Legal Issues Stemming from Active Removal of Space Debris

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I. Introduction

Since the first satellite (Sputnik 1) was put into orbit in 1957, the growing amount of space debris[2] has become a threat to satellites' sustainable operation in near-earth orbits and to their launch from the ground. In some cases, space debris even falls to earth, thus posing a risk to human life. Today, space debris is "an issue of concern to all nations."[3] Since the 1980s, the space-faring nations have made efforts not to generate debris when launching rockets and when operating satellites to the greatest extent possible, but it is believed that the amount of debris will likely increase exponentially due to collisions between individual pieces of debris (the so-called Kessler Syndrome) and that the situation will be even worse unless effective countermeasures are taken.[4] In light of that situation, active debris removal (ADR) is believed to

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[2] In this article, "space debris" means "all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional" as is defined in "Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space"(A/62/20(2007)), Annex, pp.47-50. Hereinafter referred to as either "space debris" or "debris."

[3] A/Res/62/217 (2007), preambular para. 7.

[4] D. Kessler and B. Cour-Palais, "Collision Frequency of Artificial Satellites: The Creation of a Debris Belt," *Journal of Geophysical Research*, Vol. 83, Issue A6 (1978), pp. 2637-2646.

have become a necessary adjunct to the traditional measures for debris mitigation. This article will look into the legal issues connected with the operation of ADR and will explore possible solutions for them.

II. The current status vis-à-vis space debris

According to an assessment by the European Space Agency (ESA), as of January 2019, approximately 5,450 rockets have been launched since 1957 (excluding failures), and the number of satellites these rockets have placed into Earth orbit is approximately 8,950, of which approximately 5,000 are still in space. Of these 5,000, approximately 2,300 are still functioning. The number of pieces of debris in orbit, as estimated by statistical models, is 34,000 objects > 10 cm, 900,000 objects from greater than 1 cm to 10 cm, and 129 million objects from greater than 1 mm to 1cm.[5] The major incidents that have generated significant amounts of debris include China's intentional destruction of its satellite in January 2007 and the collision of Cosmos 2251 and Iridium 33 in February 2009.[6] Currently, within low Earth orbit (LEO), which is below an altitude of 2,000 km,[7] the congestion is especially serious from 800 km to 1,000 km altitude and around 1,400 km altitude.[8] This is followed by the congestion at the altitude of 35,786 km, which corresponds to the Geostationary Earth Orbit (GEO).[9]

Debris already poses a real threat to satellites. The first collision between a functioning satellite and debris was said to be when France's Cerise satellite collided with fragments of the Ariane rocket, which exploded approximately ten years earlier.[10] The International Space Station conducted 25 collision avoidance maneuvers by 2017.[11] According to an official of the United States

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[5] European Space Agency (ESA), "Space Debris by the Numbers," at https:// www.esa.int/Our_Activities/Operations/Space_Debris/Space_debris_by_the_ numbers (last visited on February 23, 2019).

[6] ESA, *Space Debris: The ESA Approach, BR-336 (2017)*, p. 2, at http://esamultimedia.esa.int/multimedia/publications/BR-336/ (last visited on March 11, 2019).

[7] Inter-Agency Space Debris Coordination Committee, IADC Space Debris Mitigation Guidelines, p. 6, IADC-02-01 Revision 1 (2007), at http://www.unoosa. org/documents/pdf/spacelaw/sd/IADC-2002-01-IADC-Space_Debris_Guidelines-Revision1.pdf (last visited on March 11, 2019).

[8] ESA, *supra* note 6, p. 3.

[9] *Ibid.*

[10] NASA, "Space Debris and Human Spacecraft," last updated on August 7, 2017, at http://www.nasa.gov/mission_pages/station/news/orbital_debris.html (last visited on March 4, 2019).

[11] NASA, "Two More Collision Avoidance Maneuvers for the International Space Station", *Orbital Debris Quarterly News*, Vol. 19, Issue 4 (2015), p. 1, at https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv19i4.pdf (last visited on March 4, 2019); J.-C. Liou, "U.S. Space Debris Environment, Operations, and Research Updates," 55th Session of the Scientific and Technical Subcommittee, Committee on the Peaceful Uses of Outer Space, United Nations 29 Jan. – 9 Feb. 2018, Vienna, p. 6, at

Air Force (USAF), the USAF provided conjunction alerts to satellite operators all over the world more than 300,000 times in 2017 alone.[12]

Space debris sometimes falls to the ground as well, as seen in such cases as the falling to Earth in January 1978 of fragments of the USSR's Cosmos 954, including fragments contaminated by radioactive substances,[13] and an incident in which a fuel tank of a French rocket fell on a village in Brazil in February 2012.[14]

III. Current counter-debris measures

So far, space faring nations are implementing the following counter-debris measures: (1) monitoring debris by radars and telescopes and informing satellite operators of the approach of other space objects so that the operator can decide if they should maneuver the satellite to avoid the collision; (2) improving the technical specifications of rockets and satellites and the way in which they are operated to mitigate the creation of debris, in addition to either re-orbiting the satellites to graveyard orbits or forcing them to re-enter the atmosphere in a controlled way, thereby opening space in the congested orbits [Post-mission Disposal (PMD)]; and (3) establishing international guidelines concerning (2) above at international fora to harmonize and further improve the counter-debris measures of space-faring nations. This chapter takes a general view of the aforementioned three measures.

1. Monitoring of debris for collision avoidance

This measure constitutes one of the elements that form the concept of space situational awareness (SSA). The most prominent provider of collision avoidance alerts is the U.S. Strategic Force. Its Joint Functional Component Command for Space conducts surveillance of space objects through the Combined Space Operation Center (CSpOC). CSpOC monitors space objects larger than approximately 5 cm in diameter in LEO and 1 m in diameter in GEO using the U.S. Space Surveillance Network and maintains a catalog of approximately 19,000 space objects.[15] Through Space-Track.org, CSpOC provides information about orbit

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http://www.unoosa.org/documents/pdf/copuos/stsc/2018/ tech-14E.pdf (last visited on February 23, 2019).

[12] D. Mosher, "The US Government Logged 308,984 Potential Space-junk Collisions in 2017 — And the Problem Could Get Much Worse", *Business Insider* (2018), at https://www.businessinsider.com/space-junk-collision-statistics-government-tracking-2017-2018-4 (last visited on February 23, 2019).

[13] S. Aoki, *Nippon no uchu senryaku [Japan's Space Strategy]*, Keio University (2006), pp. 211-215.

[14] M. Schladebach, "Space Debris as a Legal Challenge," *Max Planck Yearbook of United Nations Law*, Vol. 17, Issue 1 (2013), p. 68.

[15] Liou, *supra* note 11; NASA, "Satellite Box Score," *Orbital Debris Quarterly News*, Vol. 22, Issue 4 (2018), p. 10, at https://www.orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnv22i4.pdf (last visited on March 18, 2019); NASA *supra* note 10.

congestion and the probability of collision, and the satellite operators all over the world decide if they have to maneuver their satellites to avoid a possible collision. This is critical infrastructure for the satellite operators, who usually do not possess strong monitoring capabilities.

The quality of monitoring of space objects can be improved through enhancing the network of monitoring assets and analysis. The United States is deepening cooperation with like-minded partners such as the European countries and Japan. The U.S.–Japan cooperation in this field is already one of the major pillars of the U.S.–Japan space cooperation, in addition to the security cooperation between the two allies.[16]

In Japan, the Japan Aerospace Exploration Agency (JAXA) monitors space objects using telescopes and a radar system located in Okayama Prefecture. The JAXA uses those data, together with the data provided by CSpOC, to protect its space assets.[17] In May 2014, the two governments decided that the JAXA should begin providing its SSA data to CSpOC so that both sides can further improve the quality of their respective SSA.[18] In addition, Japan's Air Self Defense Force plans to deploy its SSA capabilities and exchange data gathered by the new assets and JAXA's assets with the U.S. side.[19]

2. Improvement of the technical specifications of rockets and satellites, in addition to the mode of operations

Space agencies of the major space-faring nations, in pursuit of mitigating the creation of debris, have improved the technical specifications of rockets and satellites and their mode of operations, including the steady implementation of PMD. Such efforts have been documented in the form of domestic guidelines that govern their national space activities.

