

Space Debris and Liability Schemes under International Law

Kimitake Nakamura¹

Introduction

1. Liability Scheme under the Space Treaties
 2. Damage Caused by Debris and Space Treaties
 3. Toward the Enhancement of Effectiveness of Space Treaties
 4. Damage Caused in the Operation of Active Debris Removal
- Final Word

Introduction

Space debris² has drawn attention from a significant number of individuals regarding the challenges of international society vis-à-vis space activities. To cope with the orbital congestion because of the growing number of debris, the international community has taken the following basic measures:

- (a) tracking and monitoring of the debris, as part of the Space Situational Awareness (SSA), and sending conjunction alerts to the satellite operators to help them decide if they should conduct a collision avoidance maneuver³;
- (b) improvement of technical specifications of the rockets and the satellites and of their operation so that they produce less debris, including post-mission disposal by such means as re-orbit and de-orbit; and
- (c) establishment of international guidelines regarding item (b) that facilitate the harmonization of the measures of space-faring nations and the further enhancement of those

* The views expressed in this article are those of the author and do not represent those of his current or former employers. This is a translation of an article published in *Waseda Law Review*, 95-3 (2020) with some modifications.

¹ Visiting Scholar, Space Policy Institute, The George Washington University; Minister, Japanese Embassy in Washington, D.C.

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 defined in “Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space”(A/62/20(2007), Annex), pp. 47-50.

³ In April 2019, the Government of Japan and the Government of the United States held the Japan–U.S. Security Consultative Committee (so-called 2+2) in Washington D.C., and they welcomed the opportunity to host U.S.-provided payloads for space situational awareness on Japan's Quasi Zenith Satellite System, planned for launch in 2023 (<https://www.mofa.go.jp/mofaj/files/000470738.pdf>) (last visited on Mar. 23, 2020).

measures⁴.

Additionally, research and development (R&D) by entrepreneurs on active debris removal (ADR) is underway. In September 2018, Surrey Satellite Technology's small satellite successfully captured a decoy of debris by using its net⁵. Japanese company Astroscale plans to launch an ADR satellite for demonstration purposes in 2020⁶. Japan Aerospace Exploration Agency initiated a project to develop technologies for debris removal in 2018, and the project is underway and engaging the private sector⁷.

The space-faring nations are taking the said measures based on the legal framework established by, inter alia, the Space Treaties,⁸ including the Outer Space Treaty (OST) and the Liability Convention. However, because the space treaties were drafted before the space-faring nations began having severe concerns over the debris, none of the said treaties has an explicit reference to the debris.

Exploring the function of the liability regime under the current international law vis-à-vis space debris is beneficial to advance the understanding of how that regime helps manage the damages caused by the debris. Such studies are also vital for elucidating the effect of the regime on the debris mitigation, because that will likely induce satellite operators and their launching States to make additional debris mitigation efforts. Additionally, the ADR operators must better understand what would occur should an ADR operation cause damage to a satellite that is not the target of the operation.

This article attempts to elucidate how the current legal scheme works regarding the said aspects and possible improvements.

⁴ Kimitake Nakamura, "Legal Issues Stemming from the Active Debris Removal", Waseda University (ed.) *Chiiki Kenkyu to shite no asia gaku* (DTP Publishing, 2020), pp. 109-113.

⁵ Surrey, "RemoveDEBRIS space junk net capture success!," at <https://www.sstl.co.uk/media-hub/latest-news/2018/removedebris-space-junk-net-capture-success> (last visited on Sept. 10, 2019).

⁶ Astroscale, "Missions", at <https://astroscale.com/missions/elsa-d/> (last visited on Sept. 10, 2019).

⁷ Ministry of Education and Science of Japan, "Reiwa 2 nendo Monbukagakusho Uchuukankeigaisanyoukyuu nitsuite", pp.1-2, at http://www.mext.go.jp/kaigisiryō/2019/09/_icsFiles/afieldfile/2019/09/25/1421471_2.pdf (last visited on Oct. 20, 2019).

⁸ 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].

1. Liability Regime under Space Treaties

Under international customary law, when a State's act constitutes a breach of an obligation of that State under international law, such an act entails the state responsibility, and that State is obliged to make reparation.⁹

Conduct of a person or entity that is not an organ of the State entails the state responsibility only when that State did not pay due diligence despite the State being under an obligation to pay such due diligence to prevent damage to another State's legal interest. The exception is that the conduct of a person or entity in question is attributable to the State under international law.¹⁰

The OST and the Liability Convention, however, establish unique norms that reflect characteristics of the space activities.

(1) Concentration of Responsibilities on States

The first sentence of Article VI of the OST sets out that State Parties shall bear international responsibility for national activities in outer space whether such activities are conducted by government agencies or by non-governmental entities, and for assuring that national activities are conducted in conformity with the provisions of the Treaty. Article VII of the OST sets out that each State Party that launches or procures the launching of an object into outer space and each State Party from whose territory or facility an object is launched is internationally liable for damage to another State Party or to its natural or juridical persons by such object or its component parts on Earth, in air space or in outer space.

Despite the aforementioned customary international law, under the OST, when activities of a non-government entity cause damage to another State Party, it is always the State Party of the said non-government entity that is directly liable to such another State Party; that does not mean that the OST obliges its State Parties to streamline indirectly its non-governmental entities' behavior by imposing those State Parties to abide by 'due diligence' obligation.

The first sentence of Article VI of the OST obliges its State Parties to assure that national activities are conducted in conformity with the provisions in the Treaty. The second sentence of the same Article establishes that the activities of non-governmental entities in

⁹ Ichiro Komatsu, "Jissen Kokusaihou, 2nd ed.", Sinzanshya (2015), p. 333.

¹⁰ Soji Yamamoto, "Kokusaihou ni okeru kikensekininshugi" University of Tokyo, 1982, p. 233.

outer space shall require authorization and continuing supervision by the appropriate State Party. These obligations differ from the said “due diligence” obligation,¹¹ and one should interpret that those obligations were introduced to ensure the principle of concentration of the responsibility on States (first sentence of Art. VI) institutionally.

As to the background of those provisions, the URSS argued during the negotiation of the OST that only States should conduct space activities, and the Western countries counterargued that private entities should also be allowed to conduct space activities. As a compromise, the negotiating countries agreed on allowing private entities’ space activities while requiring State Parties to authorize and continue to supervise them and to bear international responsibility for their activities.¹²

Thus, what is the significance of this unique regime in the history of the development of international liability law?

Space activities, in general, are not prohibited by international law. However, the consequences of an accident by the space activities might be ultra-hazardous. Thus, the OST and the Liability Convention introduced the principle of liability based on risk, and the OST obliges its State Parties to assure that private entities act in conformity with the OST by imposing all the international responsibilities on the State Parties¹³. As Professor Banzai pointed out, under such a regime, the state responsibility related to the conduct of private entities is based on the personal linkage between the State and the private entities. In this sense, the basis of state responsibility under Space Treaties differs from that of the traditional liability schemes in which the basis of state responsibility resides in the exclusiveness of state jurisdiction within the territory of a State.¹⁴

(2) Absolute Liability for Damages on the Surface of the Earth, and so Forth.

Article II of the Liability Convention, a supplementary set of rules of the OST,¹⁵ stipulates that 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 in flight.

¹¹ Fumio Ikeda, “Uchuhouron”, Seibundo, 1971, pp. 198-199.

¹² *Ibid.*, pp. 195-196, 198.

¹³ Yamamoto, *supra* note 10, pp. 235-236; Soji Yamamoto, “Uchukaihatsu”, *Miraishakai to hou 4*” Chikumashobou, 1976, pp. 73-78.

