

Zuzanna Buszman

Law, Doctoral School of Social Sciences, University of Warsaw, Poland

e-mail: zuzanna.buszman@uw.edu.pl | zuzanna.buszman@berkeley.edu

ORCID: 0000-0002-1615-9492

SUSTAINABILITY OF SPACE TRAFFIC MANAGEMENT – ADDRESSING THE ISSUE OF ORBITAL DEBRIS IN THE CONTEXT OF SPACE LIABILITY

Abstract

The problem of managing space debris is not only an international challenge but also an opportunity to preserve this environment for future space exploration missions. As more countries gain the technology and economic means to launch spacecraft, more focus is being exerted on standardizing the procedures of each country and on adhering to new developing norms under international agreements.

Over time, the increasing number of launching states proves that space debris mitigation will have to be coordinated and that preventive measures across all stakeholders – both state and non-state actors – will have to be put in place since if one actor fails to do so, this may inevitably affect all others. The article focuses on the analysis of international space law and policy steps undertaken to tackle environmental pollution in outer space, in particular in terms of accumulation of human-made debris and waste material in the Earth's orbit and beyond.

The aim of the work is to analyse to what extent the international legal framework and policy measures are failing in addressing the emerging issue of debris in outer space and to propose policy recommendations in creating a new specialized international organization along with *de lege ferenda* conclusions for international space law, especially in the context of possible amendments to the Liability Convention and the Outer Space Treaty.

KEYWORDS

pace debris, space traffic management, space liability

SŁOWA KLUCZOWE

odpady kosmiczne, zrównoważony rozwój przestrzeni kosmicznej, szkody wyrządzone w przestrzeni kosmicznej

1. INTRODUCTION

During the Cold War, only two major actors engaged in the space race, which began in 1957 with the launch of the first artificial satellite Sputnik 1. At the time, the USA and the USSR strived to make major technical and scientific advances in space from both a technological and a legal perspective. The situation today is notably different.

Firstly, the new space market does not support an ideological race. It focuses on the actual commercialization of outer space by states and private companies amidst the omnipresent need for constant telecommunications, GPS services, or even the desire for commercial space travel.¹ Secondly, not only has the space market become occupied by two major space powers, but it has encouraged new players, including China, India, and Japan, and Member States of the European Space Agency. If we consider the European Union as one launching state, then the number of countries engaged in the space industry amounts to twelve launching States.² The rapid development of space activities implies exponential utilization and exploitation of outer space by the parties involved. Therefore, the international community will be obliged to regulate and sanction space traffic management to maintain sustainable development and peaceful exploitation of outer space.

Over time, the increasing number of launching states proves that space debris mitigation measures will have to be coordinated across all above-mentioned stakeholders, since if one fails to do so it may inevitably affect all others. Furthermore, space activity generates and accumulates debris in orbit faster than any natural

¹ ESA's Annual Space Environmental Report, ESA Space Debris Office, European Space Agency, April 2022, pp. 50, https://www.sdo.esoc.esa.int/environment_report/Space_Environment_Report_latest.pdf (accessed 13.04.2023).

² P. Van Fenema, *Chapter 7. Legal Aspects of Launch Services and Space Transportation*, (in:) F. Von Der Dun, F. Tronchetti (eds), *Handbook of Space Law*, Cheltenham/Northampton 2015, pp. 409.

processes are able to remove it.³ Although the future of space debris cannot be predicted with certainty, it is reasonable to assume that the rapidly changing space traffic landscape will contribute to its further accumulation. Even if the fragmentation of space debris can be eliminated to a certain extent, collisions of objects could become a much larger player in debris generation while the rise of technology and commercial space travel will generate heavier space traffic in the Lower Earth Orbit (LEO). Thus, even though the international community will aim to enforce space debris mitigation policies while constructing new rockets and satellites, questions of international responsibility and liability mechanisms (e.g., in the context of accidental collisions) in space may be on the rise in the coming decades.