In 1988, the U.S. Government touched upon its efforts on debris mitigation in the National Space Policy for the first time. This was followed in 1993 by the National Aeronautics and Space Administration (NASA) guidelines "Management Instruction"

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[16] The Guidelines for Japan-U.S. Defense Cooperation, April 27, 2015, VI. Space and Cyberspace Cooperation, A. Cooperation on Space, at https://www.mofa.go.jp/files/000078188.pdf (last visited on Feb. 23, 2019).

[17] M. Matsuura, "Debris to uchuki no syototsu wo fusegu," March 13, 2017, at https://www.jaxa.jp/projects/feature/debris/matsuura_j.html (last visited on Feb. 23, 2019).

[18] Ministry of Foreign Affairs of Japan, "Japan-U.S. Cooperation on Space Situational Awareness," May 7, 2014, at https://www.mofa.go.jp/mofaj/press/release/press22_000049.html (last visited on Feb. 23, 2019). The author of this article was the head of the Japanese Delegation on this subject.

[19] Ministry of Defense of Japan, "Boueisho no SSA nikakaru torikumi nitsuite," May 14, 2018, at https://www8.cao.go.jp/space/comittee/27-anpo/anpo-dai27/siryou2-1.pdf (last visited on Feb. 23, 2019).

(NMI 1700.8) in 1993, which were NASA's first debris mitigation guidelines. In 1995, NASA issued "NASA Safety Standard regarding orbital debris" (NSS 1740.14). In 2001, the U.S. Government issued "U.S. Government Orbital Debris Mitigation Standard Practices" that covered all federal agencies' space activities.[20]

In Japan, too, the space agencies, including the National Space Development Agency of Japan (NASDA), made efforts to establish similar guidelines, leading NASDA to issue the "Space Debris Mitigation Standard" (NASDA-STD-18A) in 1996, which was the second document of that nature after NSS 1740.14.[21] The Japan Ministry of Education, Culture, Sports, Science and Technology and JAXA continue their research and development regarding the further mitigation of debris creation, steadier implementation of PMD, and associated issues.[22]

3. Establishment of international guidelines

(1) IADC guidelines

The measures mentioned in 2. above are unilateral ones that apply only to the respective domestic space activities. Yet, to achieve the maximum outcome, it is imperative to get as many countries as possible to participate in the norms. In the late 1990s, NASDA was reported to propose the establishment of international guidelines to its counterparts of other space-faring nations.[23] The like-minded space agencies began consultation at the Inter-Agency Space Debris Coordination Committee (IADC), and they reached an agreement on the document – IADC Space Debris Mitigation Guidelines – in 2002. This presents several measures, such as the limitation of debris released during normal operations, minimization of the potential for on-orbit break-ups, and the steady implementation of PMD.[24]

(2) COPUOS guidelines

Following the IADC guidelines, the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) issued the Space Debris Mitigation Guidelines in 2007.[25] This is a

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[20] NASA, *Orbital Debris Management & Risk Mitigation*, pp. 21-25, at https://www.nasa.gov/pdf/692076main_Orbital_Debris_Management_and_Risk_Mitigation.pdf (last visited on March 9, 2019).
[21] JAXA Space Information Center, "Space Debris Mitigation," at http://spaceinfo.jaxa.jp/ja/reduction_ space_debris.html (last visited on March 9, 2019).
[22] National Space Policy Secretariat of Japan, "Space Debris Taisaku ni tsuite," Oct. 19, 2016, at https://www8.cao.go.jp/space/comittee/27-kiban/kiban-dai24/siryou3.pdf (last visited on Feb. 23, 2019).
[23] A. Kato, "Space debris mondai no genjo to sekai no torikumi ni tsuite," *Kouku to uchu* (731), p. 22.
[24] *supra* note 7.
[25] *supra* note 2.

technical document adopted by COPUOS's Scientific and Technical Subcommittee, but it has received endorsement by the COPUOS committee[26] as well as by the General Assembly.[27] The COPUOS guidelines embody many of the IADC guidelines and state that the parties concerned may refer to the latest version of the IADC guidelines for more in-depth descriptions and recommendations pertaining to space debris mitigation measures. One can interpret this as meaning that the COPUOS guidelines intended to endorse the major elements of the IADC guidelines at the United Nations and thus encouraged the member states to follow them.[28] Both the IADC guidelines and the COPUOS guidelines are not legally binding under international law,[29] and they are not directly enforceable without specific national legislation.

(3) Importance of PMD

Among the measures set out in the said guidelines, particular attention should be paid to PMD. The IADC guidelines recommend that the objects in GEO that have terminated their mission should be re-orbited to the so-called graveyard orbits, and that the objects passing through the LEO region that have terminated their mission should be de-orbited (direct re-entry is preferred).[30] The same document states that the reasonable lifetime limit of the objects should be 25 years.[31] According to the 2018 Annual Space Environment Report from the European Space Agency (ESA), approximately 90% of the mass of payloads in GEO was successfully cleared from GEO in 2017.[32] However, in the case of LEO, statistics show that approximately 60% of the objects were cleared in 2017 (both naturally compliant and successful attempts of PMD), but that the clearance rate of objects

[26] *supra* note 2, paras. 118-119.
[27] *supra* note 3, para. 26.
[28] Japan Ministry of Foreign Affairs, "Space Debris ni kansuru kokusai rules" (Sept. 5, 2018), at https://www8.cao.go.jp/space/comittee/27-kiban/kiban-dai40/pdf/siryou1-2.pdf (last visited on Feb. 23, 2019). In addition to the aforementioned guidelines, it is noteworthy that International Organization for Standardization (ISO) also issued technical standards for the purpose of debris mitigation. See "International Organization for Standardization, ISO 24113: 2011(en), Space Systems—Space Debris Mitigation Requirements," at https://www.iso.org/standard/57239.html (last visited on February 23, 2019).
[29] The IADC guidelines do not explicitly mention its legal nature, but the intention of the member organizations to make the document non-legally binding is clear from its language and format. As to the COPUOS guidelines, see its p. 7.
[30] *supra* note 7, p. 9.
[31] *supra* note 7, p. 9-10.
[32] European Space Operations Centre, *ESA's Annual Space Environment Report*, Issue 2, Rev. 0 (2018), p. 65, at https://www.sdo.esoc.esa.int/environment_report/Space_Environment_Report_latest.pdf (last visited on February 23, 2019).

heavier than 100 kg during the same period was only 20.8%.[33] In 2018, at a session of the Scientific and Technical Subcommittee of COPUOS, a representative of IADC mentioned that the current level of implementation the IADC guidelines regarding the 25-year limitation is considered to be insufficient and that no apparent trend toward a better implementation level has been observed.[34]

(4) Guidelines for the long-term sustainability of outer space activities

In 2010, a Working Group on the Long-term Sustainability of Outer Space Activities was established by the Scientific and Technical Subcommittee of COPUOS, and it initiated consultations to establish guidelines on the topic.[35] In 2019, the 21 guidelines were adopted at COPUOS. The agreed guidelines include several items that enhance the international collective effort on debris mitigation: provision of updated contact information and sharing of information on space objects and orbital events (B.1); improvement of the accuracy of orbital data on space objects and enhancement of the practice and utility of sharing orbital information on space objects (B.2); promotion of the collection, sharing, and dissemination of space debris monitoring information (B.3); and performing conjunction assessments during all orbital phases of controlled flight (B.4).[36]

IV. The necessity of active debris removal (ADR)

As seen earlier, the international society has addressed the debris problem in various ways, but the dominant argument is that the increase of debris cannot be stopped by the current measures only and that ADR will become necessary.