¹⁴ Hiroyuki Banzai, “Kokusai ihoukouei sekinin no kenkyu”, Seibundo(2015), pp. 75-80, 86-90.

¹⁵ L. J. Smith and A. Kerrest, “Article II (Absolute Liability)”, S. Hobe et al. (eds.), *Cologne Commentary on Space Law* Vol. 2 (Carl Heymanns Verlag, 2009), p. 119.

The damage caused by a space object on the surface of the earth¹⁶ might be severe, and its consequences might result in a geographically broad impact. Additionally, the victims, in normal circumstances, can neither control facilities and equipment related to the project by which the damage was caused nor are familiar with the technologies involved in the project. Thus, it is challenging for the victims to prove the fault of the assailant.¹⁷ The Convention adopted the principle of absolute liability as an exceptional measure as opposed to the fault-based liability, which is widely adopted in the tort law of many countries, because of the unique character of space activities.¹⁸

Exoneration from absolute liability shall be granted to the extent that a launching State establishes that the damage has resulted either wholly or partially from gross negligence or from an act or omission performed with the intent to cause damage on the part of a claimant State or of the natural or juridical persons it represents (para. 1, Art. VI). No exoneration whatever shall be granted in cases where the damage has resulted from activities conducted by a launching State that are do not conform with international law (para. 2, Art. VI). The limitation of exoneration is also the consequence of the adoption of the principle of liability based on risk.

The Liability Convention, in its Art. II, stipulates “compensation” as a means of reparation. The term “compensation” in the Convention means, in principle, compensation by financial means, because Art. XIII establishes, “[u]nless the claimant State and the State from which compensation is due under this Convention agree on another form of compensation, the compensation shall be paid in the currency of the claimant State ...”¹⁹

(3) Fault-based Liability for Damage Caused Elsewhere than on the Surface of the Earth

Article III of the Liability Convention sets forth the principle of fault-based liability. Concerning the reason that Article III adopted the fault-based liability principle as opposed to the absolute liability principle under Article II, many scholars have mentioned that in outer space, all the actors conduct activities by equally taking risks, and it is sufficiently fair to equalize their burden to assume such risks, and that the Convention introduced the traditional

¹⁶ Hereinafter, the term “the surface of the earth” includes aircraft in flight.

¹⁷ Yamamoto, *supra* note 10, pp. 11-12.

¹⁸ *Ibid.*, p. 64.

¹⁹ The author of this article considers that Art. XIII does not necessarily prohibit other means of reparation including “satisfaction” as long as the relevant parties so agree.

fault-based liability scheme, which is widely adopted in the tort law of many countries.²⁰ During the negotiation of the draft Liability Convention, the Japanese delegation argued that the principle of absolute liability should apply to any damage sustained by a third party, irrespective of the location where the damage was caused, and it argued that the fault-based liability principle should apply to the damage sustained by space objects that collided with each other.²¹ This argument was in line with the thought that it is unnecessary to pay particular consideration to the damage caused between two space objects as opposed to the sudden damage caused by a falling object from the sky. Professor M. Nakamura is of the view that the said Japanese proposal gained support from many delegations, and it became the basis of the current Article III.²²

The OST, by stipulating the principle of the freedom of exploration and use of outer space, the prohibition of the claim of sovereignty, and so forth, described its basic stance: Any country has freedom, in principle, to conduct outer space activities, and those activities can be performed without a permit. Thus, the basic principle of liability, adopted in outer space where freedom prevails, should be fault-based liability. Professor S. Yamamoto pointed out that the absolute liability introduced by Article II of the Liability Convention is an exceptional scheme that considered the space activities' ultra-hazardous character.²³

2. Damage Caused by Debris and Space Treaties

How does the liability scheme of Space Treaties work vis-à-vis damage caused by space debris? This section presents specific issues drawn from the relevant provisions of the Liability Convention and others.

(1) Debris and Space Objects

As aforementioned, space treaties do not explicitly reference space debris. Articles II and III of the Liability Convention refer to damage caused by a space object. Thus, one should first examine whether debris falls within the definition of a space object. Several

²⁰ As an example, see Megumi Nakamura, "Chapter 7, Uchuhou no taikai", Kokusaihougakkai (ed.) "Nihon to Kokusaihou no 100 nen 2 riku, sora, uchu", Sanseido, 2001, p. 202.

²¹ Summary Record of the Ninety-Fourth Meeting held on Monday, June 10, 1968, at 10.50 a.m. (A/AC.105/C.2/SR.94), pp. 50-51, at http://www.unoosa.org/pdf/transcripts/legal/AC105_C2_SR090-101E.pdf (last visited on Sept. 10, 2019).

²² Nakamura, *supra* note 20, p. 208.

²³ Yamamoto, *supra* note 10, p. 64.

scholars are of, or at least favorable to, the view that under the Space Treaties, debris is within the definition of space object because the Liability Convention and the Registration Convention stipulate, respectively, that space object includes the component parts of a space object and its launch vehicle and parts thereof.²⁴

However, space debris has many forms—from a satellite that apparently remains in operation to small fragments created by explosion or collision. Professor Jasentuliyana posits that what constitutes the component parts is not defined and that whether fragmentation debris and micro-particulate matter are component parts remains undecided.²⁵ Professor Wirin states that if liability remains even after the object has become debris, the coverage of space objects seems too broad.²⁶ Dr. Kerr opines that the question of whether the pieces of a space object, when fragmented because of collision, remain part of the original “space object” has not been addressed.²⁷

By contrast, the Author has not found any legal opinion that there is no space debris at all that falls within the definition of the space object. Additionally, when examining States’ practice, one can find much debris on the list of the space objects maintained by the United Nations under the Registration Convention.²⁸ Many articles have scrutinized the applicability of Article VII of the OST and the Liability Convention based on the recognition that debris—at least some of them if not all—falls within the definition of a space object.²⁹ This article, too, considers that at least some of the debris is within the definition of space object, but it discusses only identifiable debris to which the Space Treaties can be applicable ((2) below).

If one takes that interpretation, how to manage damage caused by debris is nothing but how to manage damage caused by a space object. Yet, in the case of damage caused by debris,

²⁴ Paul Larsen, “Solving the Space Debris Crisis”, *Journal of Air Law and Commerce*, Vol. 83, Issue 3(2018), p. 483.; Delbert D Smith, “The Technical, Legal, and Business Risks of Orbital Debris”, *N.Y.U. Environmental Law Journal* (1997), p. 55; Bernhard Schmidt-Tedd and S. Mick, “Article VIII”, Stephan Hobe, Bernhard Schmidt-Tedd and Kai-Uwe Schrogl (eds.), *Cologne Commentary on Space Law*, Vol. 1 “Outer Space Treaty” (Carl Heymanns verlag, 2009), pp. 153-154.

²⁵ Nandasiri Jasentuliyana, “Space Debris and International Law”, *Journal of Space Law*, Vol. 26, No. 2(1998), p.142.

²⁶ William B. Wirin, “Space Debris and Space Objects”, *Proceedings on the Law of Outer Space*, No. 34 (1991), p. 46.

²⁷ Scott Kerr, “Liability for space debris collisions and the Kessler Syndrome (part 1)”, *The Space Review* (2017), p.3.

²⁸ For example, “Envisat”, a dead satellite that was operated by European Space Agency (ESA), is still on the UN list (http://www.unoosa.org/oosa/osoindex/search-ng.jsp?lf_id=) (last visited on Sept. 10, 2019).