2. THE SCOPE OF THE PROBLEM

Environmental pollution in outer space generally refers to the accumulation of human-made debris and waste materials in the Earth's orbit and beyond. This pollution includes items such as spent rocket stages, defunct satellites, and other debris generated by space activities. As there is no universal legal definition of space debris, scholars tend to use the working definition established by the Inter-Agency Space Debris Coordination Committee (IADC), which describes space debris as *all man-made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional*.⁴ Examples may include derelict spacecraft and upper stages of launch vehicles; defunct satellites; fragments from explosions, collisions, or intentional destruction of objects in space; and other tools or objects lost during spacewalks or other activities. As space debris can range in size – from tiny paint flecks or gloves to large components of rockets – they all may pose a significant threat to operational spacecraft and satellites, as they can cause damage upon impact. Moreover, space debris that orbits Earth can move very fast, calculated at 18 000 miles per hour on average.⁵ As a result, its exponential growth and dynamic movement threaten the sustainability of outer space and the safety of space-based services, explorations, and further operations by posing a serious risk to both people and property in space and on Earth.⁶

³ IADC Space Debris Mitigation Guidelines, Inter-Agency Space Debris Coordination Committee (IADC) Steering Group, IADC-02-0, March 2020, pp. 6, <https://orbitaldebris.jsc.nasa.gov/library/iadc-space-debris-guidelines-revision-2.pdf> (accessed 13.04.2023).

⁴ ARES, *Frequently Asked Questions*, <https://orbitaldebris.jsc.nasa.gov/faq/#> (accessed 07.07.2023).

⁵ J.C. Liou, *Highlights of Recent Research Activities at the NASA Orbital Debris Program Office*, Paper presented at the 7th European Conference on Space Debris, Germany, April 2017, Report No. JSC-CN-3199.

⁶ S.J. Garber, *Incentives for Keeping Space Clean: Orbital Debris and Mitigation Waivers*, 'Journal of Space Law' 2017, No. 41(2), pp. 179-180.

In fact, low Earth orbit (LEO) is now viewed as the World's largest garbage graveyard. To put this phenomenon into perspective, the amount of waste material orbiting LEO was approximately 9,000 metric tons as of January 2022,⁷ with over 10,000 objects in a size of 10 cm or larger.⁸ There are many reasons and examples of human activities, which explain why LEO has become an orbital graveyard. One of the most notable historical events includes the intentional breakup of the Chinese Fengyun-1C spacecraft in 2007, which caused the most severe artificial debris in Earth's orbit since the very beginning of space exploration.⁹ Still, before the Fengyuan-1C, accidental explosions – including the explosion of the Soviet Cosmos 1275 or the United States Nimbus 4 rocket body (1970-025C) – dominated as sources of long-lived debris.¹⁰ The afore-mentioned incidents have increased LEO's large orbital debris quantity by 70%, posing more significant collision risks for spacecraft operating in low Earth orbit.¹¹ On top of that, some scientists argue that the exponential growth of space debris increases the potential threat of the Kessler effect, which is used to describe a scenario in which too high density of objects in LEO results in cascading collisions between objects, thus generating space debris that increases the likelihood of further collisions.¹²

All in all, the aim of this article is to examine the current state of international legislation, analyse policy measures and identify legal gaps in addressing the space debris mitigation regime. As a result, the work will propose possible recommendations and *de lege ferenda* conclusions for regulators in designing effectively sustainable management of space traffic in the future.

3. CURRENT STATE OF AFFAIRS

3.1. POLICY DIRECTIONS

On the national level, one way to respond to this alarming problem was to launch the NASA Orbital Debris Program in 1979 in the Space Sciences Branch at the Johnson Space Center (JSC) in Houston, Texas. The program aims to explore possibilities to produce fewer orbital debris and design equipment to track and

⁷ ARES, *op. cit.*

⁸ NTSS, *Handbook for Limiting Orbital Debris*, July 2008, pp. 26, www.standards.nasa.gov/sites/default/files/standards/NASA/Baseline/1/nasa-hdbk-871914_baseline_with_change_1.pdf (accessed 13.04.2023).