J.-C. Liou et al. published the result of a simulation based on the scenario that three Large Constellations (LCs) operate a total of 8,300 spacecraft at altitudes between 1,000 and 1,325 km with different inclinations and orbital planes.[37] According to that report, when assuming that no LC is deployed, that the success rate of the post mission disposal (PMD) is 90%, and that the upper stages and spacecraft explode with the same probability as in past

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[33] *Ibid*., pp. 56-60.
[34] M. Ohnishi (JAXA), "The Inter-Agency Space Debris Coordination Committee (IADC)—An Overview of IADC's Annual Activities (2018)," p. 13, at https://www.iadc-online.org/index.cgi?item=docs_pub (last visited on February 23, 2019).
[35] Press release "Guidelines for the long-term sustainability of outer space activities adopted," June 22, 2019, at http://www.unoosa.org/oosa/en/informationfor/media/2019-unis-os-518.html (last visited on Aug. 15, 2019).
[36] Guidelines for the Long-term Sustainability of Outer Space Activities of the Committee on the Peaceful Uses of Outer Space (A/74/20), Annex II.
[37] J.-C. Liou et al., "NASA ODPO's Large Constellation Study," *Orbital Debris Quarterly News*, Vol. 22, Issue 3 (2018), pp. 4-7, at https://orbitaldebris.jsc.nasa.gov/quarterly-news/pdfs/odqnx22i3.pdf (last visited on March 9, 2019).

cases, the additional population of objects larger than 10 cm in LEO will increase by approximately 110% in 200 years, from 2016 to 2215. When the LCs are deployed and the success rate of the PMD is 90%, the additional population increase will be 290%. If the PMD success rate is 95%, the additional increase will be 100%, whereas, if the rate is 99%, the additional increase will be 22%.[38] This eloquently demonstrates how the steady implementation of PMD is important for the debris mitigation. In 2015, IADC compiled a set of recommendations vis-à-vis the environment of LEO bearing in mind the deployment of LCs, which was revised in 2017. The document recommends that satellite operators follow the 25-year lifetime limit and encourages them to consider additional measures beyond the existing guidelines, such as shortening the PMD lifetime.[39]

The operators of LCs are slated to deploy several hundred satellites to cover a vast area of the ground. Some of them will likely fail to implement PMD, and ADR will be necessary to discard the nonfunctional satellites. Additionally, those satellites' expected lifetime will be only several years, and the satellite operators will need to replace one with another, which also necessitates ADR.[40]

V. Methods of ADR

In the past, when the U.S. operated space shuttles, there were cases in which the space shuttles' crews captured nonfunctional satellites in orbit for repair and then redeployed them. For example, the Space Shuttle "Endeavor" captured "Intelsat 6" in May 1992, and "Colombia" captured an American satellite "Spartan" in November 1997, respectively, to repair and redeploy them.[41] However, the space shuttle series has already terminated its mission, and the operating orbit was relatively low (up to approximately 550 km). Additionally, the space shuttles were not specifically designed to conduct debris removal missions. Few people believe that the same method would be sustainable even if similar spacecrafts are put into operation in the future.[42]

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[38] *Ibid.*

[39] Inter-Agency Space Debris Coordination Committee, IADC Statement on Large Constellations of Satellites in Low Earth Orbit, IADC-15-03 (2017), pp. 9-10, at https://www.iadc-online.org/index.cgi?item=docs_pub (last visited on March 23, 2019).

[40] See, e.g., J. Foust, "Astroscale to Partner with SSTL on Orbital Debris Removal Mission," *SPACENEWS*, Nov. 21, 2017, at https://spacenews.com/astroscale-to-partner-with-sstl-on-orbital-debris-removal-mission/ (last visited on March 23, 2019).

[41] R. Legler and F. Bennett (Mission Operations, Johnson Space Center, NASA), *Space Shuttle Missions Summery* (2011), pp. 2-107, at https://spaceflight.nasa.gov/outreach/SignificantIncidents/assets/space-shuttle-missions-summary.pdf (last visited on February 24, 2019).

[42] JAXA, "Naze Koshoshita Eisei wo Space Shuttle de Shuri ni ikanai no desuka" (March 18, 2003), at http://iss.jaxa.jp/iss_faq/shuttle/shuttle_011.html (last visited on February 24, 2019).

Space agencies and private companies of several countries are rushing the research and development (R&D) of sustainable methods of debris removal. The representative methods under R&D include the "push-type" and the "pull-type." The former means that an ADR satellite captures the targeted objects with such devices as magnets and robotic arms. The latter means that net and harpoon capture the targeted objects. The methods of de-orbiting/re-orbiting the captured objects into the desired orbit include chemical thrusters, electric thrusters, and electrodynamic tethers. All of these necessitate extremely sophisticated technology, for various reasons. First, debris is not equipped with a target-marker, and thus a highly advanced positioning system is required to enable capture. Besides, debris is not equipped with a docking port, and most debris is thought to be auto-rotating, which makes the capture even more difficult.[43]

Today, ADR is often discussed in the context of more comprehensive on-orbit services (OOS).[44] Satellites on orbit cease their function for multiple reasons: for example, draining of fuel, technical failure, and the end of the lifetime of the critical devices. If it is possible to implement remedies such as refueling, repair of the broken devices, and software updating, the devices' lifetimes can be extended.[45] In particular, in GEO, where the number of available slots is quite limited,[46] there is little room for leaving nonfunctional satellites in orbit. Although the relevant guidelines encourage the implementation of PMD, it might fail. ADR can potentially play an important role in such a case. Also, there are old satellites on GEO that lack the capabilities of PMD, and they can be removed only by ADR operations. If OOS becomes technically and commercially feasible in the future, such operations of ADR will likely be part of the services.

VI. Legal issues stemming from ADR

ADR means the removal of defunct satellites, the upper stages of rockets, and their components and fragments. Thus, it is necessary to carefully consider legal issues deriving from such removal operations. This article first studies what legal norms exist

[43] JAXA, "Space Debris no hokaku gijutsu no kenkyu" at http://www.kenkai.jaxa.jp/research/debris/deb-capture.html(last visited on February 24, 2019). On September 19, 2018, Surrey announced the success of capture of a decoy of debris by net. (https://www.sstl.co.uk/media-hub/latest-news/2018/removedebris-space-junk-net-capture-success) (last visited on 23 March 2019).

[44] H. Alshamsi et al., "As the Grapefruit Turns Sixty, It's Time to Get Serious About Clean Up in Outer Space," Journal of Air Law and Commerce, Vol. 83, Issue 1 (2018), pp. 52-53.

[45] *Ibid.*, pp. 50, 52-53.

[46] M. Finch, "Limited Space: Allocating the Geostationary Orbit," *Northwestern Journal of International Law & Business,* Vol. 7, Issue 4 (1986), p. 789.

vis-à-vis space debris, because that constitutes the basis for the discussion on the legal issues stemming from ADR.

1. Does international law oblige debris mitigation?

The basis of the space law regime is formed by the so-called "space treaties,"[47] which include the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (OST). However, as the space treaties were concluded before the growth of the sense of urgency concerning the debris problem,[48] they do not explicitly mention debris.[49]

A pertinent part of Article I of the OST stipulates that "The exploration and use of outer space […] 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." In a pertinent part of the first sentence, Article IX stipulates that "In the exploration and use of outer space, […] States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, […] with due regard to the corresponding interests of all other States Parties […]." The second sentence of the same Article sets out that States Parties shall pursue studies of outer space and conduct exploration of them so as to avoid their harmful contamination. The third sentence sets out that if a State Party has reason to believe that an activity or experiment would cause potentially harmful interference with activities of other States Parties, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. The fourth sentence establishes that a State Party that has reason to believe that an activity or experiment

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[47] In this article, the term "space treaties" means the set of the following international agreements: Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, Jan. 27, 1967, 610 UNTS 205[OST]; Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 672 UNTS 119[Rescue Agreement]; Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 961 UNTS 187[Liability Convention]; and Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 1023 UNTS 15[Registration Convention].

[48] P. Larsen, "Solving the Space Debris Crisis," *Journal of Air Law and Commerce*, Vol. 83, Issue 3 (2018), p. 482.

[49] In 1963, the U.S. Air Force conducted experiments to disperse 100 pounds of dipoles thereby creating an orbital belt that is used as a military communication network (Project West Ford). That caused harsh criticism by radio and optical astronomers for its potential interference with the astronomy observation. That debate is believed to lead the negotiation of the OST to stipulate the third sentence of Article IX, which includes the term "potentially harmful interference." In this sense, it can be said that even before the negotiation of the OST, there had been an awareness about a certain type of debris in a limited context. See. D. Terrill Jr, "The Air Force Role in Developing International Outer Space Law" (1999), pp. 58-63.

planned by another State Party would cause potentially harmful interference with activities in the peaceful exploration and use of outer space may request consultation concerning the activity or experiment.