²⁹ Larsen, *supra* note 24, p. 483; Smith, *supra* note 24, p. 55, pp. 57-58.

there are additional issues to consider. Therefore, this article carefully examines the relevant rules of the space treaties regarding damage caused by space objects and then examines issues unique to the case of debris.

(2) Identification of the Launching State of Debris

If a space object (including debris) causes damage to another space object, or if a space object reaches the surface of the earth, surviving the re-entry, and causes damage, a claim for compensation can be filed against the launching State of the space object that caused the damage, according to Articles II or III and VIII of the Liability Convention.

There have been cases in which the launching States were identified, including the fragments of the URSS's satellite Cosmos 954, which fell in Canada's territory in 1978, and the collision between Iridium 33 and Cosmos 2251 in 2009, which is believed to be the first in-orbit collision case between satellites.³⁰

Where damage occurs on the surface of the earth, the fallen space object is unlikely to be a small fragment; thus, it is likely that the U.S. Space Surveillance Network has tracked it while it was in orbit. In the case of Cosmos 954, too, there was communication between the governments of the URSS and Canada before the fall, and there was no question that the falling object was of the URSS.³¹ After the fall, the Canadian government surveyed the damage to its territory and claimed compensation of approximately CAD 6 million against the URSS in 1979 under Article II of the Liability Convention, and so forth.³² This case was the very first of a claim filed under the Convention. As a result of the bilateral consultation, they reached an agreement in November 1980 that the URSS 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.³³ Several scholars are of the view that the URSS's payment was not compensation for damage but a voluntary payment.³⁴

However, it is inappropriate to argue that the Liability Convention was not effective.

³⁰ Setsuko Aoki, "Uchu no tansa, riyou wo meguru "kokusaisekinin" no kadai – Cosmos 2251 to Iridium 33 no shoutotsujiko wodaizai to shite", *The Journal of international law and diplomacy* (110-2)(2011), p.26.

³¹ Setsuko Aoki, "Nippon no uchu senryaku", Keio University (2006), pp. 211-215.

³² Department of External Affairs of Canada, "Canada: Claim against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954", No. FLA-268, Annex A, paras. 14-24, at www.emp.ca/links/intlaw7/cases/soviet.doc (last visited on Sept. 10, 2019).

³³ Protocol between the Government of Canada and the Government of the Union of Soviet Socialist Republics, at http://www.unoosa.org/oosa/en/ourwork/spacelaw/nationalspacelaw/bi-multi-lateral-agreements/can_ussr_001.html (last visited on Sept. 10, 2019).

³⁴ Aoki, *supra* note 31, p. 214.

When a country pursues state responsibility of another country, it is often unrealistic to pursue a full and binding reparation under the dispute settlement procedure of the relevant treaties, and the claiming country often attempts to obtain a diplomatic solution to secure the maximum outcome possible, bearing in mind the reality.³⁵ The said claim by Canada used the Convention and other international law as the legal foundation for the claim, and the Convention was undoubtedly used as a vital tool in the said consultation between the two countries. Thus, this case became a notable precedent regarding the application of the Convention.³⁶

In the case of collisions in orbit, even small debris can cause a severe impact on a satellite in operation.³⁷³⁸ To identify the debris accurately, support is necessary from one or more SSA providers,³⁹ but there is no guarantee of such support if the launching State of the debris in question and the country of the SSA provider are the same. Although the victim State can obtain support from multiple SSA providers, their views might differ, especially when the debris is very small, or its orbit takes a shape that does not allow the sensors to maintain constant tracking. In these cases, the identification of the causing debris and its launching State will likely be challenging. This constraint is more significant in the case of a collision that involves debris than in a case of collision between functioning satellites.

Based on the aforementioned points, the Author concludes that in the context of the application of the Liability Convention, one should discuss debris that is identifiable under the current technology only.

(3) Coverage of claims

As to the “damage” to which the Convention applies, its Article I (a) defines “loss of life, personal injury or other impairment of health; or loss of or damage to property of States or persons, natural or juridical, or property of international intergovernmental organisations.” The launching State is liable under the Convention when the damage was caused by a space object of that launching State (Articles II and III), and the damage was caused “on the surface of the earth or to aircraft in flight” (Article II) or “to persons or

³⁵ Komatsu, *supra* note 9, pp. 345-347.

³⁶ Smith and Kerrest, *supra* note 15, pp. 127-128.

³⁷ European Space Agency, “*Space Debris: The ESA Approach*” (2017), p. 1, at <http://esamultimedia.esa.int/multimedia/publications/BR-336/> (last visited on Sept. 10, 2019).

³⁸ Brian Weeden, “Overview of the legal and policy challenges of orbital debris removal”, *Space Policy* 27 (2011), p. 41.

³⁹ *Ibid.*

property on board such a space object” (Article III). The following is an analytical explanation concerning the aforementioned elements:

(a) “Damage”

Article I (a) clearly covers physical damage, but the gray zone has long been subjected to debate during the negotiation of the Convention and subsequently.

- (i) First, as to whether or not “loss of life, personal injury or other impairment of health” includes injury of mental health, Professor Gorove refers to the language of the Constitution of the World Health Organization⁴⁰, which describes health as “a state of complete physical, mental and social well-being.” He concludes that the definition under the Convention may mean not only physical injury but also injury affecting mental and social well-being. ⁴¹ Professor Heard generally echoes that view.⁴² In the language, “loss of life, personal injury or other impairment of health,” “personal injury” is a grammatic example of “impairment of health.” The term “health” mentioned in the said Constitution, which is concluded by as many as 194 countries and areas,⁴³ includes “mental and social well-being.” Thus, as is written in Article 31 of the Vienna Convention on the Law of Treaties⁴⁴ “the ordinary meaning to be given to the terms of the treaty in their context and in the light of its object and purpose,” the definition of “damage” in the Convention can be interpreted to include injury affecting mental.
- (ii) Second, there is a question of whether the “damage” includes nuclear radiation on the surface of the earth caused by a fallen satellite with nuclear power sources. That concern was one of the significant negotiating items of the Convention. The URSS and its allies argued that the radiation damage should be addressed by other international agreements related to the nuclear damages. By contrast, other countries argued that the radiation damage should be explicitly mentioned in the Convention to ensure the reparation of victims.⁴⁵ At last, the URSS delegation made a statement

⁴⁰ Constitution of the World Health Organization, at <https://www.mofa.go.jp/mofaj/files/000026609.pdf>.

⁴¹ Stephen Gorove, “Cosmos 954: Issues of Law and Policy”, *Journal of Space Law*, Vol. 6, no. 2 (1978), p. 140.

⁴² Kevin Heard, “Space Debris and Liability: An Overview”, *Cumberland Law Review*, Vol. 17, no. 1 (1986), p. 181.

⁴³ World Health Organization, “Countries”, at <https://www.who.int/countries/en/> (last visited on Sept. 22, 2019).

⁴⁴ Vienna Convention on the Law of Treaties, May 23, 1969, 1155 UNTS 331 [VCLT].

⁴⁵ Yamamoto, *supra* note 13, pp. 81-82.

that it was prepared to agree to the extension of the convention to cover nuclear damage, and the agreement was reached finally.⁴⁶ Although that common understanding is unclear in the Convention's language, in 1992, the U.N. General Assembly adopted a resolution titled "Principles Relevant to the Use of Nuclear Power Sources in Outer Space," which stipulated that Article VII of the OST and the relevant provisions of the Convention fully apply to the case of a space object carrying a nuclear power source onboard (Principle 9).⁴⁷ That can be understood as the "subsequent agreement" referred to in Article 31 - 3(a) of the VCLT.⁴⁸ As to the radiation damage on the earth's surface, in addition to the damage caused by a nuclear power source carried onboard the satellite, there can be damages to nuclear power generation facilities on the earth's surface, too. In the view of the Author, it is unreasonable to exclude the latter from the coverage of "damage" of the Convention, either.

