resources.

[10] Li, L. (2015). Space debris mitigation as an international law obligation. *International Community Law Review 17(3)*, 300. See also Rendleman. (2010). Non-cooperative Space Debris Mitigation*, Proceedings of the 53nd Colloqium on the Law of Outer Space*, IAC 10.E7.4.12.

1. THE CURRENT LEGAL FRAMEWORK FOR OUTER SPACE ACTIVITIES

1.1 Treaties applicable to the space debris mitigation and strict liability

The current legal framework for the regulation of outer space activities consists of five international treaties and five sets of principles. The treaties analysed in this chapter are the Treaty on Principles Governing the Activities of States in the Exploration of and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space Treaty),[11] Convention on International Liability for Damage Caused by Space Objects (Liability Convention)[12] and Convention on Registration of Objects Launched into Outer Space (The Registration Convention).[13]

The remaining two treaties, the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies will not be included as the first-mentioned concerns rescuing the crew of manned space flights and the last-mentioned regulates the activity on the Moon and distribution of its natural resources, therefore, falling out of the scope of the space debris issue. In addition, whereas national space legislation in eight states requires space debris mitigation procedures in order to authorise the launch and eight states to provide other mitigation mechanisms with the main launching states the United States and Russian Federation included, the national space legislation does not address the active space debris mitigation. Therefore, this thesis will mention the national legislation but not analyse it within the national context but in the contect of the current international legal framework for outer space activities.

1.2 The 1967 Outer Space Treaty

Treaty on Principles Governing the Activities of States in the Exploration of and Use of Outer Space, including the Moon and Other Celestial Bodies, informally known as Outer Space Treaty,

[11] *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, 27 January 1967, 610 UNTS 205 [Outer Space Treaty)
[12] *Convention on International Liability for Damage Caused by Space Objects*, 29 March 1972, 961 UNTS 187 [Liability Convention]
[13] *Convention on Registration of Objects Launched into Outer Space*, 14 January 1975, 1023 UNTS 15 [Registration Convention)

is a legal framework for the international space law. Signed on 27 January 1967, it currently has 108 Parties have signed and ratified it, whereas 23 have signed it but not ratified it as of March 2019. Whereas the treaty prohibits placing the weapons of mass destruction in the orbit, the Moon or other Celestial Bodies and bans weapon testing in space but does not prohibit placing conditional weapons in space, it was modelled after the Antartic Treaty, and it is seen as 'non-armament' treaty.

The Antartic Treaty signed on December 1 1959[14], was the first arms control agreement between the West and Iron Curtain during the Cold War. The treaty reserved the only inhabitant continent of the Earth for the scientific purposes with a for military activity. President Eisenhower addressed the General Assembly of United Nations on September 22, 1960, and proposed the model and principles of the Antartic Treaty to be implemented to the outer space and other celestial bodies. As the space race had begun on October 4, 1957, with the Soviet Union's successful launch of Sputnik 1 into elliptical low Earth orbit with earlier experiments of its ICBM, the need for a legal framework and principles governing the use of outer space became imminent. On September 19, 1963, Foreign Minister Gromyko of USSR and The United States Ambassador to the United Nations Adlai Stevenson II agreed that the intention of both nations is to refrain from placing weapons of mass destruction into outer space.[15]

Whereas the draft of the U.S space treaty only included celestial bodies, the USSR version included the coverage of outer space entirely, the scope U.S accepted and which was eventually adopted into the Treaty elaborated by the states.[16] The treaty entered into force on October 10, 1967. The Outer Space Treaty "laid the foundation to a distinct branch of public international law and may have transcended, in part, into the real of customary international law according to widespread scholarly conviction" and does not act merely a political instrument of the Cold War.

1.2.1 Public strict liability on the private outer space activity

The Outer Space Treaty was in ahead of time in its many ways at the time of ratification in 1967. Nonetheless, it misses the specific development of the use and challenges of outer space activity. Firstly, as the name of the treaty states, the legal framework governs the activity of states with no

[14] *The Antarctic Treaty*, 1 December 1959, 402 UNTS 71
[15] Neger, T., Walter, E (2011). *Space law – an independent branch of the legal system.* Outer Space in Society, Politics and Law. Studies in Space Policy. SpringerWienNewYork. pp 234-243
[16] Dembling, P., Arons, D. (1967). The Evolution of the Outer Space Treaty. *Journal of Air Law and Commerce 33*, pp 419-456..

mention of the private operators. At the time of ratification, the only operators capable of launching objects into space were governmental agencies. Upon the first launch of privately owned and operated rocket Conestoga 1 on 9, September 1982, by Space Services Inc. and Orbital Sciences Corporations Pegasus on April 5, 1990, which was the first completely privately developed and manufactured rocket, the private launch business have begun competitive solution for undertaking to launch payloads into orbit considering the reduction of cost of launching one kilo into the orbit. Whereas the Outer Space Treaty mentions non-governmental entities in its Article VI:

"*The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorisation and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international organisation, responsibility for compliance with this Treaty shall be borne both by the international organisation and by the States Parties to the Treaty participating in such organisation.*"

The authorisation and supervision of non-governmental activities in space lead to public responsibility of private operations which is rather a different approach to corporate liability compared to the field of air law, in which the States are not responsible for the actions of airliners. Therefore, private operators are the extension of States in space as the States bear the liability.[17] In light of that, the Outer Space Treaty has a significant effect on preventing and mitigation space debris as the States takes the final responsibility for the prevention and mitigation.