There are diverse views on the legal implication these provisions have vis-à-vis space debris. On the one hand, some scholars argue that the aforementioned provisions establish, to certain extent, a legal obligation to implement debris mitigation. For example, R. Jakhu and M. T. Ahmad opine that Article I of the OST implies that states have an obligation to mitigate debris, as debris can hinder states' rights to explore and use outer space freely.[50] They also state that not taking necessary initiatives to mitigate debris will violate the principle of due regard enshrined in Article IX of the OST because debris can endanger the space assets of other states, and that the presence of debris in outer space can arguably be considered as "harmful contamination" stipulated in Article IX, and states must adopt appropriate measures, which may include ADR, to mitigate them.[51] S. Marchisio states that space debris should be considered as being a form of "harmful contamination," and that under the principle of "due regard' of the first sentence of Article IX, states must prove beyond a reasonable doubt that everything possible was undertaken to prevent a harmful act from occurring.[52] J. H. Mey also argues in this context that, in the absence of a definition of "contamination," the ordinary meaning does not *prima facie* exclude space debris from its scope, and that states are obliged to prevent or minimize the risk of environmental harm to other states and to global commons under the second sentence of Article IX.[53] In addition, Jakhu and Ahmad argue that under the customary international law, states have a responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or of areas beyond the limits of national jurisdiction and that the presence of space debris is injurious to the outer space environment; thus, states need to actively remove debris for which they are responsible.[54] They refer to the general international law principle of preventive action, which, in their view, also obliges states to actively remove debris created by their activities.[55]

On the other hand, there are more conservative opinions. For example, C. Kypraios and E. Carpanelli opine that Article IX

[50] R. Jakhu and M. Ahmad, "The Outer Space Treaty and State's Obligation to Remove Space Debris: A US Perspective," *The Space Review* (2017).
[51] *Ibid.*
[52] S. Marchisio, "Article IX," S. Hobe, B. Schmidt-Tedd and K.-U. Schrogl (eds.), *Cologne Commentary on Space Law*, Vol. 1 (2009), p. 175-177.
[53] J. Mey, "Space Debris Remediation," *German Journal of Air and Space Law*, Vol. 61, Issue 2 (2012), pp. 258-260.
[54] Jakhu and Ahmad, *supra* note 50.
[55] *Ibid.*

at best encourages state parties to limit the generation of new orbital debris in a nonspecific manner, that there is little chance for a state to ever be held internationally responsible for a violation of that Article based upon creating ordinary space debris.[56] According to R. Popova and V. Schaus, in the context of Article IX, the legal framework provides for some general direction for co-operation between the users of outer space, but concrete instruments on how to ensure sustainability need to be formulated in more detail, and the treaties on space law do not expressly prohibit the creation of space debris.[57]

Regarding whether debris constitutes the "harmful contamination" referred to in the second sentence of Article IX, it is worth recalling that the "draft of the International Law Association for a Convention on Space Debris" set out separate definitions for debris and contamination/pollution.[58] This structure does not necessarily match the interpretation of the aforementioned arguments represented by Jakhu and Ahmad, Marchisio, and Mey. This shows the diversity of legal opinions vis-à-vis the relation between the term "harmful contamination" and space debris.

There are opinions that are close to the aforementioned "conservative" opinions but that emphasize the significance of the space treaties. For example, N. Jasentuliyana opines that space debris and the problem it represents are to some extent accounted for, albeit indirectly, within the space treaties, and that the OST does provide guidance as to the manner by which the generation of space debris and the liability for damage caused by such debris might be regulated, despite the vagueness and lack of precision of its provisions.[59] S. Aoki points out that Articles I has insufficient clarity and specificity to demand that parties take concrete measures for debris mitigation, but that the first sentence of Article IX does have a function as a guiding principle that leads parties to implement the contents of the relevant international guidelines.[60]

The space-faring nations, using the space treaties as a legal basis, have attempted to harmonize their behaviors in a desirable direction through establishing the aforementioned domestic regulations and international guidelines. These guidelines are not legally binding,[61] and, when they were adopted at the Scientific and Technical Subcommittee of the COPUOS, the role

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[56] C. Kypraios and E. Carpanelli, "Space Debris," *Oxford Public International Law* (2018), paras 16-19.
[57] R. Popova and V. Schaus, "The Legal Framework for Space Debris Remediation as a Tool for Sustainability in Outer Space," *AEROSPACE* (2018), p. 6.
[58] K.-H. Bockstiegel, "Draft of the International Law Association for a Convention on Space Debris," *Proceedings of the Law of Outer Space,* No. 38 (1995), pp. 71-76.
[59] N. Jasentuliyana, "Space Debris and International Law," *Journal of Space Law*, Vol. 26, No. 2 (1998), pp. 140-143.
[60] Aoki, *supra* note 13, pp. 207-210.
[61] *supra* note 7; *supra* note 2.

of the Legal Subcommittee was minimal. However, they are still critical norm-setting documents to implement the above-mentioned aforementioned articles of the space treaties. However, considering the highly technical nature of the document, selecting the type of paper (non-legally binding guidelines) should be appreciated as being pragmatic and being well aware of the reality of the international society. Additionally, several countries have adopted the contents of the guidelines into their domestic laws and regulations. Thereby, such contents have become legally binding within the jurisdiction of those countries.[62]

The norms embodied in such Articles as I and IX of the OST do not have enough clarity to resolve debris problems. However, they continue to be crucial provisions as guiding principles that lead the states to keep making efforts toward solving the debris problem by actions such as introducing domestic regulations and establishing international guidelines.

2. Liability regime concerning damage caused by debris

Article VII of the OST stipulates that "Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the moon and other celestial bodies." The Liability Convention stipulates the absolute liability for damage caused by a space object on the surface of the earth or to aircraft in flight (Art. II) and the fault-based liability for the damage caused by a space object elsewhere than on the surface of the earth or to aircraft in flight (Art. III).

Later, this article looks into the issue of whether debris falls within the definition of "space object." Some scholars analyze the applicability of Article VII of the OST and the relevant provisions of the Liability Convention, based upon the assumption that debris corresponds to "space object" referred to in the said treaties.[63] The following analysis is based on the same assumption.

Consider the case in which debris known to have been launched from a particular state has caused damage in another country. The major space-faring nations including the U.S. used to register their space objects that had become debris according to the Registration Convention. Thus, such a case is not an unrealistic

[62] Larsen, *supra* note 48, p. 483.

[63] See, e.g., *Ibid.*, p. 483; D. Smith, "The Technical, Legal, and Business Risks or Orbital Debris," *New York University Journal of Environmental Law*, Vol. 6, Issue 1 (1997), pp. 55, 57-58.

scenario. (They discontinued this practice because the amount of debris increased greatly.[64]) In such a case, it is relatively realistic to pursue compensation based on Article VII of the OST and Articles II or III of the Liability Convention. In fact, in the aforementioned case of Cosmos 954, there was communication between the USSR and Canada before its reentry. The parties concerned recognized that the falling object was from the USSR.[65] After the fall of the satellite residue, the Government of Canada claimed compensation from the USSR, referring to, *inter alia*, Article II of the Liability Convention.[66]

However, in most cases, it is necessary to obtain the assistance of SSA providers to identify the debris that has caused damage and its launching state.[67] There might be cases where the launching state of the debris cannot be identified fully.[68] Depending on the size and/or the shape of the orbit of the debris, the assessments of different SSA providers might differ. Thus, in the case of damage caused in outer space, there will be cases in which identifying the damage-causing debris is not an easy task.

Besides, in the case of damage caused in outer space, the liability under the Liability Convention requires that the launching state be at fault. That convention does not have a definition of "fault," and it is uncertain of the extent to which it is possible to determine the fault in particular cases.[69] Some scholars are of the view that damage caused by debris should be construed to be the responsibility of launching state under the OST and the Liability Convention and that failure of that state to monitor its debris constitutes fault if such debris causes damage to satellites of another launching state.[70] If all the countries that operate satellites were required to possess sophisticated SSA capabilities, that would be quite challenging. Also, it is debatable as to what extent the launching states are required to keep monitoring their space objects even after such objects have been transformed into fragments. Further discussion is necessary to establish norms regarding the standard of care to ensure that the fault-based liability scheme under the Liability Convention really works.

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[64] Larsen, *Ibid.*, p. 485.
[65] Aoki, *supra* note 13, pp. 211-215.
[66] As a result of the bilateral consultation, they reached an agreement in November 1980 that the USSR pay CAD 3 million to Canada. However, the agreed document, dated April 2, 1981, has no precise wording regarding the legal nature of the payment. Several scholars opine that the URSS's payment was not compensation for damage but a voluntary payment. See, e.g., Aoki, *supra* note 13, pp. 211-215.
[67] See, e.g., B. Weeden, "Overview of the Legal and Policy Challenges of Orbital Debris Removal," *Space Policy*, Vol. 27, Issue 1 (2011), pp. 38-43, esp. p. 41.
[68] *Ibid*.
[69] Smith, *supra* note 63, p. 58.
[70] Jakhu and Ahmad, *supra* note 50.