This issue was widely discussed after the case of the Cosmos 954. Canada claimed compensation for damage against the URSS, arguing that the radiation damage caused by the fragments of the Cosmos on the surface of the Canadian territory was "damage to the property" referred to in Article I of the Convention.⁴⁹ However, it remains unknown what the URSS counterargued and if both countries reached a common understanding on the issue.

- (iii) As to the environmental contamination on the earth's surface caused by a fallen space object other than radiation damage, no case can be used as precedent. Dr. Kerr points out that the language of Article I (a) of the Convention is a purposefully broad definition, because the type of damage flowing from space activities can lead to unpredictable effects, including environmental damage.⁵⁰ Environmental contamination other than nuclear radiation, too, has a significant impact on human society, and it should be covered by the term "damage."
- (iv) By contrast, as to the deterioration of the orbit congestion by debris, many scholars,

⁴⁶ As to the URSS delegation's remark, UN Doc. A/AC.105/C.2/SR.116-131, p.82, at http://www.unoosa.org/pdf/transcripts/legal/AC105_C2_SR116-131E.pdf (last visited, on Oct. 12, 2019). See, Yamamoto, *supra* note 13, p. 82; Kyoko Hamakawa, "Uchubuttai ni yori syoujita songai nikansuru kokusaisekinin", *Reference*, National Diet Library, 2008, p. 81.

⁴⁷ U.N. Doc. A/RES/47/68 (Feb. 23, 1993).

⁴⁸ Elena Carpanelli and Brendan Cohen, "Interpreting Damage Caused by Space Objects under the 1972 Liability Convention", *Proceedings of the International Institute of Space Law*, 56 (2013), p.34.

⁴⁹ Department of External Affairs of Canada, *supra* note 32, para 15.

⁵⁰ Kerr, *supra* note 27, p. 2.

including Professor Jasentuliyana,⁵¹ Professor von der Dunk,⁵² Dr. Kypraios et al.,⁵³ Professor Malanczuk,⁵⁴ Chairman Smith et al.⁵⁵ point out that it is difficult to interpret that such deterioration corresponds to the “damage” under the Convention. The preamble of the Liability Convention sets out “[r]ecognizing the need to elaborate effective international rules and procedures concerning liability for damage caused by space objects and to ensure, in particular, the prompt payment under the terms of this Convention of a full and equitable measure of compensation to victims of such damage.” Unlike the damage caused by debris to a satellite in operation, it is difficult to consider that the deterioration of the orbital congestion means “damage” because such a vague situation, although severe, does not create specific victims who need reparation. Another possibility is an agreement, an interpretation, or a customary international law that such deterioration of the orbital congestion by debris corresponds to the damage under the Convention establishes. That possibility would constitute either “subsequent agreement,” “subsequent practice in the application of the treaty which establishes the agreement of the parties regarding its interpretation,” or “any relevant rules of international law applicable in the relations between the parties” of Article 31 of the VCLT. However, at this juncture, it is difficult to interpret that the said deterioration corresponds to the damage mentioned in the Convention.

(b) Meaning of “caused by space object”

How space objects, including space debris, cause damage on the earth’s surface or to a satellite varies. Thus, there is a question of whether the term of damage under the Convention includes “consequential damage”⁵⁶ and “delayed damage.”⁵⁷

During the negotiation of the Convention, the Hungarian delegation argued to exclude these concepts from its coverage. By contrast, the Japanese delegation, in its Working

⁵¹ Jasentuliyana, *supra* note 25, p. 143.

⁵² Frans von der Dunk, “1972 Liability Convention, The”, *Proceedings on the Law of Outer Space* (1998), p. 369.

⁵³ Christos Kypraios and Elena Carpanelli, “Space Debris”, *Oxford Public International Law* (2018), para 14.

⁵⁴ Peter Malanczuk, “Review of the Regulatory Regime Governing the Space Environment – The Problem of Space Debris”, *Zeitschrift für Luft - und Weltraumrecht (Sonderdruck)*, Vol. 45(1) (1996), p. 53.

⁵⁵ Smith and Kerrest, *supra* note 15, p.111.

⁵⁶ Black’s Law Dictionary, Eighth Edition (Thomson West, 1999), at p. 416, defines “Losses that do not flow directly and immediately from an injurious act but that result indirectly from the act”.

⁵⁷ There is no clear definition of “delayed damage”, and in this article, it is defined as “damage which emerges significant amount of time after the accident.”

Paper submitted to the Legal Subcommittee of COPUOS in 1969,⁵⁸ pointed out that “[t]he Japanese delegation believes that all damages which have an adequate relationship of cause and effect with the space activities should be covered in this convention. To avoid endless discussion on whether to include those terms of ‘indirect damage’ or ‘delayed damage’ in the definition of damage, we should discuss the problem of these two terms not in the context of the definition of damage but in the context of the manner in which the damage occurred, by introducing the notion of adequate relationship of cause and effect or so-called ‘the existence of proximity’ in the Anglo-American laws.”⁵⁹ Article I (a) did not include languages on the indirect damage/consequential damage and delayed damage; thus, after the Convention was enforced, the debate on this issue was done over the interpretation of “caused by” (Articles II and III). In particular, after the Cosmos 954 case, many scholars discussed this issue. Some scholars propose requiring a stricter relationship between cause and effect.

On the one hand, Professor Kellman states that the recovery may be for only direct damage; indirect damage is not recoverable, and that if debris falls on an electrical facility, the damage to the facility may be the basis of recovery, but whatever damage follows from the loss of electricity is for the victim State to absorb.⁶⁰ Professor Gorove states that there must be proximate causation between the damage and the activity from which the damage resulted, that is, the word “by” could also imply that the damage must be caused directly by the space object in the sense of physical damage or impact, and that consequential damage,

⁵⁸ Japan: Working Paper, UN Doc. A/AC.105/C.2/L.61 and Corr. 1, reprinted in Report of the Legal Subcommittee on the Work of its Eighth Session to the Committee on Peaceful Uses of Outer Space, U.N. Doc. A/AC.105/58, annex II, p. 31 (1969). See Nakamura, *supra* note 20, p. 202. The Japanese delegation tabled the proposal to secure all damages which have adequate relationship of cause and effect with the space activities to be subjected to the compensation. Because of this position, the delegation proposed to stipulate “damage arising out of or resulting from” in Article II instead of the current language (“damage caused by its space object”).

⁵⁹ Adjunct Professor Burke points out that the Japanese solution ignores the problem of the narrow definition of recoverable damages in Article I (Joseph Burke, “Convention on International Liability for Damage Caused by Space Objects: Definition and Determination of Damages After the Cosmos 954 Incident”, *Fordham International Law Journal* Vol. 8, Issue 2 (1984), p. 281). Additionally, Professor Sekiguchi points out that the Japanese delegation proposed to adopt the principle of proximate causation in the context of absolute liability but that the said principle should be applied only in the context of fault-based liability (Masao Sekiguchi, “Uchubuttai niyori hikiokosareru songai nitsuiteno kousaiteki sekinin ni kansuru jouyaku”, *Hougakuronshu*, 23-3 (1981), Komazawa University, p. 56). The proposals by the Japanese delegation should be interpreted an attempt to widen the coverage of damage without mentioning the definition of damage while there was no consensus on the said definition.