⁹ *Ibid.*, p. 27.

¹⁰ *Ibid.*, p. 28.

¹¹ *Ibid.*, pp. 29-30.

¹² D.J. Kessler, B.G. Cour-Palais, *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt*, 'Journal of Geophysical Research' 1978, No. 83, pp. 2640–2641.

remove the debris already in space. As a result of the Orbital Debris Program, NASA was able to develop some general standards, policies, and procedural requirements, including a Handbook for Limiting Orbital Debris.¹³

On the horizontal level, among the critical international efforts to understand and mitigate the current issue we have the “Space Debris Mitigation Guidelines” developed by the Inter-Agency Space Debris Coordination Committee (hereinafter IADC) in 2002. The IADC is an intergovernmental forum for the worldwide coordination of activities and technical issues related to man-made and natural debris in space.¹⁴ The guidelines have served a role of preventive practices designed to control the increase of space congestion in popular orbital regions such as LEO to preserve their scientific and commercial value and the possibility of space exploitation for peaceful purposes for future users.¹⁵

Based on the developed policy guidelines, the United Nations (UN) General Assembly has endorsed them in its Resolution 62/217 of 22 December 2007 by underlying global mitigation standards with seven guiding principles. These include minimization of debris released during normal operations; limitation of potential break-ups during operational phases and post-missions resulting from stored energy; probability of accidental collision in orbit; avoidance of intentional destruction and other harmful activities; and finally, recommendations on limiting the long-term presence of spacecraft and launch vehicle orbital stages in the LEO region and or Earth orbit region after the end of the mission.¹⁶ From a technical point of view, the guidelines apply to mission planning and the operation of newly designed spacecraft and, if possible, to implementation in existing ones.¹⁷

Lastly, the Committee on the Peaceful Uses of Outer Space (COPUOS) updated a Compendium of space debris mitigation standards in March 2023, which does not only provide guiding principles but also – based on the universal templates – compiles current instruments, best practices, and measures that States and international organizations have implemented.¹⁸ As a result, the Compendium remains one of the most important sources and handbooks providing up-to-date knowledge and recommended solutions on space debris mitigation mechanisms. For example, it enumerates procedures chosen by the European

¹³ NTSS, 2008, *op. cit.*

¹⁴ UNOOSA, *Space Debris Mitigation Guidelines of the United Nations Committee on the Peaceful Uses of Outer Space*, Inter-Agency Space Debris Coordination Committee, A/AC.105/C.1/L.260, 2007, pp. 1, https://www.unoosa.org/pdf/publications/st_space_49E.pdf (accessed 13.04.2023).

¹⁵ *Ibid.*, p. 2.

¹⁶ *Ibid.*, p. 3.

¹⁷ United Nations Committee on the Peaceful Uses of Outer Space, *Compendium: Space Debris Mitigation Standards adopted by States and International Organizations*, A/AC.105/C.2/2022/CRP.17, March 2023, pp. 91, https://www.unoosa.org/documents/pdf/spacelaw/sd/Space_Debris_Compendium_COPUOS_20_March_2023.pdf (accessed 13.04.2023).

¹⁸ *Ibid.*

Code of Conduct for Space Debris Mitigation,¹⁹ consistent with Space Debris Mitigation Guidelines. In addition, however, it provides much more technical details and explanations of enlisted guidelines. Interestingly, from the legal perspective, it also directly references Articles I and IX of the Outer Space Treaty of 1967 and the Liability Convention of 1972.²⁰ Moreover, in the Nicaraguan contribution to the Compendium the government noted that although it does not have a specific law on instruments relating to space debris mitigation, it expresses its devotion to the cause by noting the example of the Liability Convention, which was adopted by the government in 2017.²¹

It shall be noted that the guidelines in question aim only at encouraging international adoption of voluntary debris mitigation measures, which are not legally binding and, therefore, cannot enforce their applicability to States at the international level. Still, the example of the Nicaraguan statement or the European Code of Conduct may be perceived as a subjective element of *opinio iuris* that could also support the crystallization of the customary law in the international legal framework. Thus, the role of the guidelines and compendiums referred to above may not only lie in raising awareness of good practices but could also show what the State “thinks” about its legal obligation towards space debris mitigation measures.