According to Article III of the Liability Convention, in the case of damage caused in outer space, compensation shall be sought from the launching state of the damaged object to the launching state of the damage-causing object. However, if a private company acquires a launching service provided in another state, the state of the company cannot automatically be understood to be a "launching State" under Article I (c)(i) of the Convention, unless that state corresponds to "a state which […] procures the launching of a space object." In that case, even when a space object damages a satellite in outer space and the fault lies with the launching state of the damage-causing object, the state of the victim company is not allowed to seek compensation under Article III of the Liability Convention. Several states whose private companies launch satellites from another state have declared the status of the launching states, in spite that it is debatable whether such relation between the company and the state of its nationality generates the status of the launching state referred to in the definition of "launching State" under the Liability Convention. At the end of the day, if the state of the company does not declare the status of the launching state, it is difficult to determine that that state is the launching state under the Liability Convention.[71]

As to the coverage of "damage" under the Convention, Article I (a) sets out that "damage" means "loss of life, personal injury or other impairment of health; loss of or damage to property of states or of persons, natural or juridical, or property of international intergovernmental organisations." This should be interpreted to exclude the environmental damage caused by the proliferation of space debris.[72]

Although several collisions have occurred in orbit, as of March 2019, there has not been any case in which a launching state sought compensation pursuant to the Convention.

One should admit that the OST and the Liability Convention lack explicit norms for the liability regime for debris damage. Some scholars opine that the Liability Convention only deals with the damage already caused and does not help in avoiding the creation of additional debris.[73] On the other hand, it is common practice for satellite operators to purchase insurance before launching to address the potential risk of collision. The space business community has not complained much about the deficiencies of the current liability scheme probably because of the

[71] S. Aoki, "Uchu no tansa riyou wo meguru kokka sekinin no kadai" [Issues relating to liability vis-à-vis exploration and use of outer space], *The Journal of international law and diplomacy*, 100-2 (2011), pp. 25-49.
[72] Kypraios and Carpanelli, *supra* note 56, para. 14.
[73] Schladeback, *supra* note 14, p. 71.

existence of the said insurance products.[74] Also, it is fair to say that the current liability scheme under the OST and the Liability Convention provides a certain level of deterrent effect that motivates launching states to make the utmost effort to avoid damage to other states.[75]

3. Legal justification of ADR

Unlike the avoidance of debris creation and PMD by the thrust of satellites, when attempting to forcefully either de-orbit or re-orbit debris, it is necessary to carefully look into whether such operation causes legal issues in relation to the launching state of that debris.

(1) Relevant provisions of the space treaties

Article II of the Registration Convention stipulates, in its first paragraph, that when a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry that it shall maintain and that each launching state shall inform the Secretary-General of the United Nations of the establishment of such a registry. Article IV of the same Convention sets out, in paragraph 1, that each state of registry shall furnish to the Secretary-General of the United Nations, as soon as practicable, information such as the name of launching state and an appropriate designator of the space object. Article VIII of the OST stipulates that a state party to the treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body. The same provision also stipulates that ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth.

Article I (b) of the Registration Convention sets out that the term "space object" includes component parts of a space object as well as its launch vehicle and parts thereof. Although there is no definition of "space object" in the space treaties, generally it is understood to be every object that has been launched into outer space to explore or use outer space and every object that is intended to be launched.[76] Although the term "an object launched into outer space" under Article VIII of the OST is not defined in the treaty either, there is no substantial difference between that

[74] D. Bensoussan, "Satellite Vulnerability to Space Debris Risk," Sixth IASS Conference — Montreal 21-23 May 2013, at http://iaassconference2013.space-safety.org/wp-content/uploads/sites/19/2013/06/1440_Bensoussan.pdf.
[75] Larsen, *supra* note 48, p. 487.
[76] Schmidt-Tedd and Mick, *supra* note 52, p. 150.

term and the aforementioned general description of the space object. Thus, this article will proceed based on the assumption that the term "an object launched into outer space" under Article VIII of the OST and the term "space object" under the Registration Convention and the Liability Convention are identical.

(2) Does debris constitute space objects?

If space debris constitutes "space objects" and is registered pursuant to Article VIII of the OST, such debris is under the jurisdiction and control of its launching state, and the ownership of the debris remains. If the debris does not correspond to "space objects," it is unnecessary to consider the relationship with Article VIII. Still, it is necessary to look into what kind of legal norm exists regarding removing such debris.

Many scholars are of the view that debris corresponds to "space objects." For example, P. Larsen points out that both the Liability Convention and the Registration Convention provide that the definition of space objects includes their component parts and that space debris is, therefore, considered by space law experts to be "space objects."[77] B. Schmidt-Tedd and S. Mick also opine that space debris fulfills the criteria of classification as space objects because the term "space object" includes the component parts in which many common forms of space debris are included.[78]

Jakhu and Ahmad are of the view that the term "space object" does not differentiate "functional" objects from "nonfunctional" ones, and, thus, "space debris" falls within the definition of "space objects."[79] One might recall that the definition of "space debris" in the COPUOS debris mitigation guidelines provides that it is nonfunctional.[80] That tends to lead the reader to assume that while space objects are functioning, they are called "space objects," whereas, once they cease to be functional, they are called "space debris." However, the COPUOS guidelines are technical documents adopted by the Scientific and Technical Subcommittee of the COPUOS. The guidelines' definition of space debris and the status of space debris under the space treaties are not necessarily identical. Additionally, the distinction between functional objects and non-functional objects is not simple. A. Salter points out that when it becomes possible to conduct repair and manufacturing of satellites in orbit, space debris can justifiably be claimed as valuable resources.[81] Therefore, it will be increasingly difficult to distinguish between functional objects and

[77] Larsen, *supra* note 48, p. 483.
[78] Schmidt-Tedd and Mick, *supra note* 52, pp. 153-154.
[79] Jakhu and Ahmad, *supra* note 50.
[80] *supra* note 2.
[81] A. Salter, "Space Debris: A Law and Economic Analysis of the Orbital Commons," *Stanford Technical Law Review*, Vol. 19, Issue 2 (2016), pp. 233-234.

non-functional ones in the future. In a similar context, J. Chatterjee refers to Envisat, a satellite of the ESA, with which contact was lost in 2012.[82] She opines that Envisat can be recommissioned back to service as a space object and reminds that the 2006 IAA Cosmic Study on Space Traffic Management points out that no legal distinction is made between valuable active space-craft and valueless space debris.[83]

W. Wirin refers to Diederiks-Verschoor's argument that on a policy basis, liability should remain even after the object has become debris and that debris may be safely assumed to cover fragments of a space object.[84] Wirin opines that such coverage of space objects seems too broad.[85]

However, it is safe to say that it is difficult to find scholars who argue that no space debris falls within the definition of "space objects" under the Liability Convention and the Registration Convention. This article, too, considers that at least some of the debris is within the definition of space objects and focuses on the legal issues regarding such debris.[86]

(3) How to remove the launching state's jurisdiction and control over space objects

If debris is registered under the Registration Convention, jurisdiction and control over it are protected by Article VIII of the OST. According to Schmidt-Tedd and Mick, "Jurisdiction" means the legislation and enforcement of laws and rules in relation to persons and objects, and "control" means the exclusive right and the actual possibility of supervising a space object's activities and, if applicable, the personnel thereof.[87] They explain that "jurisdiction and control" must be read as one block.[88] If either a state or a private company of that state removes a registered space object against the will of the launching state, it is inevitable that the state that conducted the removal operation will be legally

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[82] J. Chatterjee, "Legal Issues Relating to Unauthorized Space Debris Remediation," *Proceedings of International Institution of Space Law,* No. 57 (2014), pp. 21-22.
[83] *Ibid.*; C. Contant-Jorgenson, P. Lala, K.-U. Schrogl (eds.), *Cosmic Study on Space Traffic Management* (2006), p. 40.
[84] W. Wirin, "Space Debris and Space Objects", *Proceedings of the Law of Outer Space,* No. 34 (1991), p. 46.
[85] *Ibid.*
[86] H. Hertzfeld points out that some space debris may not be included in the definition of a space object under the Liability Convention and the Registration Convention. He refers to the difference between the term "component parts of a space object" and the term "its launch vehicle and parts thereof," and opines that some types of space debris such as a paint chip might not be considered a "component part." Additionally, he points out that under the Registration Convention, definitions of exactly what qualifies as a space objects for purposes of registration are up to each State. See H. Hertzfeld, "Fault Liability for Third Party Damage in Space: Is Article IV (1)(b) of the Liability Convention Useful Today?," IAC-10. E7.3 (2010), pp. 6-7.
[87] Schmidt-Tedd and Mick, *supra* note 52, p. 157.
[88] *Ibid.*

responsible for the breach of jurisdiction and control under Article VIII of the OST.