The Outer Space Treaty shares similarities with international environmental law. It recognizes similar "imputation of liability where the prerequisite of control is established" which is also found on The Declaration of the United Nations Conference on the Human Environment adopted on June 16 1972, in which the Principle 21 obligates States to "to ensure that activities within their jurisdiction or control do not cause damage to areas beyond the limits of national jurisdiction" similarly with Principle 21 of the Declaration of the United Nations Conference on the Human Environment as well as on the Article 30 of the Charter of Economic Rights and Duties.[18]

[17] Kayser, V. (2010). *Launching Space Objects: Issues of Liability and Future Prospects*. Kluwer Academic Publishers. p. 41.
[18] Charme, J. S. (1989). Transnational Injury and Ultra-Hazardous Activity: An Emerging Norm of International Strict Liability. *Journal of Law and Technology, 4*, 75-92.

Therefore, the States are responsible for the damages of their non-governmental entities operating in outer space pursuant to Article VI and must authorise and continuously supervise the outer space operations, whether governmental or non-governmental. The activity of private entities in outer space is not merely regulated by international treaties, as the focus has shifted towards numerous new national space legislation. As the states are obliged to authorise the launch and continuously supervise the operational activity of the private entities obliged by Article VI of the Outer Space Treaty, the responsibility is vested to the principle of "private operations, public responsibility".[19]

Secondly, as the launches into orbit were infrequent and the demand for the services provided by the satellites was lower than nowadays as the global positioning systems and communication satellites were yet to come, there was no rush of satellites orbiting the earth. The number of satellites orbiting the earth posed no threat similar to current congested LEO orbit. At the time, the issue of space debris and its mitigation was not a concern.[20] Nonetheless, regarding the liability of operators to prevent and mitigate debris, it may be derived from the Outer Space Treaty.

1.2.2 Aspects of the international environmental law

The Outer Space Treaty shares similar aspects and principles with international environmental law. Article IX has underlying principles with the Rio Declaration which emphasises on the sustainable development and precautionary principle. Principle 2 of the Rio Declaration emphasises on the responsibility of the States to ensure that activities within their jurisdiction or control beyond the limits of national jurisdiction do not cause damage to the environment in whereas the Outer Space Treaty commits states to avoid harmful contamination and adverse changes of the environment. Principle 21 of the 1972 Declaration on the Human Environment at Stockholm thus addresses the avoidance of the damage beyond national jurisdiction when the prerequisite of control which bears the same effect than the Article VI of the Outer Space Treaty.[21]

[19] Larsen, P. B. (2018). Solving the space debris crisis. *Journal of Air Law and Commerce 83(3)*, pp 505-507.
[20] The issue of space debris was recognised in 1989 by the ESA UN, see Orbital Debris: A Technical Assessment. Chapter: A Space Law And Orbital Debris (1995). Available from https://www.nap.edu/read/4765/chapter/14
[21] Charme, J. (1989), Supra nota 18, pp 86.

ARTICLE I

"The exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind.

Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on the basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies.

There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation."

Whereas the original intention to grant the right to free exploration and use by all States may have been related to the fiery situation during the Cold War to prevent the distribution of technology and setting launch restrictions, the principle of free use and access may be derived into the issue of space debris. If the Earth's orbit falls into "an uncontrollable self-sustained growth of the space debris population", it severely restricts the free use and exploration of the outer space. The use of Earth's orbit and space environment usage notices the development for long-term sustainability. [22]

Article IX

"In the exploration and use of outer space, including the Moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in ... with due regard to the corresponding interests of all other States Parties to the Treaty. ... , and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose. If a State Party to the Treaty has reason to believe that an activity or experiment planned by it or its nationals in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities of other States Parties in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, it shall

[22] Mey, J. (2012). Supra nota 8, pp 251-272.

undertake appropriate international consultations before proceeding with any such activity or experiment. A State Party to the Treaty which has reason to believe that an activity or experiment planned by another State Party in outer space, including the Moon and other celestial bodies, would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, including the Moon and other celestial bodies, may request consultation concerning the activity or experiment."