3.2. LEGAL FRAMEWORK

3.2.1. MITIGATION AND PREVENTION OBLIGATION

To begin with, it should be underlined that the current space treaties do not define, address or imply a direct reference toward space debris.²² The only indirect connection that might be considered relies on Article IX of the Outer Space Treaty, which obliges all State Parties to conduct all their activities in outer space with “due regard to the corresponding interests of all other States Parties” to the Treaty. Furthermore, any exploration of outer space shall avoid its “harmful contamination” and “adverse changes in the environment of the Earth,” which

¹⁹ The Code was developed and adopted in cooperation with Italian, British, French, German, and the European space agencies.

²⁰ European Space Agency, *European Code of Conduct for Space Debris Mitigation*, ESA/IRC(2004)20, June 2004, <https://www.unoosa.org/documents/pdf/spacelaw/sd/2004-B5-10.pdf> (accessed 13.04.2023).

²¹ *Ibid.*, p. 59.

²² These include Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies; Agreement on the Rescue of Astronauts, the Return of Astronauts and Return of Objects Launched into Outer Space; Convention on International Liability for Damage Caused by Space Objects; Convention on Registration of Objects Launched into Outer Space and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies.

resulted from “the introduction of extra-terrestrial matter”.²³ The passage also indicates that States should consult with other States beforehand in case of engaging in activities that might cause “harmful interference” with the activities of other States. Moreover, any State Party has the right to request consultations if it considers that activities of another State(s) might cause harmful interference.²⁴

Article IX undoubtedly creates a treaty obligation upon State Parties to take reasonable measures and accurate procedural steps while conducting any space activity by assessing any interference with the interests of other States or possible causation of harmful contamination. It also lays down a duty and a right to consult such activities between relevant stakeholders. This reasoning may imply that if a State creates debris during its activities in outer space, then it may cause interference with other States’ interests or it may even face an allegation of harmful contamination.

Nevertheless, international law does not prohibit States from creating debris while performing their activities. As outer space “shall be free for exploration and use by all States,”²⁵ any state can use this privilege – based also on the *Lotus* presumption – and justify its actions with its national interests while creating debris as a side effect, which is not prohibited by international law. As the quoted treaty language needs a definitional setting for space debris, it is also impossible to assess the amount of debris that could result in a too high degree of possible interest interference or harmful contamination, thus breaching the before-mentioned obligation. Likewise, it would be difficult to put any allegations or salvage procedures against a debris-producer given the discrepancies between space debris, property, and remedial mechanisms.

The said issues lead to the question of enforcing such vague treaty obligations. In the context of space debris, Article IX encourages States to limit its generation without specifying any definitional or procedural scope. As a result, there is little chance a State would ever be held internationally liable for violating Article IX based on activities that create orbital debris in any ordinary manner. Apart from this provision, the international legislative process has not scrutinized space traffic management except for a few non-binding policy documents illustrated above.

²³ Treaty Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 27 January 1967, RES 2222 (XXI), (hereinafter: Outer Space Treaty).

²⁴ *Ibid.*

²⁵ *Ibid.*, Article 1.