Astroscale, a Japanese company that has a plan to establish an ADR business, has made clear that it will remove either debris under the jurisdiction and control of Japan upon either request or consent by the Government of Japan (and, if applicable, its owner companies) or debris under the jurisdiction and control of countries friendly with Japan upon their request or consent (and, if applicable, its owner companies).[89] In 2001, the United Nation's International Law Commission (ILC) submitted "Draft articles on Responsibility of States for International Wrongful Acts"[90] to the General Assembly. Article 20 stipulates that valid consent by a state to the commission of a given act by another state precludes the wrongfulness of that act in relation to the former state to the extent that the act remains within the limits of that consent. As ILC explains[91], this draft Article 20 reflects the basic international law principle of consent in the particular context of the general conditions necessary for State responsibility to arise, and, thus, in principle, it is not necessary to worry about potential wrongfulness as long as the removal is conducted upon either request or consent of the launching state that has the jurisdiction and control over the target debris.

(4) ADR without consent

However, there might be cases where removing debris whose state of registry is unknown becomes necessary in the future to mitigate the probability of collision in orbit. Additionally, it might even become necessary in the future to remove debris without consent of the state of registry for certain reasons, despite the state of registry being clearly identified, although such an operation is not foreseen as a realistic scenario at this juncture. Salter points out that much debris is valuable scrap material that is already in orbit, that launching States may be unwilling to either participate in or permit such efforts because they would bear costs associated with accidents during the removal, and that obtaining consent from the state of registration will probably not be easy.[92] Larsen is of the view that the owner of a defunct satellite may not wish to define it as space debris for several reasons, one of them being that the owner wishes to retain the orbital slot.[93] M. Frigoli foresees that although the prior consent of the state of registry would remove the

[89] N. Okada, CEO, Astroscale, personal communication (March 18, 2019).
[90] *Yearbook of International Law Commission*, 2001, Vol. 2, Part 2.
[91] Draft articles on Responsibility of States for Internationally Wrongful Acts, with commentaries, p. 72.
[92] Salter, *supra* note 81, pp. 233-234.
[93] Larsen, s*upra* note 48, pp. 483-484.

wrongfulness of the conduct, such a method would not be suitable to deal with the large-scale removal operation.[94]

Therefore, this article will examine whether it is possible to legalize ADR without consent of the state of registry. As aforementioned, one of the most representative companies running ADR-related business has the clear intention of obtaining the prior consent of the parties concerned, including the state of registry. That said, it is beneficial to consider the legal implications of such exceptional scenarios. Here are some examples of the academic arguments in this respect.

(a) Establishment of universal jurisdiction

Mey argues that although space debris that corresponds to space objects under the space treaties is under the jurisdiction and control of the state of registry, the right balance should be sought between the interest of the state of registry and those of other countries.[95] He suggests, by referring to the case of universal jurisdiction over pirates under the law of the Sea as a precedent, that Article VIII of the OST does not foreclose that states exercise universal jurisdiction over "rogue space objects" that have become "enemies of mankind" since they ceased functioning.[96]

This is an interesting analogy with the universal jurisdiction under the law of the sea. However, it is necessary to consider the fact that the flag of state is always unknown in the case of piracy, whereas there is much space debris whose state of registry has been identified. Additionally, in piracy, executing jurisdiction over the pirates is not generally expected to cause disputes with other countries. Yet, in the case of space debris, a country conducting an ADR without the prior consent of the state of registry of the targeted debris might lead to a severe dispute.

(b) Legalization based on the breach of obligation of the state of registry

M. Carns argues, in exploring several ways to legalize ADR without consent of the state of registry of targeted debris, that any state that creates debris that cannot be tracked is arguably in violation of the relevant provisions of the OST, which requires the launching states, *inter alia*, to continue supervising their space activities.[97] He concludes that if a state removes debris and

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[94] M. Frigoli, "Between Active Debris Removal and Space-Based Weapons: A Comprehensive Legal Approach," A. Froehlich (ed.), *Space Security and Legal Aspects of Active Debris Removal* (2019), p. 58.
[95] Mey, *supra* note 53, pp. 264-269.
[96] *Ibid.*
[97] M. Carns, "Consent Not Required: Making the Case That Consent Is Not Required under Customary International Law for Removal of Outer Space Debris Smaller than 10CM," *Air Force Law Review*, Vol. 77 (2017), pp. 220-222.

another state challenges its legality, the former can raise the defense that the challenging state is in violation of its own treaty obligations, and, thus, that that state's hands are not clean.[98]

Similarly, M. Force opines that once a space object's useful life is ended, its launching state cannot enjoy the right of free use of outer space by that object, and that occupation of an orbital slot becomes national appropriation that is prohibited by Article II of the OST when the object is no longer being used.[99] She also argues that states have a due diligence obligation to evaluate the potential risks and take action to either control the harm or minimize its risk, and a state is vulnerable to a claim of violating generally accepted international rules and standards if it fails to take steps appropriate and proportional to the degree of risk to either abrogate or ameliorate the danger and breach of the treaty under Article 60 of the Vienna Convention of Law of Treaties.[100] She concludes that removing the legal protection provided by Article VIII of the OST from space debris is possible based upon such an argument.[101]

Both arguments depend on the recognition that leaving debris in orbit *per se* constitutes a breach of legal obligation. However, as aforementioned, there is no consensus yet as to whether such legal obligation can be drawn from the relevant provisions of the space treaties and other norms of existing international law.

(c) Termination of jurisdiction and control of the launching states

G. Chung argues that the apparently absolute nature of jurisdiction and control can be circumvented under Article VIII of the OST either in the case of an expressed or implied act of abandonment or in the case in which debris poses a danger for other states and, thus, creates a state of peril. In making this interpretation, he refers to the necessity to secure a balance between the registering state's jurisdictional power and the observance of the principle of due regard.[102]

As to this interpretation, one might question whether the launching State's responsibility over the debris in question remains after the termination of the jurisdiction and control. When a country justifies its legality to remove debris based on this

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[98] *Ibid.* Carns refers to this potential solution as a means to supplement the argument based on "instant customary international law". See (e) below.

[99] M. Force, "Legal Implications of Debris Removal," *Proceedings of the International Institute of Space Law*, No. 55 (2012), pp. 734-741.

[100] *Ibid.*

[101] *Ibid.*

[102] G. Chung, "Jurisdiction and Control Aspects of Space Debris Removal," A. Froehlich (ed.), Space Security and Legal Aspects of Active Debris Removal (2019), pp. 41-45.

interpretation, the state of registry might argue that it is no longer necessary to bear any liability. In this context, it is noteworthy to recall that L. Perek pointed out that the abandonment procedure would have to retain the liability of the launching state for possible damage caused by space objects as far as it is covered by the Liability Convention.[103]

Similarly, some scholars suggest amending the space treaties to introduce schemes of abandonment of jurisdiction and control.[104]

(d) Self-help in a state of necessity

Popova and Schaus opine that self-help in a state of necessity could justify ADR without the consent of the state of registry under exceptional circumstances.[105] They state that such a concept might gain relevance in the future and play a role in establishing a legal basis for ADR if the situation regarding space debris further deteriorates.[106] They remind that the International Court of Justice (ICJ), in the Gabcikovo–Nagymaros Project Case,[107] observed that self-help in a state of necessity as a ground for precluding wrongfulness could only be accepted under strictly defined exceptional conditions. In their view, in the context of outer space, such conditions could be met if an imminent threat to the space environment exists.[108]

It is also noteworthy to recall that ILC's draft articles on the Responsibility of States for International Wrongful Acts, in Article 25, set out necessity as one of the circumstances precluding wrongfulness under rigorous conditions.[109]

However, Popova and Schaus do not argue that self-help in a state of necessity can be generally used to justify ADR without consent of the state of registry *at this juncture*, a view the author of this article shares. Should debris approach a country's functioning satellite and the probability of collision becomes very high, there would be little chance to count on ADR operations, and in many cases the only option that is technically feasible would be maneuvering them to escape collision. Even though ADR services will become widely available in the future, there will be many cases in which collision avoidance maneuvering is the most pragmatic solution. There will be only a few cases in which the