As the original intention for this Article IX was to both preserve the nature of celestial bodies from bacterial contamination originating from the Earth and for planetary protection to the prevent possible extraterrestrial contamination upon the re-entry and landing to the Earth, the interpretation regarding space debris varies. The interpretation of the term "harmful contamination" is broad, as Committee on Space Research's (COSPAR) Planetary Protection Policy only interprets harmful contamination as biological contamination, whereas Sergio Marchisio, the Chairman of the European Centre of Space Law defines space debris as a pollutant and a "new form of harmful contamination of outer space". As the Article IX does not offer a conclusive definition for the "harmful contamination", the prima facie and absence of an original definition does not exclude space debris from being classified as a matter defined in the Article.[23]

To address whether there is a violation of the provision is difficult as there are no unique form or standard for the procedure to avoid harmful contamination as the obligation to "avoid" and "adopt appropriate measures when necessary" is not conclusive. [24]

1.3. The 1972 Liability Convention

Convention on International Liability for Damage Caused by Space Objects, The 1972 Liability Convention address the liability between the states. In case of damage occurred on the surface of Earth or to aircraft in flight by a space object, then the launching state shall be liable for the compensation. Nevertheless, if the damage occurs in "elsewhere than on the surface of the Earth", then the launching state is liable only if its the fault of the state or the persons responsible. This distinction is based on the doctrine of strict liability originated from the private tort law since

[23] Hobe, S., Schmidt-Tedd, B., Schrogl, K. (2009). Cologne Commentary on Space Law, vol. 1, Article IX, paras. 25, 29. pp 574-614.
[24] Su, J. (2006). Control over activities harmful to the environment. *Routledge Handbook of Space Law*. pp 73-75.

launching to and operating in outer space is considered inherently dangerous activity which "ordinary person" would not regularly perform. The doctrine of strict liability is applied in international environmental law, as inter alia, have been used in nuclear activities.[25]

The Liability Convention was tested only in once in 1978 when Canada demanded compensation from the USSR for the cleanup of radioactive debris after uncontrolled re-entry of reconnaissance satellite Kosmos 954. On September 18, 1977, The USSR launched Kosmos 954 reconnaissance satellite for ocean surveillance to track ships and submarines. As the solar panels at the time were undeveloped to produce a sufficient amount of power required for the high demand of the power for surveillance equipment, the power supply of Kosmos 954 consisted of a nuclear reactor with approximately 50 kilos of the Uranium-253 onboard. The Kosmos 954 was launched in a fairly high angle orbital inclination, where it posed a significant threat to major population areas on the surface. In December, the Soviets lost the control of the satellite, and on January 24, 1978, the Kosmos 954 disintegrated upon re-entry and its radioactive debris scattered in the 600 kilometres wide path in Northwest Territories of Canada.

Following the cleanup operation, Canada demanded compensation of 6,041,174,70 Canadian dollars for the cleanup. As both Canada and the USSR were Parties of the Convention, Canada could claim the compensation according to the Article II: "A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft flight.". According to the General Principles of International Law, the re-entry on Canadian airspace was considered as a violation of Canadian's sovereignty, and therefore the USSR was obliged to pay compensation.[26] Nevertheless, the partial compensation paid by the USSR was not a result of the Liability Convention as it was agreed upon diplomatic discussions where the USSR did not admit the liability for the incident. Therefore the Liability Convention remains untested.[27]

The scope of the Liability convention is to protect especially 'innocent victims' not taking part in ultrahazardous activities.[28] Therefore, the Convention excludes liability from the damage caused

[25] Kopal, V. (2011). Outer Space in Society, Politics and Law. *Studies in Space Policy*. pp 340-342.
[26] *Settlement of Claim between Canada and the Union of Soviet Socialist Republics for Damage Caused by "Cosmos 954*" (Released on April 2, 1981), available from http://www.jaxa.jp/library/space_law/chapter_3/3-2-2-1_e.html (last accessed 10 April 2019)
[27] Schwatz, B., Berlin, M. (1982). After the Fall: An Analysis of Canadian Legal Claims for Damage Caused by Cosmo 954. McGill. Accessible: http://lawjournal.mcgill.ca/userfiles/other/14022-schwartz.pdf, 10 April 2019.
[28] Kim, H. (2009). Legal Problems Concerning Space Debris and Liability Convention. *Proceedings of the International Institute of Space Law*, 52, pp 210-220.

to the State's nationals and foreigners taking part in the launch, as well as the incidents occurring in the outer space as at the height of the orbit there are no 'innocents'. As the scope of the Liability convention to hold parties liable to the damage occurring on the surface or to the aircraft in flight caused by a space object, it does not apply to space debris incidents in orbit. The Liability convention is not applicable to space debris issue unless it is amended to cover incidents in outer space.[29]

1.4 The 1974 Registration Convention

Convention on Registration of Objects Launched into Outer Space was first considered and negotiated in 1962, adopted by the General Assembly in 1974 and entered into force on 15 September 1976. The purpose of the Convention is to assist in the identification of space objects. The Register is maintained by the United Nations Office for Outer Space Affairs (UNOOSA), and the Register consists of the Name of launching State or States; an appropriate designator of the space object or its registration number; Date and territory or location of the launch; Basic orbital parameters, including nodal period, inclination, apogee and perigee; and the General function of the space object. In addition "each State of registry may, from time to time, provide the Secretary-General of the United Nations with additional information concerning a space object carried on its registry". State of registry shall also notify the Secretary-General of the United Nations if the space object is no longer in the Earth's orbit.