⁶⁰ Barry Kellman, “Space: The Fouled Frontier: Adjudicating Space Debris as an International Environmental Nuisance”, *Journal of Space Law*, Vol. 39 (2014), p. 256.

under normal circumstances, would not be covered by the Convention.⁶¹ Professor Smith et al. state that concerning both Articles II and III of the Convention, the damage caused after an interval must be within the rules of proximity.⁶²

On the other hand, Professor Foster points out that the word “caused” should be interpreted as merely directing attention to the need for some causal connection between the accident and the damage while leaving a broad discretion so that each claim can be determined on its merits and in the context of justice and equity because it is difficult, if not impossible, to foresee all the circumstances that may result in damage.⁶³ Professor Heard⁶⁴ and Professor Christol⁶⁵ supported this view.

Paragraph 1 of Article X of the Convention provides that a claim for compensation for damage may be presented not later than one year following the date of the occurrence of the damage or the identification of the launching State that is liable. Paragraph 3 of the same Article provides that in the case where the full extent of the damage may be unknown, the claimant State shall be entitled to revise the claim and submit additional documentation after the expiration of such time-limits until one year after the full extent of the damage is known. The Convention does cover damages caused after an interval, whether or not it is defined as “consequential damage” or “delayed damage.”⁶⁶

Article XII of the Convention stipulates that the compensation shall be determined in accordance with international law and the principles of justice and equity to provide such reparation based on the damage such that the person, natural or juridical, is restored. Professor Foster reminded the literature that in the course of the negotiation, the majority opinion appeared to be that no mention should be made of indirect damage in the Convention and that the question should remain open and managed as individual cases arose.⁶⁷ Management of the damage on a case-by-case basis is inevitable, and taking “a full and equitable measures of compensation to victims” is crucial (preamble of the Convention).⁶⁸

⁶¹ Gorove, *supra* note 41, p.141.

⁶² Smith and Kerrest, *supra* note 15, pp.126-127.

⁶³ W. F. Foster, “The Convention on International Liability for Damage Caused by Space Objects”, *Canadian Yearbook of International Law*, Vol. 10 (1973), p. 158.

⁶⁴ Heard, *supra* note 42, p. 178-179.

⁶⁵ Carl Q. Christol, “International Liability for Damage Caused by Space Objects”, *American Journal of International Law*, Vol. 74 (1980), p. 362.

⁶⁶ Smith and Kerrest, *supra* note 15, p.127.

⁶⁷ Foster, *supra* note 63, pp. 157-158.

⁶⁸ See “Responsibility of States for Internationally Wrongful Acts”, *Yearbook of International Law Commission*, 2001, Vol. 2 Part 2. Its Article 31 states as follows:

1. The responsible State is obligated to make full reparation for the injury caused by the internationally

Regarding the damage caused on the earth's surface, it is inappropriate to require the proximate causation between the falling of a space object and damage and to require the foreseeability generally required in the Common Law.⁶⁹ Despite requiring factual causation, the amount of compensation will be determined in accordance with international law and the principles of justice and equity (Article XII). Thus, worrying about a possible infinity chain of compensation is unnecessary.⁷⁰

(c) Meaning of “persons or property on board such a space object”

Somewhat debatable is that if this language covers damage to astronauts who are temporarily outside the spacecraft such as International Space Station. Professor Smith et al. point out that astronauts on spacewalks will fall within the provisions of Article III because they are effectively dependent on their space objects and only external to the space object on a transient basis.⁷¹ Persons onboard should be understood to remain on board even though they are outside the spacecraft temporarily. Under paragraph 1 of Article 31 of the VCLT, the said interpretation is reasonable.

(d) Damage to debris

How does the international law, including the Convention work when the object of damage is not a functioning space object but debris?

During the drafting process of the Convention, the damage was conceived to relate only to operational space objects.⁷² Debris is not functional by definition. Moreover, they are troublemakers, which deteriorate the orbital environment. Thus, if one argues that the destruction of debris constitutes a breach of legal interest of its launching State under the Convention, that might be considered illogical.⁷³ However, Assistant Professor Salter points out that the presence of valuable material already in space can justifiably be claimed as a valuable resource for repairs to current spacecraft and eventual manufacturing in space.⁷⁴

wrongful act.

2. Injury includes any damage, whether material or moral, caused by the internationally wrongful act of a State.

⁶⁹ Sekiguchi, *supra* note 59, pp. 54-56.

⁷⁰ *Ibid.*, p. 55.

⁷¹ Smith and Kerrest, *supra* note 15, pp. 133-134.

⁷² Aoki, *supra* note 30, p. 39; Martha Mejia-Kaiser, “Collision Course: 2008 Iridium-Cosmos Crash”, *Proceedings of the International Institute of Space Law*, 52 (2009), p. 276.

⁷³ Aoki, *supra* note 30, pp. 39-40.

⁷⁴ Alexander Salter, “Space Debris: A Law and Economic Analysis of the Orbital Commons”, *Stanford*

Ms. Chatterjee, taking ESA's Envisat as an example, points out that although it is drifting uncontrolled and is not maneuverable, if technological development allows re-establishing communications with it, then Envisat can be recommissioned back to service as a "space object." As she mentions, the 2006 IAA Cosmic Study on Space Traffic Management states "no legal distinction is made between valuable active spacecraft and valueless space debris."⁷⁵

If debris becomes valuable material, it is difficult to exclude the possibility that there will be claims of compensation for damage to debris under the Convention. One should pay attention to whether the operator of the debris places it as an 'asset' on its balance sheet.

(4) Issues from fault-based liability

Article III of the Convention adopts the fault-based liability scheme to the damage elsewhere than on the earth's surface. That challenges the reparation of the victims, particularly in the case of collision with debris.

The Convention neither defined "fault" nor stipulated guidelines for standards of care, and so forth. Because no claim has been made pursuant to the Convention against damage in outer space, there is no precedent by which one can foresee how the fault-based liability scheme of the Convention works. In academia, scholars have attempted to explore the function of the fault-based scheme using an analogy with the principal legal systems.

For example, Mr. Dunstan considers that the fault standard under the Convention corresponds to the negligence standard under the common law system, and refers to the Restatement (Second) of Torts, which defines negligence as "conduct that falls below the standard established by law for the protection of others against unreasonable risk of harm." Subsequently, he states that in a successful negligence suit, the plaintiff must show that each of the following five elements is present:⁷⁶

- (i) a duty of care is owed by the defendant to the plaintiff;
- (ii) a breach of that duty has occurred;
- (iii) an actual causal connection between the defendant's conduct and the resulting harm;

Technology Law Review, Vol. 19, Issue 2 (Winter 2016), p. 233-234.

⁷⁵ Joyeeta Chatterjee, "Legal Issues Relating to Unauthorized Space Debris Remediation", *Proceedings of the International Institute of Space Law*, Vol. 57 (2014), p. 21; Corinne Contant-Jorgenson, Petr Lala, Kai-Uwe Schrogl (ed.), "Cosmic Study on Space Traffic Management", *Paris: International Academy of Astronautics* (2006), p. 40.

⁷⁶ James E. Dunstan, "Space Trash: Lessons Learned (and Ignored) from Space Law and Government", *Journal of Space Law*, Vol. 39 (2013), p. 54-55.

- (iv) proximate cause, which relates to whether the harm was foreseeable; and
- (v) damages resulting from the defendant's conduct.