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[103] L. Perek, "Legal Aspects of Space Debris: A View from Outside the Legal Profession," *Proceedings on the Law of Outer Space*, No. 38 (1995), pp. 58-59.
[104] See, e.g., N. Pusey, "The Case for Preserving Nothing: The Need for a Global Response to the Space Debris Problem," *Colorado Journal of International Environmental Law and Policy*, No. 38 (2010), pp. 447-448.
[105] Popova and Schaus, *supra* note 57, p. 9.
[106] *Ibid.*
[107] *I.C.J. Reports 1997*, p. 7.
[108] Popova and Schaus, *supra* note 57, p. 9.
[109] *supra* note 90.

necessity plays roles vis-à-vis the justification of ADR. Kypraios and Carpanelli also cast doubt about the utility of the argument of necessity.[110]

(e) Development of "instant customary international law"

Carns opines that debris smaller than 10 cm^2 in size presents the most significant orbital threat because it is difficult to track and that such small debris should be distinguished from larger debris when considering the legal justification for ADR.[111] Additionally, he argues that as it is difficult to determine the ownership of such debris, it is justifiable to remove it without consent of the state of registry based on the development of "instant" customary international law.[112] He refers, as a precedent, to the case of the rights of coastal countries over the natural resources of the subsoil and sea bed of the continental shelf, which was articulated by U.S. President Harry Truman in 1945 and which, as he explains, resulted in the customary international law being established within a short period.[113]

Although debris smaller than 10 cm^2 does pose severe threats to the sustainability of Earth orbits, it is arguable whether removing such small debris is cost-effective with the technologies currently under development. As to the notion of instant customary international law, as Carns points out,[114] it too is not without critics.

(5) How to deal with unidentifiable/unregistered debris

This article has looked into several proposed solutions to remove the protection of jurisdiction and control provided by Article VIII of the OST. It is safe to say that it takes further time and effort to consolidate consensus in international society as to the legal solution. Before that, obtaining consent or request from the state of registry is still, and will continue to be, quite important for the sake of sustainable undertaking of ADR operations.

As discussed earlier, unidentifiable or unregistered debris does not enjoy the protection of jurisdiction and control of the state of registry. The question then is, do countries have complete freedom to remove it?

SSA's capabilities vary from one country to another, and one country can identify debris that is unidentifiable by another. Additionally, if one argues that it should be totally free to remove debris that is either unidentifiable or unregistered, some countries might raise voices against this because they might keep some of

[110] Kypraios and Carpanelli, *supra* note 56, para. 23.
[111] Carns, *supra* note 97, pp. 176-179.
[112] *Ibid.*, pp. 207-219.
[113] *Ibid.*
[114] *Ibid.*

their satellites unregistered due to national security considerations. If ADR operators want to gain international support for their business, they should attempt to remove debris that is identifiable and registered after obtaining either prior consent or request of the state of registry. It is imperative to maintain maximum transparency.

In 2008, Russia and China submitted the draft Treaty on Prevention of the Placement of Weapons in Outer Space and of the Threat or Use of Force against Outer Space Objects (PPWT) to the Conference on Disarmament (CD).[115] Article 1-9(d) in its latest version, produced in 2014, stipulates that the term "use of force" means any intended action to inflict damage to outer space object under the jurisdiction and/or control of other states.[116] If one applies this definition literally, removing debris without consent of the state of registry might face criticism that it constitutes "use of force." It is unlikely that the PPWT will be adopted soon at the CD because of strong opposition from several countries. Nevertheless, when designing the business and schemes of ADR, it is beneficial to take into account such debate in international society.

In 2008, the Council of the European Union approved a draft Code of Conduct for Outer Space Activities,[117] and major space-faring nations conducted consultations to establish an International Code of Conduct for Outer Space Activities (ICOC) starting in 2012, using the said EU version as the basis of the consultation[118]. Its paragraph 4.2. allows subscribing states to take action that brings about either damage or destruction of space objects when that is justified to reduce the creation of space debris, and so forth. However, Russia is opposed to that language.[119] The Russian

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[115] Conference on Disarmament, Letter dated 12 February 2008 from the Permanent Representative of the Russian Federation and the Permanent Representative of China to the Conference on Disarmament addressed to the Acting Secretary-General of the Conference transmitting the updated Russian and Chinese texts of the draft treaty on prevention of the placement of weapons in outer space and of the threat or use of force against outer space objects (PPWT) introduced by the Russian Federation and China.

[116] Conference on Disarmament, Letter dated 10 June 2014 from the Permanent Representative of the Russian Federation and the Permanent Representative of China to the Conference on Disarmament addressed to the Acting Secretary-General of the Conference transmitting the updated Russian and Chinese texts of the draft treaty on prevention of the placement of weapons in outer space and of the threat or use of force against outer space objects (PPWT) introduced by the Russian Federation and China.

[117] EU Council, Draft Code of Conduct for Outer Space Activities, document 17175/08, PESC 1697, CODUN 61Brussels, Dec. 17, 2008, Annex II, at http://register.consilium.europa.eu/pdf/en/08/st17/st17175.en08.pdf (last visited on Aug. 15, 2020).

[118] European External Action Service, "Draft International Code of Conduct for Outer Space Activities" (2014), at https://eeas.europa.eu/headquarters/headquarters-homepage/14715/eu-proposal-international-space-code-conduct-draft_en (last visited on Jun. 15, 2019).

[119] COPUOS, Working Paper Submitted by the Russian Federation, 29 April 2015 (A/AC.105/L.294), para. 9, at www.unoosa.org/oosa/oosadoc/data/documents/2015/aac.105l/aac.105l.294_0.html (last visited on March 23, 2019).

position seems consistent with its position reflected in the draft PPWT. Due to the discrepancy between the U.S., China, and Russia, the consultation on ICOC has reached an impasse.[120]

(6) A proposal from a different angle

While there is no universally accepted solution to justify ADR without consent, there have been proposals from different angles. For example, Alshamsi et al. basically propose the following:[121]

(a) As Article IX enables a State Party to request a consultation with another State Party if the former believes that an activity or experiment planned by the latter would cause potentially harmful interference with activities in the peaceful exploration and use of outer space, it should be possible to conduct this consultation multilaterally.

(b) At the consultation, scientists compile a list of space debris. They should simply review the status of space objects on an ad hoc basis without attempting to agree on the definition of debris. If a country wants to keep occupying an orbital slot with a disused satellite, that is allowed. The list is disseminated to all the relevant states who have the opportunity to share their views with others. The target of the OOS/ADR is decided on a consensus basis. Unclaimed objects whose launching state is indeterminate should be immediately listed as a target of ADR.

(c) No other state may approach a registered space object without consent. Even if a spacecraft is classified as space debris, the state of registry is still responsible for its removal. Any operation must maintain complete transparency.

To the author's understanding, this proposal attempts to obtain the prior consent of the state of registry of the listed debris in a more effective and prompter manner than the usual bilateral coordination. It is not yet time to discuss such a scheme deeply, and one should admit that this scheme could only work in some future time when all debris is identified and can be tracked accurately. Still, the pragmatic way of thinking behind the crafting of this proposal is of great significance.

4. How to deal with unintentional damage caused by ADR operations

It is difficult to exclude the possibility that during an ADR operation, the ADR satellite may cause damage to a nearby functioning satellite. Article VII of the OST and Articles II and III

[120] R. Jakhu, "Transparency and Confidence-Building Measures for Space Security," A. Lele (ed.), *Decoding the International Code of Conduct for Outer Space Activities* (2012), p. 39.

[121] Alshamsi et al., *supra* note 44, pp. 60-66.

of the Liability Convention set out principles regarding liability derived from damage caused by a space object. There will likely be quite a variety of modalities in which damage is caused. Popova and Schaus opine that if an entity undertakes an ADR operation and damage is caused to a third party's space object, the liability is attributed to the launching state of the removed object and not to the party conducting the operation.[122] However, it is debatable whether such an interpretation can gain broad support. Also, the consequences of the damage discussed here necessitate scrutiny based on the consideration of a wide variety of scenarios.

VII. Sustainable international framework for ADR including the methods of funding

As discussed in IV above, if the maintenance of the LCs requires ADR, the ADR operators will be able to establish a business model counting on the demand for their services.[123] On the other hand, as far as debris in general in concerned, there is no consensus about the legal obligation to remove it. In addition, the benefit of the removal of debris extends to the entire international society, which deprives everybody of the incentive to pay the cost of the removal operation. This is a typical case of market failure, as is the collection of waste on the ground.[124] It is difficult to count on market mechanisms, except for insurance products covering damage caused to satellites.