Apart from the space object itself, the Convention requires to register every dangerous component for the avoidance of collision and the accountability of liability. Practical problems arise in small pieces, which are hard to register or the pieces which are not even known to be detached from the spacecraft. UNGA Resolution 62/101 recommends states to notify the changes in movements to the UNOOSA Registry albeit the resolution is not mandatory in nature.[30]

[29] *Ibid.*
[30] General Assembly resolution 62/101, *Recommendations on enhancing the practice of States and international intergovernmental organizations,* available from http://www.unoosa.org/pdf/gares/ARES_62_101E.pdf
in registering space objects, A/RES/62/101 (10 January 2008)

1.4.1. Ownership of debris and the legal problem of active debris mitigation

The issue of active debris removal has at least two legal issues; have States an obligation to remove debris and do they have the right to remove debris left by other States? Since the beginning of the space age, the States have practised "fire and forget" - mentality in the outer space activity. As the potential threat by space debris to the use and access to outer space were understood in the 1980s, the planning and awareness have improved. Currently, the practice of adding re-orbit manoeuvre at the end of the satellite operation cycle is almost uniform but yet the international guidelines (namely UN Guidelines) do not emphasize on retroactive mitigation to existing satellites or debris. Therefore, the issue of active debris removal concentrates on the defunct satellites and their upper stages of launch vehicles from the "fire and forget" era as they form a significant source of the current orbital pollution.[31]

According to the issue of legal right to remove space debris launched by other States, the legal situation for such action is problematic. If the State of Registry, that is to say, the owner is known, the removal of it may be considered as a violation of sovereignty. Though If there is no reasonable level of state activity to the debris, a state may derelictio lose its sovereignty title according to the general international law. Nonetheless, the required amount of activity to maintain sovereignty particularly in remote and uninhabited areas is minimal and therefore presuming the debris being abandonment is difficult. If the effective occupation, jurisdiction or control cannot be maintained by the State of Registry and does not take reasonable measures, for example requesting assistance from other space-faring states, the debris becomes res communis. If the ownership of debris is unidentifiable, any State may exercise jurisdiction on it.

If the debris is identifiable and has the State of Registry, it may be classified as a space object. The definition and classification of the space object remain disputed: Whether the criteria of the space object requires functionality or not as if the launched object have an intention to perform certain tasks in the space, and will the space object remain the classification after the end of the operational cycle. The International Academy of Astronautics (IAA) Cosmic Study on Space Traffic Management (2006) concluded that as meant an object in the Treaties, there no legal distinction between functional object and functionless debris. Therefore, clarification definitions and revision of the Treaties for the distinction of functioning and functionless space object is needed.[32]

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[31] Klinkrad, H. (2014). Space Debris Mitigation Activities at ESA. *51st UNCOPUOUS STSC*.

[32] *"Clarifies "space objects", including legal distinction between valuable objects and valueless space debris."* The IAA Cosmic Study on Space Traffic Management. (2006). 89-92.

Is the consent of an owner needed for the removal of a defunct satellite? Firstly, the owner of a defunct satellite may not wish to declare its satellite to be categorised as space debris. The owner may want to retain the orbital slot for the new functioning satellite by reserving it via defunct satellite, yet prohibition of this type of conduct may be derived from Article II of the Outer Space Treaty, as orbital slots do not have a property right or are allowed to be occupied. Even though the owner of the defunct satellite is non-governmental or not, the states have the interest to reserve the orbital slots for their own governmental or non-governmental activity. Pursuant to Article VII of Outer Space Treaty, the State of Registry retains its jurisdiction and control over the satellite.
Therefore, as maintaining the sovereignty over the object requires very little maintenance, the risk of violation of sovereignty is severe if the removal of the defunct satellite is conducted a state other than in the Registry.[33]

Albeit Article VI stresses the responsibility of "States Parties to the Treaty shall bear international responsibility for national activities in outer space,..." and removing the satellites after its operational cycle may be part of the states international responsibility, the sentence does not commence legal obligation nor mandates the Parties for removal of a defunct object.