3.2.2. THE ROLE OF RESPONSIBILITY AND LIABILITY RULES

The United Nations Register of Objects Launched into Outer Space²⁶ and its implementation was established as a consequence of the Convention on Registration of Objects Launched into Outer Space.²⁷ State Parties to the treaty must establish their own national registries and provide information on their space objects, thus ensure transparency on space operations. Furthermore, exemplifying Articles VI, VII, and VIII of the Outer Space Treaty is needed to understand the legal framework of all objects and their ownership in outer space. Article VI prescribes international responsibility of States for their national activities in outer space, which include both activities carried on by governmental agencies and by non-governmental entities.²⁸ As mentioned before, in the past – when the Outer Space Treaty came into force – private commercial activity in space was virtually non-existent.²⁹ The situation started to change in the 1990s and now varies significantly as civil and commercial entities perform a substantial portion of space activity.³⁰ Still, as the legal framework has not changed and States bear international responsibility for governmental and non-governmental enterprises, private entities require authorization and continuing supervision by the appropriate State Party to the Treaty in all their space activities.³¹ Thus, based on the interpretation of Article VI, States are directly responsible to other States for any possible consequences of orbital debris generated by non-governmental entities.

Furthermore, Article VII of the Outer Space Treaty addresses liability of States. It includes several concepts relevant to orbital debris and different categories of “launching States,” whereby it is vital that they are analysed step by step. Article VII states:

“Each State Party to the Treaty 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 to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air or in outer space, including the moon and other celestial bodies.”³²

²⁶ See United Nations Register of Objects Launched into Outer Space, United Nations Office for Outer Space Affairs, official website: <http://www.unoosa.org/oosa/en/spaceobjectregister/index.html> (accessed 13.04.2023).

²⁷ Convention on Registration of Objects Launched into Outer Space, 12 November 1974, RES 3235 (XXIX), (hereinafter: Registration Convention).

²⁸ Outer Space Treaty, Article VI.

²⁹ B. Cheng, *Studies in International Space Law*, Oxford 1997, p. 607.

³⁰ ESA's Annual Space Environmental Report, 2022, *op. cit.*, p. 50.

³¹ *Ibid.*

³² Outer Space Treaty, Article VII.

As mentioned beforehand, Article VII enumerates possible facets of a “launching State” – demonstrated in Article I of the Liability Convention³³ and Article I of the Registration Convention – in four different dimensions:

1. a State that launches a “space object”;
2. a State that procures the launching of a space object;
3. a State from whose territory a space object is launched;
4. a State from whose facility a space object is launched.

Consequently, as different States may be defined as launching States simultaneously, multiple States may be jointly liable for the damage. This damage may be caused by space debris resulting from the collision of space objects caused in outer space, on Earth, or in the atmosphere.

Thus, the Liability Convention is a critical source of treaty law – especially regarding analysis of the space debris concept – that defines and clarifies the liability regime established by Article VII of the Outer Space Treaty. First and foremost, it defines “damage” as the “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 organizations”.³⁴ In the next two articles the Convention establishes two distinct regimes of liability that depend on (1) the location where the damage occurred and (2) the type of object that was damaged. First, the absolute liability of a launching State to pay compensation occurs for damage caused by its space object on the earth’s surface or to aircraft in flight.³⁵ The second branch refers to a fault-based system in which a launching State is liable only if the damage is due to its fault or the fault of persons for whom it is responsible when the damage occurred elsewhere than on the earth’s surface.³⁶

Last but not least, Article VIII of the Outer Space Treaty declares 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 [...] while in outer space [...]” It further explains that ownership of objects launched in outer space is not affected by their presence in outer space, on a celestial body, or by their return to Earth.³⁷ Together with Article II of the Registration Convention, these provisions explain that only one State (and in case of multiple States, then always one of the launching States) will have jurisdiction and control over space objects it launched.

³³ Convention on the International Liability for Damage Caused by Space Objects, Res. 2777 (XXVI), 29 March 1972 (hereinafter: Liability Convention). In Article I (c), the launching State is defined as a State which launches or procures the launching of a space object as well as a State from whose territory or facility a space object is launched.

³⁴ Liability Convention, Article I(a).

³⁵ Liability Convention, Article II.

³⁶ Liability Convention, Article III.

³⁷ Liability Convention, Article VIII.