He points out that there is no duty of care for orbital debris, making it difficult, if not impossible, to prove that a satellite loss was caused by collision and the source of the colliding debris.⁷⁷ Professor Kozuka et al., too, state that the “fault” in many Civil Law jurisdictions is close to the “negligence” in common law jurisdictions, and that the foreseeability of the outcome is necessary as the basis of the duty of care, but that in the case of space debris, it is usually not possible for the launching state or the owner of the space object generating the debris to foresee that the debris will damage another object; therefore, the liability can be affirmed only in a limited case where an action can be taken after the threat of collision with a concrete object arises but such an action was not taken after all.⁷⁸

By contrast, Professor Aoki analyzes whether one of the parties of the collision between Cosmos 2251 and Iridium 33 can be found liable in the following manner.⁷⁹ Per Iridium 33, she makes a hypothetical assumption that its launching State is the United States (U.S.) for the purposes of the discussions and proposes that the fault be determined in the following test:

- (a) whether Iridium abided by the U.S. regulations governing, for example, the satellite design and collision avoidance measures, which adopted the Space Debris Mitigation Guidelines established by the Inter-Agency Space Debris Coordination Committee (IADC)⁸⁰ and/or by COPUOS,⁸¹ whether Iridium was able to obtain credible orbital congestion data, and whether it was reasonably expected to foresee the collision and to conduct a collision avoidance maneuver; and
- (b) whether the launching State (the U.S.) did not send a warning to Iridium despite it being technically able to foresee the collision and to send the warning.⁸²

⁷⁷ *Ibid.*, p. 55.

⁷⁸ Souichirou Kozuka, Motoko Uchitomi and Hiroyuki Kishindo, “International Regime for Space Debris Remediation in Light of Commercialized Space Activities, The”, *Proceedings of the International Institute of Space Law* 56 (2013), pp. 400-401.

⁷⁹ Aoki, *supra* note 30, pp. 43-47.

⁸⁰ Inter-Agency Space Debris Coordination Committee, *IADC Space Debris Mitigation Guideline*, 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 Sept. 10, 2019).

⁸¹ *supra* note 2.

⁸² Aoki, *supra* note 30, p. 46.

As to Russia, she points out that at the time of the collision caused by Cosmos 2251, it was already out of function, and it was difficult to legally criticize the Russian government for leaving it after the end of its life because there were no international rules to oblige the government to dispose of its dead satellite, and that the fault of the Russian government should be determined by checking if it was able to foresee the collision and was able to notify Iridium but failed to do so.⁸³

Subsequently, she concludes that if the Russian government was able to foresee the collision and to notify Iridium, but the said government failed to do so, maybe one can determine that Russia was in breach of the obligation regarding the avoidance of potentially harmful interference with activities of other State's Parties (Articles IX, I, III, etc. of the OST) and the obligation regarding the principle of cooperation and mutual assistance (Article IX of the OST).⁸⁴

One can summarize that according to Aoki, the fault should be determined by the following testing formula: (a) whether the launching entity has abided by the relevant domestic regulations for the purpose of collision avoidance, and the launching entity was reasonably expected to foresee and avoid the collision; and (b) whether the launching State was able to foresee the collision by its SSA capabilities and notified the relevant parties of such assessment. Because Article III of the Convention covers the fault of both the launching State and of persons for whom the launching State is responsible, the structure of these two tests is consistent with that of the said Article.

However, as Aoki points out, the details of SSA capabilities tend to be classified as military information. Where the launching State of the space object or debris, which caused damage to the functioning satellite of another country, is suspected to be the country that provides SSA services, it is unlikely for the victim launching State to obtain sufficient evidence to prove the fault of the assailant launching State.⁸⁵ Additionally, if one considers that the more SSA capabilities a country has the more likely it is that that country is responsible for a fault, such a practice is unlikely to obtain an understanding of the significant SSA providers, including the United States and Russia. Additionally, such interpretation would discourage international cooperation for the sake of SSA information sharing. Thus, the implementation of test (b) is likely unfeasible.

⁸³ *Ibid.*, pp. 46-47.

⁸⁴ *Ibid.*, p. 47.

⁸⁵ *Ibid.*, pp. 46-47.

Then, what about test (a)? Major space-faring nations have introduced regulations that embody the said guidelines regarding debris mitigation, and some of them apply penalties against breaches of such regulations.⁸⁶ The determination of fault must be performed according to international law because Article III does not mention domestic laws and regulations as criteria for the fault. However, the said guidelines, despite being non-binding,⁸⁷ reflect a consensus among major space-faring nations and have a substantial effect on international harmonization. In many countries, such regulations are legally binding. Because of this State practice, it is reasonable to check as criteria of fault if the launching entity abided by the said regulation. That said, it is unlikely that there are cases in which the launching entity is reasonably expected to foresee the collision and to avoid it, because of the current limited quality of SSA services.

There is an opinion that goes so far as to say that failing to monitor debris that caused damage constitutes a fault of the launching State of that debris.⁸⁸ Nevertheless, SSA requires highly advanced technology and a large budget. Additionally, today, only a few countries are providing SSA service to public users, and the accuracy of its service varies among several providers. Therefore, it is inappropriate to determine the fault based on the country in question not monitoring its debris.⁸⁹

(5) Other methods of reparation

Even if the victim launching State fails to prove the fault of the other launching State, that does not necessarily mean that there is no chance at all for the former to receive reparation.⁹⁰ Article XI of the Convention does not prevent “a State, or natural or juridical persons it might represent, from pursuing a claim in the courts or administrative tribunals or agencies of a launching State.” A launching State means either the assailant State or victim State. The judicial branch will likely refer to the domestic regulations regarding the debris mitigation that embody the said international guidelines. Because few legal instruments can

⁸⁶ “Jinkoeiseitou no uchiage oyobi jinkoueisei no kanri ni kansuru houritsu” (Space Activities Law), Article 22, at https://elaws.e-gov.go.jp/search/elawsSearch/elaws_search/lsg0500/detail?lawId=428AC0000000076 (last visited on Sept. 10, 2019), “Jinkoeiseitou no uchiage oyobi jinkoueisei no kanri ni kansuru houritsu sekoukisoku”, Articles 22, 23 and 24.

⁸⁷ See *supra* 2, para 2.

⁸⁸ Ram Jakhu and Md Tanveer Ahmad, “The Outer Space Treaty and States’ Obligation to Remove Space Debris: a US Perspective”, *The Space Review* (2017), at <http://www.thespacereview.com/article/3370/1> (last visited on Sept. 11, 2019).

⁸⁹ Nakamura, *supra* note 4.

⁹⁰ Smith and Kerrest, *supra* note 15, p. 133.

be used to prove the fault of the assailant, the court will likely use domestic regulations as part of the materials for the determination of fault.⁹¹

However, if the defendant is a foreign government, and it claims sovereign immunity, the victim cannot obtain the reparation in a domestic court.⁹² Additionally, the laws and regulations of the country where the court is located might require the plaintiffs to prove the fault of the assailant even in the case of damage on the earth's surface, unlike the case in which Article II of the Liability Convention is applied. Besides, the enforcement of the court decision might be difficult even when the victim wins a ruling, because of the lack of properties of the assailant in the victim's country.