As there is the uncertainty of property rights in regard to removal of unidentified objects, third parties are currently not advised to remove object which the State of Registry is not identified. A possible solution to solve the uncertainty of property right for objects not registered is to "treat all unregistered debris as free of ownership claims and thus freely removable by third parties".[34]

1.5 National space legislation and soft-law instruments

1.5.1 National space legislation

Current mechanisms are rather advisory. Entities, whether governmental or private are mainly affected by the codes of conduct, guidelines and implementable standards with sparse national

[33] Weaver, J. H. (1992). Illusion or reality--state sovereignty in outer space. *Boston University International Law Journal* 10(2), pp 205-207.
[34] Muñoz-Patchen, C. (2018). Regulating the Space Commons: Treating Space Debris as Abandoned Property in Violation of the Outer Space Treaty. *Chicago Journal of International Law*: Vol. 19: No. 1, Article 7.

space legislation of the launching states. National space laws are particular applications of the implemented international space law requirements. The nations currently holding launching facilities, France and the United States have implemented the requirement of the space debris mitigation procedures to be included in the operational cycle of the launch and satellite in-orbit-period in order to obtain authorisation for the launch, whereas China, Russian Federation and Japan require other space debris mechanism for the authorisation. For example, the French Space Law requires procedures for the debris mitigation, the calculations for the probability of occurrence of an accidental break-up and imposes an obligation to the operators following at the disposal phase to de-orbit the satellite within 25 years after the end of its operational cycle.[35]

1.5.2 Soft-law instruments

Nevertheless, these guidelines and mechanism, for example, The Inter-Agency Space Debris Coordination Committee's (IADC) Space Debris Mitigation Guidelines which obligates the launcher to deorbit the debris in LEO in twenty-five years and transfer the space object located in GEO to the graveyard orbit before it becomes defunct, are remedial at best and mitigate only the new debris.[36]

The 2007 Space Debris Mitigation Guidelines by the UNGA obligates to limit and minimise the probability of potential or accidental break-ups, mitigate the debris when the break-up happens and to avoid intentional destruction of the space objects and other harmful activities.[37] The guidelines are legally non-binding and depend on the monitoring, adopting and enforcement of the states. The guidelines do not have the mandating power of the treaty obligation. The implementation varies, as it is interpreted differently by the states. Therefore, regulating outer space activities differs from aviation and maritime standards and procedures.

The standards and procedures drafted by the International Civil Aviation Organization (ICAO) and International Maritime Organization (IMO) become mandatory uniformly for the contracting states unless a state files a request for an exemption. [38]

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[35] Petros, É. (2016). *Space Debris Mitigations in National Space Legislation.* Institute for Space and Telecommunications Law. Available from https://indico.esa.int/event/128/attachments/728/796/Space_Debris_mitigations_in_national_space_legislation.pdf (Last accessed 9 May 2019)

[36] INTER-AGENCY SPACE DEBRIS COORDINATION COMMITTEE, THE IADC *Space Debris Mitigation Guidelines* (2007) available from http://www.unoosa.org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris-Guidelines-Revision1.pdf

[37] FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE 276 (2d ed. 2018)

[38] Larsen, P. B. (2018). Solving the space debris crisis. Journal of Air Law and Commerce 83(3), 475-520.

It appears that using soft-law instruments for inherently dangerous activities in which may result in utmost harm for the Earth's orbit may not be sufficient enough for the governmental or private entities to be held liable.

2. THE APPLICABILITY OF THE STRICT LIABILITY FOR SPACE DEBRIS MITIGATION

The doctrine of *sic utere tuo ut alienum non laedas* of the customary and international law, states are responsible to ensure that the activities it performs or authorises do not cause damage or harm to other states or areas outside its national jurisdiction. This responsibility may be divided into three issues: the criteria of liability of the states, the definition of environmental damage caused by the conduct and the form of appropriate reparation.

The states have strict liability if they authorise inherently dangerous or ultrahazardous activities and may even be held absolute liable regardless of the due diligence and bear the harm resulting even from an act of God. These inherently dangerous activities are not prohibited under international law, but states bear strict or absolute liability, not of the conduct itself, but the potential harm resulting from the conduct.

Convention on Civil Liability for Damage Resulting From Activities Dangerous to the Environment (the 1972 Stockholm Convention) defines environmental damages as any injury or degradation to natural resources whereas the generally accepted form of reparation is the restitution of environment to a state if that harmful act had not been committed.[39]

In regard to transfrontier or transnational pollution, The Organisation for Economic Co-Operation and Development (OECD) defines that the term pollution "means the introduction by man, directly or indirectly, of substances or energy into the environment resulting in deleterious effects of such a nature as to endanger human health harm living resources and ecosystems, and impair or interfere with amenities and other legitimate uses of the environment".[40] Therefore, the space debris fits the OECD definition of the pollution as it indirectly results in deleterious effects to nature of outer

[39] Soto, M. (1996). General principles of international environmental law. *ISLA Journal of International Comparative Law, 3(1)*, pp 193-212.
[40] Organisation for Economic Co-Operation and Development. *Recommendation of the Council on Principles concerning Transfrontier Pollution*, 14 November 1974, OECD Doc. C(74)224.

space and impairs and interferes legitimate use; satellite activity and exploration, in the orbits of the Earth and access beyond.