In fact, as most scholars ultimately agree, every object launched into space has the potential to become debris.³⁸ As exemplified before, the Outer Space Treaty and the Liability Convention make a State liable for damage caused by any “object or its component parts” launched into outer space.³⁹ Thus, whether it relates to non-functional payloads (e.g. satellite running out of fuel) or any other type of small object launched into outer space, it must be considered a space object that might become space debris. Consequently, the provisions mentioned above – of the Liability Convention, the Outer Space Treaty, and the Registration Convention – govern the consequence of possible liability of orbital debris.⁴⁰ It must be noted, though, that these regulations do not provide any guidance on definitional scope of how and when a space object may be interpreted as a space debris..

4. DISCUSSION – RECOMMENDATIONS AND PROPOSALS FOR CHANGE

4.1. CREATION OF A SPECIALIZED INTERNATIONAL TREATY WITH A CONSULTATIVE FORUM

In order to introduce any enforcement mechanisms that would not discourage State Parties of the Outer Space Treaty and Liability Convention, rather than introducing a sanctioning system, a specialized international organization with a flexible instrument of a consultative forum could be a practical solution to this emerging global problem. This platform could be a source of possible financial incentives and funding opportunities, an instrument for transferring knowledge with a repository of good practices, and a creative lab with innovative technological solutions. Furthermore, by introducing an international treaty, which would constitute an international organization, it would be possible to integrate all soft laws and policies discussed above in comprehensive and binding space law. This regime, based on existing international environmental law principles and the existence of an international obligation to cooperate to ensure sustainable development of outer space activities, would be able to offer legal and technical solutions and dispute resolution mechanisms.

³⁸ See e.g., H.A. Baker, *Space Debris: Legal and Policy Implications*, Dordrecht 1989.

³⁹ Outer Space Treaty, Article VII; Liability Convention, Articles I-III.

⁴⁰ Some scholars do not agree with conclusions that space debris is governed by existing liability rules. See e.g., C.D. Williams, *Space: The Cluttered Frontier*, ‘Journal of Air Law and Commerce’ 1995, No. 60(4), p. 1147.

4.2. INTRODUCING BINDING LEGAL INSTRUMENTS

Based on the analysis of the legal framework presented above, the primary issue in the sustainability of space traffic is the need for a binding and comprehensive international law to provide norms on space debris removal and prevention. In a nutshell, a revision of international space treaty law should consider, among other concepts, a legal definition of space debris (that differentiates between space objects and space debris), technical solutions for a regime on the removal and prevention of space debris, space traffic management, a clear notion of fault, negligence, and causation as well as the application of environmental law principles in space. Notably, interpretative manuals or guiding interpretations should be established to explain the volume of debris caused by State(s)' activity that can constitute harmful the contamination illustrated in Article IX.

Firstly, one of the main starting points would be establishing a standard legal definition of space debris, which will be essential to any effective remediation regime. The reason is that without such a definition, it will be impossible to implement salvage rights in outer space as neither the Outer Space Treaty nor the Registration Convention recognizes these rights. Thus, a space object remains the property of its launching state – even if in no further use – and it is illegal to move such objects without prior permission from that state. By establishing a legal working definition of space debris, as a derivative from Article IX of the Outer Space Treaty, it would be possible to differentiate between a space object⁴¹ and space debris. As overlapping between these definitions is inevitable, the distinction between space objects and space debris should focus on evolving a remediation regime to establish more accessible procedures for debris remediation in outer space.⁴²

4.3. LEGAL AND TECHNICAL MEASURES

When it comes to possible legal measures, there are two main options available. The first proposal, rendered more radical, would include a total deletion of the

⁴¹ The term “space object” is not used in the Outer Space Treaty, but it appears in the Liability Convention, the Registration Convention, the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, RES 2345 (XXII), 22 April 1968 (hereinafter: Rescue Agreement), as well as the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, RES 34/68, 18 December 1979 (hereinafter: Moon Agreement). The treaties are inconsistent in terminology, the Liability Convention and Outer Space Treaty do not have any agreed legal definition, and the closest description of a space object appears in the Liability Convention in Article I, which notes “[t]he term ‘space object’ includes component parts of a space object as well as its launch vehicle and parts thereof.”