In 2011, the Permanent Court of Arbitration adopted "Optional Rules for Arbitration of Disputes Relating to Outer Space Activities."⁹³ Associate Professor Tronchetti underscores the advantages of this rule, for example, be accessible to all space actors regardless of their governmental or non-governmental nature, leave parties free to determine the law to be used by the arbitral tribunal, enable the selection of arbitrators with expertise in outer space, and lead to a binding arbitral award.⁹⁴

3. Toward enhancement of the effectiveness of Space Treaties

The current liability scheme of the Space Treaties has many problems to be solved regarding, *inter alia*, how to secure reparations for damages in outer space. The Author echoes Professor Larsen, who states that absolute liability under Article II of the Convention would be a significant deterrent such that States would be cautioned not to authorize outer space activities that may result in state liability.⁹⁵ By contrast, Professor Schladebach points out that the Convention does not solve the problem faced by the international community because it provides a legal basis only for compensation of damages, which is merely

⁹¹ *Ibid.*

⁹² Ikeda argues that the government of the assailant country cannot refer to sovereign immunity if that country is a party of the OST when that government is claimed to pay compensation for damage by a person of another country. However, he says whether the laws governing judicial proceedings allow that or not remains unknown (See Ikeda, *supra* note 11, p. 197).

⁹³ Permanent Court of Arbitration, *Optional Rules for Arbitration of Disputes relating to Outer Space Activities*, at <https://pca-cpa.org/wp-content/uploads/sites/6/2016/01/Permanent-Court-of-Arbitration-Optional-Rules-for-Arbitration-of-Disputes-Relating-to-Outer-Space-Activities.pdf> (last visited on Sept. 10, 2019).

⁹⁴ Fabio Tronchetti, "The Problem of Space Debris: What Can Lawyers do about It?", *Zeitschrift für Luft- und Weltraumrecht - German Journal of Air and Space Law*, Vol. 64, Issue 2 (2015), p.351.

⁹⁵ Larsen, *supra* note 24, p. 487.

repressive.⁹⁶ Professor Kellman criticizes that the Convention mischaracterizes the wrongfully caused injury as a past impact rather than a chronic and impending nuisance.⁹⁷ Major Carns points out that liability is unlikely to be imposed, which creates perverse incentives that favor low accountability.⁹⁸ Here are three signs of progress the international community has attempted to supplement the current space treaties: (1) proposals of new treaties, (2) international cooperation for the sake of debris mitigation and tracking, and (3) imposition of the obligation of purchasing insurance and the introduction of supplementary assistance by the government.

(1) Proposals of new treaties

In 1994, the International Law Association published “International Instrument on the Protection of the Environment from Damage Caused by Space Debris.”⁹⁹ That document, in Article 8, states that the launching States are internationally liable for damage arising therefrom to another State.¹⁰⁰ This provision does not adopt fault-based liability, and the damage in the Article includes any adverse modification of both the outer space and earth environments.¹⁰¹ This document is often cited as a critical effort to improve the current liability scheme, but little movement has been observed toward the eventual international legislation in line with it.

⁹⁶ Marcus Schladeback, “Space Debris as a Legal Challenge”, *Max Planck Yearbook of United Nations Law*, Vol. 17, Issue 1 (2013), p. 71.

⁹⁷ Kellman, *supra* note 60, p.258.

⁹⁸ Marc G. 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), p.198.

⁹⁹ Karl-Heinz Bockstiegel, “Draft of the International Law Association for a Convention on Space Debris”, *Proceeding on the Law of Outer Space* 38 (1995)

¹⁰⁰ “International Instrument on the Protection of the Environment from Damage caused by Space Debris” states as follows:

Art 8: International Liability

Each State or international organization party to this Instrument that launches or procures the launching of a space object is internationally liable for damage arising therefrom to another State, persons or objects, or international organization party to this Instrument as a consequence of space debris produced by any such object.

¹⁰¹ The document (*supra* note 100) states as follows:

Art. 1 (d) “Environment” for the purposes of this Instrument, includes both the outer space and earth environments within or beyond national jurisdiction.

(e) “Damage” means loss of life, personal injury or other impairment of health, or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organisations, or any adverse modification of the environment of areas within or beyond national jurisdiction or control.

Some scholars propose amending the Convention to introduce the absolute liability for the damage in outer space,¹⁰² and others propose to grant a general reprieve of liability over existing debris.¹⁰³ Another proposal is to introduce the so-called Market-Share Liability in which the relevant parties share liability based on the market share, which is derived from California jurisprudences.¹⁰⁴ To date, however, there is little momentum to move forward based on any of these proposals.

(2) International cooperation for the sake of debris mitigation and trucking

Additionally, major space-faring nations are attempting to improve debris mitigation and the capabilities of debris-trucking through international cooperation.

Since the 1980s, major space-faring nations have introduced regulations regarding the satellite design and operational requirements for the sake of debris mitigation, and the said international guidelines had a vital role in harmonizing such best practices and even to elevate its level. Neither the domestic regulations nor the international guidelines were introduced to improve the existing liability scheme. However, these documents contribute to the debris mitigation and, thus, to the mitigation of the risk of damage caused by the debris. Additionally, from 2010 to 2018, COPUOS's Science and Technology Subcommittee held consultations to craft "Guidelines for the Long-term Sustainability of Outer Space Activities" (GLTS). In June 2019, COPUOS unanimously adopted GLTS.¹⁰⁵ Examples of the agreed 21 guidelines are as follows: "[p]romote the collection, sharing and dissemination of space debris monitoring information"(GL. B.3), and "[d]esign and operation of space objects regardless of their physical and operational characteristics"(GL. B.8).¹⁰⁶ When adopted by individual countries, these guidelines help avoid collisions in outer space and investigate causes of collisions, which in a sense enhances the effectiveness of the liability scheme of the current space treaties.

¹⁰² See Natalie 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*, Vol. 21, Issue 2 (Spring 2010), p.447.

¹⁰³ Michael Listner, "Addressing the Challenges of Space Debris, part 2: Liability, *The Space Review* (2012), at <http://www.thespaceview.com/article/2204/1> (last visited on Sept. 12, 2019).

¹⁰⁴ Mark J. Sundahl, "Unidentified Orbital Debris: The Case for a Market-Share Liability Regime", *Hastings International and Comparative Law Review*, vol. 24, no. 1 (2000), pp. 143-147.

¹⁰⁵ 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 Oct. 2019).

¹⁰⁶ COPUOS "Guidelines for the Long-term Sustainability of Outer Space Activities", at <https://undocs.org/A/AC.105/C.1/L.366> (last visited on Oct. 19, 2019).

Additionally, some countries are attempting to improve the quality of their SSA services through international cooperation. In particular, information sharing among such significant players as the Joint Functional Component Command for Space (JFCC Space) under the U.S. Space Command, ESA, and Japan is expected to improve the tracking capabilities, ensuring broader geographical coverage and thus contributing to the identification of space objects and debris that improves the implementation of the Convention.

(3) Establishment of an obligation to purchase insurance, and the introduction of supplementary assistance by the government

Today, space agencies and private space companies purchase insurance products that cover potential damages caused to its satellites or to address third party liability. The space business community has not complained much about the deficiencies of the current liability scheme because of the existence of the said insurance products.¹⁰⁷ This situation means that the overall character of the liability scheme has shifted from the original one introduced by the Convention, which concentrates responsibility on States to a so-called mixed responsibility scheme.

U.S., Chapter 509—Commercial Space Launch Activities introduced a scheme where launching operators are required to purchase insurance for the damage on the earth's surface. The government is to supplement the payment by the insurance company when the amount of that compensation is insufficient (Sec. 50914 and 50915).¹⁰⁸ Japan also introduced a similar scheme by enacting a new law in 2016.¹⁰⁹ Professor Aoki predicted in 2011 that the liability scheme for damages caused by space activities would move toward the institutionalization of international cooperation for the sake of avoidance of damage, and would shift from the concentration of responsibility on States to mixed responsibility.¹¹⁰ Her prediction was generally consistent with what subsequently occurred.