Outer space is a "global commons confirmed by the Articles I and II of the Outer Space Treaty".As contrary to the international environmental law where the scope of the protection is strict "no changes to the environment", The Article IX of the Outer Space Treaty does not prohibit contamination nor changes but imposes an obligation to prevent or mitigate the effects to the environment and global commons. The 1992 UN Conference on Environment and Development which resulted in major legally binding instruments in Rio Declaration, adopted the principle that states may exercise preventive measures if there is a danger of irreversible damages to the environment. As Principle 15 of the Rio Declaration mandates;

In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.[41]

As there is no doubt of "If" the matter rather than when the irreversible damage is to escalate, and cost-linear effect of postponement of the removal of the objects as the amount of debris is to increase due to the Kessler syndrome, it is "a classic example where remedial action should begin sooner than later".[42]

As the space debris fits in the definition of the pollution, precedents of prior international law decision addressing pollution may be useful for the liability of current debris. Therefore the precedent decisions of pollution by the International Court of Justice could similarly be applied to the space debris. In customary international law, the states can be held responsible for polluting another state. The polluter pays for pollution principle is adopted to Art. 191 of the Treaty of the Functioning of the European Union and increasingly implemented in national legislation. As the outer space activity is inherently dangerous, strict liability is applied and Precautionary principle

[41]Principle 15, Rio Declaration, Preamble, United Nations Conference on Environment and Development. (1992).
[42] Mey, J. (2012), Supra nota 8, pp 263.

with launcher state to exercise extraordinary caution if the outcome of the launch may result in space debris.[43]

2.1 The International Court of Justice and the principle of sustainable development

Strict liability to prevent and mitigate space debris under the auspices of applicable treaties and international customary law in general, the forum of law to have jurisdiction for the matter relies on the International Court of Justice (ICJ). The ICJ is the principal legal organ of the United Nations and all nations being *ipso facto* parties to the Statutes of the International Court of Justice, therefore it has the jurisdiction to litigate in cases which the state have given the consent for. As a state with a threat of costly clean-up operation in outer space would not voluntarily submit to face consequences of the environmental harm caused, the form of consent may be derived from the binding treaties and declarations the state have signed for. Therefore, in theory, the state may be held liable for the remediation.[44]

In 1987, the Brutland Report defined the term of sustainable development as the needs that meet present but do "not compromise the ability of future generations to meet their own needs".[45] The ICJ introduced the concept of sustainable development to litigation 1997 on *the Case Concerning the Gabcikovo-Nagymaros Project*, a dispute between Hungary and the Slovak Republic. Pursuant to the treaty adopted between Hungary and former Czechoslovakia in 1997 to build a dam to produce hydroelectricity, prevent floods and improve navigation, Hungary withdrawing itself from the project due to concerns of depletion of groundwater and wetlands in 1989 whereas Slovakia continued the project and diverted the electricity produced from the dam to its own power station. Whereas the dispute were taken to the ICJ to review the rights and obligations of the treaty, the court widened its perspective and looked at the conventions two states were a party of and looked the principles from the international customary law. In its Advisory Opinion, the ICJ considered: "*Throughout the ages, mankind has, for economic and other reasons, constantly interfered with tha nature. In the past, this was often done without the consideration of the effect upon the*

[43] See *Gabcikovo-Nagymaros Project (Hungary/Slovakia) Judgment*, I.C.J Reports 1997, p. 7
and polluter pays principle on Vinuales, J. (2008). The Contribution of the International Court of Justice to the Development of International Environmental Law: A Contemporary Assessment. *Volume 32, Issue 1, Article 14, Fordham International Law Journal.*
[44] *See Chapter 93,* Charter of the United Nations. Retrieved from http://legal.un.org/repertory/art93.shtml (last accessed 9 May 2019)
[45] Soto, M. (2006), Supra nota *39,* pp 196.

environment. Owing to new scientific insights, and to a growing awareness of the risks for mankind ... new norms and standards have been developed ... such new norms have to be taken into consideration, and such new standards have given proper weight, not only when states contemplate new activities but also when continuing with activities begun in the past. This need to reconcile economic development with protection of the environment is aptly expressed in the concept of sustainable development".[46]

As it comes to a legal principle guiding the interpretation of international customary law and dispute resolution, "it must not be a legal principle but a rule-generating adjudicatory norm"[47]. Therefore, the principle of sustainable development is not a definitive rule-creating character as "it contains a number of competing and even contradictory sub-principles that dilute its normative power.[48]

The adjudicatory norm of the sovereignty of the states on the ICJ rulings alters the principle of sustainable development to become a normative power. Until 1997 Gabcikovo-Nagymaros ruling, the issues of sustainable development and depletion of natural resources were not considered as an obligation of the states to maintain and prevent but rather in passing remarks as the principle of equity between sovereign states were applied in the ICJ decisions.[49]