⁴² F. Haroun, S. Ajibabe, P. Oladimeji, J.K. Igbozurike, *Toward the Sustainability of Outer Space: Addressing the Issue of Space Debris*, ‘New Space’ 2021, No. 9(1), 2021, p. 66.

current space treaty law to construct a new comprehensive space treaty regime that would include all essential changes, such as orbital debris and commercial entities' engagement in space traffic management. Some States put forward this proposal during discussions in one of the COPUOS Legal Subcommittees, but other countries condemned this idea as neither necessary nor wise.⁴³ Secondly, legislators should consider improving the responsibility and liability regime under international space law. Here, legal terms of fault, negligence, and causation with respect to the Liability Convention in accordance with the current meaning of space traffic rules should be defined. Notably, the proposal could aim at broadening and modifying liability rules to also affect orbital debris and support the unification of private international law.⁴⁴ For example, some amendments could be introduced to the already-explained fault-based standard applicable to damage occurring in outer space. In addition, the modification could include a system in which a State would be presumed liable for damage caused by its space objects, but only if it failed to implement all necessary mitigation measures.⁴⁵

Hence, international technical and legal standards should be enacted and regularly updated based on the work primarily expressed in the IADC Guidelines. The universal standardization should include the technical requirements of satellites and their operationalization, e.g. collision avoidance mechanisms and other possible procedures. In particular, mitigation regimes, efforts at tracking objects and debris, and guidelines for satellite specifications should be unified, like, for example, standards of the International Civil Aviation Organization.

4.4. DISPUTE RESOLUTION MECHANISMS

Furthermore, the vagueness of international space law, including treaty law, acquiesces the international community to refrain from reacting to possible negligence and cease taking necessary legal steps to mitigate and prevent the accumulation of debris in outer space. More distinctively, one major issue concerns the need to revise the dispute resolution mechanism under the Liability Convention. For example, Article XIX (2) of the Liability Convention illustrates that the decision can be final and binding if the parties have so agreed, and otherwise, its Commission shall render a final and recommendatory award, which the parties shall consider in good faith.⁴⁶

⁴³ UN COPUOS, Report of the Legal Subcommittee on Its Forty-Fifth Session, A/AC.105/871, 2006, para. 45-48.

⁴⁴ D. Maniatis, *The Law Governing Liability for Damage Caused by Space Objects: From State Responsibility to Private Liability*, 'Annals of Air and Space Law' 1997, No. 22(1), pp. 399-400.

⁴⁵ J.P. Lampertius, *The Need for an Effective Liability Régime for Damage Caused by Debris in Outer Space*, 'Michigan Journal of International Law' 1992, No. 13(2), pp. 464.

⁴⁶ Liability Convention, Article XIX.

Thus, without the introduction of proper enforcement mechanisms and sanctioning tools, the management of space debris will not be effective. One of the possible solutions to overcome this issue would be to recommend some options of binding or non-binding procedures of the ILA Draft Convention on the Settlement of Disputes in Space for the disputing parties to use, with the ultimate goal of a compulsory third-party dispute settlement and to prescribe arbitration as the preferred subsidiary method, which is accessible to private parties who have become essential players in the current space industry.⁴⁷

5. CONCLUSIONS

As the number of space activities and amount of debris generated grow exponentially, it is necessary to guarantee sustainable development of Outer Space and Earth's orbit, which does not only foster protection of human life in space but also sustains the development of space exploration and travel per se.

The current international legal regime regulating space activities needs to be updated as, in many ways, it is unable to address contemporary issues thrown up by new vital stakeholders, space traffic, and generation of space debris. The lack of a regulatory framework in space debris management may pose a severe risk to man's ability to travel and further commercialize outer space.

The utmost priority of the international space community would be to set strict legal rules against pollution damage and provide universal technical standards in order to organize outer space activities in a manner that preserves outer space and mitigates the creation of possible space debris. The accumulation of debris in space poses a risk not only to the protection of the space environment but also to the safety of manned missions and space objects. Embracing sustainable management policies is a necessity for the future of the space industry in order to support and ensure safety and a thriving market of innovative business enterprises.