Some commentators propose that the launching states' governments impose a tax on the business entities, including launching companies and satellite operators, to collect costs associated with ADR. Nevertheless, the introduction of such a tax would be extremely challenging politically.[125] Besides, most of the satellites in LEO are owned and operated by governments, making the funding by tax even more unrealistic.[126]

This article hereinafter explores some representative opinions vis-à-vis the question of how to establish a sustainable model in which public sectors of each country procure ADR services, thus making the ADR business sustainable.

1. Proposals on "hard methods," including the establishment of an international organization or amendments of the space treaties

Some scholars propose establishing an international organization that will undertake ADR activities. Member countries

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[122] Popova and Schaus, *supra* note 57, p. 9.
[123] Foust, *supra* note 40.
[124] Salter, *supra* note 81, p. 228.
[125] *Ibid.*
[126] Secure World Foundation, *Trash in the Skies III: Prospects for Active Removal of Space Debris* (2017), p. 25.

will be obliged to contribute to it financially. For example, Jakhu et al. propose establishing an international regulatory regime and an international organization.[127] According to their proposal, state parties should be obliged to either remove or service their own dead satellites or procure the ADR/OOS services provided by the organization.[128] They are required to oblige their satellite operators to conduct end-of-life disposal, and the operators have to purchase insurance that covers the cost of removal in case of the failure of such disposal.[129] Though the international organization is to be established as an inter-governmental entity, once its operations have become well-established, it could transition into a private corporation in the same manner as did INTELSAT and INMARSAT.[130] N. Pusey also proposes establishing an international fund for ADR operations to which member countries are required to contribute.[131] V. Degrange also proposes the establishment of an international organization.[132]

On the other hand, Schladebach opines that the OST needs to be amended, so that de-orbiting defunct satellites and bearing the associated cost become the obligation of the State Parties.[133]

2. Counter-arguments against the proposals on "hard methods"

On the other hand, M. Ansdell argues that no international cooperation in space has resulted in either cost-effective or expedient solutions, especially in politically-charged areas of uncertain technological feasibility, and she proposes that one country, the U.S. in her opinion, should take a leadership role by establishing a national space debris removal program.[134] She opines that this would accelerate technology development and demonstration, which would, in turn, build-up trust and hasten international participation in space debris removal.[135] J. Dunstan also points out that whenever the international society starts talking about an international agreement, the discussion reaches deadlock, and he suggests taking domestic, unilateral actions to pave the way

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[127] R. Jakhu et al, "Regulatory Framework and Organization for Space Debris Removal and on Orbit Servicing of Satellites," *Journal of Space Safety Engineering*, Vol. 4, Issue 3-4 (2017), pp. 129-137, esp. pp. 135-136.
[128] *Ibid.*
[129] *Ibid.*
[130] *Ibid.*
[131] Pusey, *supra* note 104, pp. 448-449.
[132] V. Degrange, "Active Debris Removal: A Joint Task and Obligation to Cooperate for the Benefit of Mankind," Froehlich (ed.), *supra* note 102, pp. 12-15.
[133] Schladebach, *supra* note 14, pp. 84-85.
[134] M. Ansdell, "Active Space Debris Removal: Needs, Implications, and Recommendations for Today's Geopolitical Environment," *Journal of Public & International Affairs*, Vol. 21 (2010), pp. 17-18.
[135] *Ibid.*

first.[136] Carns also opines that the U.S. can take the lead in ADR and build a successful domestic program that includes an incentive program to encourage private companies to develop a viable U.S. ADR system.[137] Salter also argues, from an economic perspective, that the costs of changing the legal framework to secure a global response to a global commons problem are potentially quite high and echoes the aforementioned opinion of Ansdell.[138]

As Weeden points out,[139] it has been the case most often that policy did not come first and then drive actions; in most cases, policy basically codified things that were already being done. Although it is unnecessary to totally exclude the possibility of either establishing a new international organization or amending the space treaties, the space-faring nations should undertake what they can do pragmatically.

3. Potential schemes of cost-sharing

S. Hobe suggests that the principle of "common but differentiated responsibility"(CBDR) may guide the fair allocation of costs of ADR.[140] CBDR was introduced at the United Nations Conference on Environment and Development in 1992.[141] On the other hand, Schladebach opines that it is questionable whether the CBDR can represent the right legal basis for sharing the costs associated with ADR because neither space-faring nations nor non-space-faring nations will likely be ready to contribute to the costs.[142] He concludes that only the polluter-pays-principle (PPP) can have legal relevance for that issue.[143]

The most significant sources of space debris are said to be the U.S., Russia, and China.[144] If the international society attempts to apply the CBDR to cost-sharing regarding ADR, it would be likely inevitable to face serious circumstances that are similar to the situation concerning climate change. As to the rule-making in the field of outer space, the north–south confrontation has long hindered the progress of discussion. Applying the CBDR, which reflects the mindset of the north–south confrontation, would lead the international society into a serious deadlock. On the other hand, regarding the PPP, it could be introduced in domestic legislation,

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136 Secure World Foundation, *supra* note 126, p. 24.
137 Carns, *supra* note 97, p. 229.
138 Salter, *supra* note 80, pp. 234-235.
139 Secure World Foundation, *supra* note 126, p. 13.
140 S. Hobe, "Environmental Protection in Outer Space: Where We Stand and What is Needed to Make Progress with regard to the Problem of Space Debris," *Indian Journal of Law and Technology*, Vol. 8 (2012), p. 9.
141 The Rio Declaration on Environment and Development (1992), Principle 7, at http://www.unesco.org/education/pdf/RIO_E.PDF.
142 Schladebach, *supra* note 14, pp. 84-85.
143 *Ibid.*
144 See, e.g., NASA, *supra* note 15.

but it is too premature to pursue the establishment of an international fund whose guiding principle of cost-sharing is the PPP.

After looking into the international debate on the cost-sharing regarding ADR, the author believes that a step-by-step approach will be more realistic, in which space-faring nations first develop technologies of ADR, carry out experiments in outer space targeting debris that is under the jurisdiction and control of the same countries, then experiment with targeting debris of partner countries after obtaining their prior consent, and pursue the establishment of a non-binding goal in terms of the achievement of ADR in a global forum such as the United Nations. Such a global goal, if carefully designed, might be capable of inducing many countries to take proactive measures toward the goal, as is the case of the United Nations' successive goals concerning development assistance, including the Sustainable Development Goals.[145]

VIII. Importance of monitoring and verification

As ADR means either de-orbiting or re-orbiting debris physically, such technology can theoretically be used to take hostile actions against the satellites of adversaries. Thus, discussion on the aspect of this dual use has been held in international fora.[146] The aforementioned position of Russia and China regarding ADR perhaps reflects that recognition. To conduct ADR operations without triggering unnecessary criticism from other countries, the operators and their launching state will need to ensure maximum transparency regarding their intentions and specific operation plans, for example. Article XI of the OST stipulates that states parties agree to inform the Secretary-General of the United Nations, in addition to the public and the international scientific community, to the greatest extent feasible and practicable, of the nature, conduct, locations, and results of such activities. This provision is of high relevance in pursuit of the political sustainability of ADR business.

From that point of view, the importance of SSA cannot be overstated. SSA is already the critical infrastructure for avoidance of collision of space objects, and, when the ADR business begins, SSA will be vital both for its successful operation and for its transparency.

IX. Final words

There are numerous legal issues deriving from ADR, and this article has touched upon only part of them. Other issues

[145] The United Nations, "Sustainable Development Goals," at https://www.un.org/sustainabledevelopment/sustainable-development-goals/.
[146] Popova and Schaus, *supra* note 57, p. 10; Ansdell, *supra* note 134, p. 16.

include how to deal with intellectual property rights embodied in the targeted satellites[147] and how to deal with the U.S. International Traffic in Arms Regulations.[148] International rule-making regarding outer space activities has almost always been quite challenging due to the political dynamism between the U.S., Russia, and China, the discrepancies between developed and developing countries, and the discrepancies between consideration from a commercial perspective and from a defense perspective. While private enterprises are developing related technologies, the international legal community should sort out legal issues and streamline the discussion to the maximum extent possible in the preparation of creating norms for the sake of success and sustainability of the ADR business. The author hopes that this article is of some help in that collective endeavor.

[147] Weeden, *supra* note 66, p. 42.
[148] Force, *supra* note 97, p. 734; Jakhu et al., *supra* note 125, p. 131.