Nevertheless, defining the normative power of the principle of sustainable development may have been hindered by the 'essential interest' of a state, as the ICJ understood that the environmental concerns presented by Hungary were, at least partially, affected by the reason that the project would affect the watercourses and divert 80 per cent of the water flow of the Danube river from Hungary and therefore the concerns were not entirely environmental rather than economic, which the ICJ acknowledged.[50]

The strict liability to become the normative norm in the international customary law, regardless of the due diligence or duty to care. Strict liability requires no fault or negligence, as it was contested

[46] Trevisan, L. (2009). The international court of justice's treatment of sustainable development and implications for argentina v. uruguay. *Sustainable Development Law Policy, 10(1),* pp 40-85
[47] Bosselman, K. (2008). Sustainability jurisprudence in the international judicial system. *The Principles of Sustainability: Transforming law and governance*. 2nd edition. Routledge. 83-92.
[48] *Ibid.*
[49] *Ibid. See also Gabcikovo-Nagymaros Project (Hungary/Slovakia) Judgment*, I.C.J Reports 1997, p. 7
[50] *Ibid.*

as early as in *the 1938 Trail Smelter Arbitration* where Canada was held responsible for the transboundary pollution despite the diligence of the private owners of the smelter, albeit, the court of arbitration did not have to make a choice between fault and strict liability as to the decision was made based on the tort's law of nuisance. It seems that "the ICJ prefers to apply general principles of domestic jurisprudence, particularly that of private law, insofar they are applicable to the State relations".[51] As the States domestic law recognises the inherently dangerous, ultrahazardous activty, the law of torts, the fault and negligence is exluded and strict liability imposed.

Reductant to establish *opinio juris* on strict liability, states prefer *ex gratia*, voluntary payments to compensate transboundary harm, namely in pollution, nuclear and outer space activities.[52] The Soviet Union paid compensation for the clean-up operation to Canada upon the uncontrolled re-entry of Kosmos 954 via diplomatic channels therefore not admitting liability for the incident. Abeit the practise of *ex gratia* payments may be catogetsed as a implied liability, the continued practise of voluntary payments does not constitute *opinio juris* and create precedents for international tribunals.[53]

2.1.1. Liability for intentional harmful activity resulting in space debris

On January 11, 2007, China performed an anti-satellite test on a ballistic missile, payload consisting of the kinetic kill vehicle. At an altitude of 864km, it collided with its target, Chinese defunct weather satellite the Fengyun-1C (FY-1C) over the relative velocity of 32,400 km/h destroying it and creating orbital space debris of more than 3 000 trackable pieces and even over 32,000 pieces which are untrackable. The spread of debris covers the entire orbit of the Earth ranging from the altitude of 175km to 3,600km.[54]

The kinetic kill vehicle experiment generated the largest amount of space debris in a single event, and as a result, international space station needed to divert its orbits to avoid collision with the debris. Whereas Article IV of the Outer Space Treaty prohibits placement of the weapons of mass

[51] Charme, J. (1989), Supra nota 18, pp 75.
[52] *Ibid, 89.*
[53] Ulfah, S., Manuputty, A., Noor, S., Wahid, A. (2018). Strict Liability Principle in Environmental Legal System. Journal of Law, Policy and Globalization, 71, pp 100-107.
[54] "Orbital Debris Quarterly News", Volume 14, Issue 4, October 2010, NASA Orbital Debris Program Office, http://www.orbitaldebris.jsc.nasa.gov/
newsletter/newsletter.html

destruction in outer space, but there is no internationally binding regulation to ban the use of anti-satellite weapons. The discussion of preventing such intentional harmful activity has been discussed as early as in 1978 and 1979 when US-USSR ASAT negotiations were held and in 1985, when Conference on Disarmament of the UN established an ad hoc committee to examine whether legal protection of satellites and nuclear power systems in space should be guaranteed by a new treaty.[55]

The proposed prevention of an arms race in space treaty (PAROS) was drafted but the United States refused to give the committee negotiating power as it preferred bilateral discussions with the USSR. On 4 April 2016, the Russian Federation, one of the three nations which have conducted anti-satellite experiments in space, released a statement declaring that it will not be the first to deploy any type of weapon in outer space. After the 2007 ASAT test, China maintained its official policy to promote disarmament of the outer space even tough the ASAT test was a violation of the concept of peaceful purposes.[56]

Nevertheless, the kinetic kill vehicle experiment conducted by China could establish a precedent for future space debris litigation in the ICJ if taken there. The experiment both hindered free access to outer space, harmfully contaminated orbits trajectories in which the liability may be derived from both the Outer Space Treaty and principles of sustainable development of the international environmental law. As the ICJ stresses in its Advisory Opinion the new norms, standards and growing awareness of the risks for mankind, the past experiment conducted by other space-faring nations does not constitute remedy.