Therefore, the legal definition of space debris and further explanations on liability, ownership, causation, and negligence should be clearly defined in the space context. Moreover, international policy changes should focus on introduction of co-financed traffic coordination mechanisms and affordable removal services, including technology development, missions, and embedded interface standards, which would reduce the cost and risk of removing space objects in case of failure. Otherwise, without legal instruments and policy developments at the inter-

⁴⁷ Arbitration of Disputes Regarding Space Activities, proceedings of the 36th Colloquium on the Law of Outer Space, IISL, October 1993, Graz, AIAA, 1994, pp. 137, 139.

national level, there will be no incentives for a greater collective action towards sustainable development of space activities.

As more countries and private corporations gain the technology and economic means to launch spacecraft, more focus should be exerted on standardizing and unifying debris mitigation procedures – both technical and legal – while adhering to international agreements.

As shown before, international involvement in the regulation-making process regarding space traffic management and space debris removal has been minimal and envisaged in a few non-binding documents. Adopting an international treaty on space debris removal and creating a dedicated international organization is a plausible option for policymakers and legislators. The main agenda of this body would be to coordinate activities harmonizing national rules and policies as well as developing space debris mitigation and clean-up plans that rely on a fund fed by financial grants supported proportionally by State Parties.

Thus, possible dispute resolution mechanisms in the form of consultations or judicial arbitration proceedings, under the supervision of the created international organization, would intend to assess the liability regime related to space debris.

Still, until significant difficulties with applying the legal liability regime to space debris are resolved, it will be impossible to launch any proceedings in this regard. Therefore, an update of international space law requires (1) the creation of a legal definition of space debris differentiated from space objects; (2) a test on proving causation between damage suffered by a standard space object and debris in orbit; (3) the establishment of a negligence regime; (4) procedures on the identification of the liable launching State; and lastly (5) construction of a mandatory international standard, from which it would be possible to assess the behaviour of a State concerned and determine whether or not this behaviour is at fault or negligent.

If issues of identity, negligence, and causation are not resolved, the Liability Convention will be ineffective in preventing debris accumulation and providing redress for damage caused by orbital debris.

REFERENCES

- Baker H.A., *Space Debris: Legal and Policy Implications*, Dordrecht 1989
Cheng B., *Studies in International Space Law*, Oxford 1997
Garber S.J., *Incentives for Keeping Space Clean: Orbital Debris and Mitigation Waivers*, 'Journal of Space Law' 2017, No. 41(2)
Haroun F., Ajibabe S., Oladimeji P., Igbozurike J.K., *Toward the Sustainability of Outer Space: Addressing the Issue of Space Debris*, 'New Space' 2021, No. 9(1)
Kessler D.J., Cour-Palais B.G., *Collision Frequency of Artificial Satellites: The Creation of a Debris Belt*, 'Journal of Geophysical Research' 1978, No. 83

-
- Lampertius J.P., *The Need for an Effective Liability Régime for Damage Caused by Debris in Outer Space*, 'Michigan Journal of International Law' 1992, No. 13(2)
- Liou J.C., *Highlights of Recent Research Activities at the NASA Orbital Debris Program Office*, Paper presented at the 7th European Conference on Space Debris, Germany, April 2017, Report No. JSC-CN-3199.
- Maniatis D., *The Law Governing Liability for Damage Caused by Space Objects: From State Responsibility to Private Liability*, 'Annals of Air and Space Law' 1997, No. 22(1)
- Williams C.D., *Space: The Cluttered Frontier*, 'Journal of Air Law and Commerce' 1995, No. 60(4)
- Van Fenema P., *Chapter 7. Legal Aspects of Launch Services and Space Transportation*, (in:) F. Von Der Dunk, F. Tronchetti (eds), *Handbook of Space Law*, Cheltenham/Northampton 2015