¹⁰⁷ Mr. Denis Bensoussan of Hiscox states that risk of collision was not a severe worry for insurers until recently, but that the current situation is likely time-limited because occurrences will happen and space debris risk may become uninsurable or only under drastic coverage restrictions and rate increases. See “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 (last visited on April, 1, 2020).

¹⁰⁸ Chapter 509—Commercial Space Launch Activities, at <https://uscode.house.gov/view.xhtml?path=/prelim@title51/subtitle5/chapter509&edition=prelim> (last visited on Sept. 10, 2019).

¹⁰⁹ *supra* note 86.

¹¹⁰ Aoki, *supra* note 30, p. 49.

However, whether this trend will continue is unknown. In August 2019, Swiss Re, the second-largest reinsurance company, announced it would stop insuring satellites and launches because of the deterioration of the business environment.¹¹¹ If the number of accidents covered by aerospace insurance increases significantly, which leads the premium to increase or which begins to put the sustainability of the business into question, the division of the role between the government and the private sectors will likely be revisited.¹¹²

4. Damage Caused During the Operation of Active Debris Removal

Here is a preliminary analysis of how to manage the damage, which is unintentionally caused to a satellite of the third country during ADR operations. The actual damage is supposed to take place in an entirely diverse manner; thus, this article only describes the most typical cases. The basic assumption is that the ADR operator conducts its operation based on a contract with the operator of a satellite (debris), which is to be removed.

(1) The case in which while the ADR satellite (A) is attempting to remove the target satellite (B) A makes B collide with a functioning satellite of a third country (C) by mistake

Because the collision occurs in outer space, fault-based liability is applied. Dr. Popova et al. state that in such a case, B shall bear the responsibility.¹¹³ However, where the operator of B is proven to have abided by the regulations of its launching State, which embody the debris mitigation guidelines, it will be difficult to blame the operator of B or its launching State legally.

By contrast, Professor Jakhu et al. state that in the said scenario, the launching State of A shall bear the responsibility.¹¹⁴ However, as Dr. Weeden points out, in the absence of a standard of care regarding the ADR, it will be difficult to prove the fault of the launching State of A or the operator of A.¹¹⁵ Once the actual ADR operation starts, it will be inevitable to start detailed discussions on such standard of care in the international fora such as the

¹¹¹ Caleb Henry, “Space insurer Swiss Re leaves market”, *Space News*, Aug. 1, 2019, at <https://spacenews.com/space-insurer-swiss-re-leaves-market/> (last visited on Oct. 14, 2019).

¹¹² D. Bensoussan, *supra* note 107.

¹¹³ Rada Popova and Volker Schaus, “The Legal Framework for Space Debris Remediation as a Tool for Sustainability in Outer Space”, *Aerospace* (2018), p. 9, at <https://www.mdpi.com/2266-4310/5/2/55/htm> (last visited on Sept. 10, 2019).

¹¹⁴ Jakhu et al, “Regulatory framework and organization for space debris removal and on orbit servicing of satellites”, *Journal of Space Safety Engineering* 4 (2017), p. 132.

¹¹⁵ Weeden, *supra* note 38, p. 42.

IADC and COPUOS.¹¹⁶

Notably, this case differs from the scenario that Article IV of the Convention envisions, because the latter relates to a case in which a space object of the country X causes damage to a space object of country Y, and the consequence of that damage reaches a space object or the territory of country Z. In such a case, Article IV demands both X and Y be jointly and severally liable to Z. By contrast, in the said scenario of ADR operation, the operator of A is conducting the removal operation based on a contract with the operator of B, and the removal is not the same as causing damage to B.

However, the launching State of C may claim for the damage against the launching States of both A and B, using an analogy with the joint responsibility scheme under Article IV.

To be prepared for such uncertainty, the launching States of A and B can conclude a bilateral agreement to determine how to manage the potential claim by third parties before ADR operation, but it is difficult to decide how it looks at this juncture. If the B side wants the A side to bear more responsibility, it is not sure if such an agreement can obtain support by taxpayers of the launching State of A, because the operator of A is expected to conduct many similar operations in the future and the conclusion of such an agreement means that the launching State A will continue to bear significant financial risk in the long run. By contrast, if the A side wants the B side to bear more responsibility, it is necessary to consider to what extent such an agreement will disincentivize future clients of ADR services. Further research is necessary to pursue a well-balanced study of such aspects as the development of the ADR business, the extent of risk of the third party's damage, and international debate on the standard of care regarding the ADR operations.

(2) The case in which while A is attempting to remove B, B explodes or breaks up unintentionally

This scenario is somewhat ironic because lots of new debris are created precisely because of the operation to remove debris. The explosion of debris increases the threat against other functioning satellites, but under the current international law, there is no legal basis for imposing a penalty on the launching State of A.

¹¹⁶ See Wilton Park, Foreign & Commonwealth Office, "Report Operating in space: towards developing protocols on the norms of behavior"(A/AC.105/2019/CRP.12), at http://www.unoosa.org/res/oosadoc/data/documents/2019/aac_1052019crp/aac_1052019crp_12_0_html/AC105_2019_CRP12E.pdf (last visited on Oct. 27, 2019).

If debris created in this manner causes damage to a satellite of other launching States, the liability is determined in the same manner as in (1) above, but causation will be an issue, especially when there was an interval between the explosion/breakup and the collision and when the sequence until the collision is complicated.

(3) A de-orbited B, but B becomes out of control and causes damage on the earth surface

Due to the damage on the earth's surface, the absolute liability in Article II of the Convention applies. The debris that directly caused the damage is B, but depending on the actual sequence of the incident, A might be blamed for the damage. The victim country will likely claim for compensation against the launching State of A and/or B. Notably, in all these cases, the parties concerned will likely want to conclude a bilateral agreement to cope with the liability needs before the actual ADR operations.

Final word

As the risk of damage caused by debris increases and the R&D concerning ADR progresses, it becomes increasingly more important to research the function of the liability scheme in international law and the challenges the international community will likely face in that context.

In addition to the issues this article discussed, there are several other complicated issues. For example, as Dr. Carpanelli et al. suggest¹¹⁷, a worthy exploration would be how to manage damage caused by a space object manufactured by a 3D printer in outer space as Made in Space plans¹¹⁸ (whether or not such an object corresponds to a space object under the Convention). Another notable topic is how to manage damage caused by an asteroid that was towed from the asteroid belt and placed in the earth's orbit, as Planetary Resources used to plan^{119,120} (whether or not such an asteroid corresponds to a space object under the Convention). Additionally, Professor Nakamura suggests further research on how to manage damage to a facility on the Moon's surface (whether or not such a facility corresponds to the earth's surface or a space object under the Convention).¹²¹

¹¹⁷ Carpanelli and Cohen, *supra* note 48, p.32.

¹¹⁸ Made in Space Inc., "Our Mission", at <https://madeinspace.us/about/> (last visited on Sept. 22).

¹¹⁹ Planetary Resources was acquired by ConsenSys in Oct. 2018.

¹²⁰ Carpanelli and Cohen, *supra* note 48, p.32.

¹²¹ Megumi Nakamura, "Uchubuttai rakka jiko to daisannsyu songaibaisyuu sekinin seido", Nihon hougaku,

The Convention entered into effect approximately 50 years ago, and it is worth deeply exploring its functions and how to improve it to cope with the new challenges posed by the development of new space businesses and the deterioration of the orbital environment.