[55] Christol, C. Q. (1988). Space Debris and Military Testing. *Proceedings on the Law of Outer Space 31*, 234-242.
[56] Kaiser, S. A. (2007). Chinese Anti-Satellite Weapons: New Power Geometry New Legal Policy. *Proceedings on the Law of Outer Space 50*, 591-600.

CONCLUSION

It appears that the prevention of the forthcoming space debris and the duty to mitigate current active debris requires strict liability for the launching and operating states when they launch or conduct activities in the outer space. As the current practice of space debris guidelines and other soft-law instruments concentrate on the issue of prevention and minimisation of the risk of accidental collisions, break-ups and effective removal of a satellite at the end of its operational cycle, the liability upon the realisation of the risk remains untested.

Therefore, the regulation of space debris and the obligation to mitigate requires both legally binding guidelines for comprehensive space debris mitigation procedures before and during the launch, within the operational cycle of a spacecraft and effective removal of it from the orbit before it becomes defunct and amending existing treaties to determine the issue of liability upon the risk realisation.

Whereas the outer space activity is transforming from the state-driven activity towards market-driven activity, the states should bear the substantial strict liability in instances regard to non-governmental operations. As the consequences of a break-up of the satellite resulting large debris cloud are utmost, prolonged and global in its literal sense, such liability may not be entirely vested on private entities. The strict liability that is applied in nuclear activity may be comparable and therefore be applied to the outer space activity as the potential harm upon risk realisation are comparable.

The Liability Convention and the general principles of international law are applicable in situations where the claimant and respondent are States. As there is no violation of sovereignty in the LEO, MEO or GEO areas of the orbit, a State may not represent itself as a claimant and demand compensation for the damages caused by the space debris. As the main principle behind the Liability Convention was the strict liability among the nations who were capable to explore and exploit the outer space and to protect unrelated persons and property from the harm caused by a space object, the Liability Convention is not applicable to prevent space debris as it may be applied

only to harm occurring on the surface or to aircraft in flight. Therefore an amendment, where the strict or absolute liability in orbit is included, is required for the mitigation and prevention of the space debris.

As mentioned, outer space activities is an inherently dangerous activity which upon the risk realisation may have global consequences and not be comparable with the aviation and maritime standards, where the potential harm caused is not as global as the potential break-up of the satellite and spread of space debris in orbit. Therefore relinquishing a similar amount of liability from the states to the private operators as is not sufficient enough to mitigate the global consequences. Drafting guidelines, standards and procedures comparable to the ICAO Standards and Practices and the IMO oil pollution prevention guidelines and conventions are not sufficient enough and therefore outer space activity is in need of the strict liability of the States.

In regard to the registering and sovereignty of space objects, besides the practical trouble of registering very small objects or the particles not detected upon detachment, the Registration Convention and Article VIII of the Outer Space Treaty severely hinders to the right of third parties to remove the unidentified or non-operational objects from the orbit either by deorbiting or transferring them to the graveyard orbit. A practical solution for the removal of unidentified objects would be to amend the Outer Space Treaty to limit the sovereignty appertain only on functional or operational objects and add the Registration Convention an annexation that declares all objects not in the Registry to be registered as abandoned and therefore to be removed without the risk of violating the sovereignty or the ownership of another state or operator.

If a party is found liable for the pollution of the environment, the difficulty arises how to compensate or restitute the harm caused. Whereas the "polluter pays" principle is feasible to the cleanup of the environment on the surface and may also be implemented through the emission trading to compensate pollutants the activity caused which may be effective in when neutralising carbon monoxide emission by establishing, *inter alia*, natural reservoirs of carbon sink, to clean up and restoring the orbits to the state it was before the damage occurred as it may not be economically feasible nor technologically possible. Therefore restitution of the orbits to the state it may serve its primary purpose, providing trajectories to the satellites and free access to outer space beyond should be the objective for the restitution, although the costs of the remediation may be disproportionate to the results desired.

The states generally are unwilling to admit the liability and rather compensate transboundary harm in *ex gratia* payments. Whereas the continuing trend of voluntary payments creates *de facto* normative power to remediate environmental harm, it does not establish *opinio juris*, precedents for international tribunals. Therefore the strict liability remains untested on the issue of the space debris mitigation albeit the ICJ does have States consent to rulings from binding treaties and declarations the States have signed for. Even though the sovereignty of the states remain the adjudicatory norm of the ICJ, new norms and standards, and the growing awareness of the risks for mankind as mentioned in the Gabcikovo-Nagymaros case's Advisory Opinion confers the principle of sustainable development more normative power than in the past. As the space debris issue fits in the context of the depletion of a natural resource and sustainable development, both past and forthcoming space debris caused from the outer space activity can be taken to the ICJ or other international tribunals.

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