Outer Space Exploration and the Sustainability of the Space Environment – An Uneasy Relationship

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Abstract

In contrast with the early years of space flight that were dominated by the political priorities and military concerns of the two superpowers, the USA and the then Soviet Union, a new space era has dawned where not only states are involved as serious actors in the space arena, but also private companies. Because of the significant increase in the number of space actors, outer space is becoming a congested and competitive environment. It is self-evident that the significant increase in private and state-sponsored space ventures has serious implications for the protection and sustainability of the outer space environment. Specifically, the proliferation of space debris and the current lack of protection of vulnerable scientific, historical, and cultural sites on celestial bodies are issues of concern. Several measures to balance the seemingly competing interests of space exploration and the sustainability of the space environment have been suggested. This article aims to discuss these measures and to assess to what extent they are in conformity with the current outer space governance regime. It is concluded that the measures suggested to actively address the space debris problem and to protect the cultural heritage in space may contravene the *Outer Space Treaty*, especially the rules and prohibitions regarding property rights in space. Moreover, whilst the removal of orbital debris is essential to ensure the sustainable use of the outer space environment, some space junk may have cultural significance and be worthy of protection. A balance should thus be struck between preserving cultural heritage and managing the risks posed by space debris. It is therefore recommended that the development of interim soft-law rules (and an eventual treaty) should be undertaken under the auspices of existing United Nations bodies, namely the UNCOPUOS and UNESCO.

Keywords

Outer space; sustainability; space debris; outer space heritage; cultural heritage; human heritage; planetary parks; outer space environment; anthropocentrism; UNCOPUOS; UNESCO.

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> From low-Earth orbit to our return to the Moon, we are laying the foundation for humanity's next giant leap, human exploration of Mars.
>
> *Jim Bridenstine, former administrator of NASA.*[1]

1 Introduction

Since the launch of the first artificial satellite, Sputnik, by the Soviet Union in 1957, outer space activities have increased significantly. Having space capabilities is no longer a mere luxury for states but is becoming an increasingly important national development and security tool even for developing states.[2] Moreover, in contrast with the early years of space flight that were dominated by the political priorities and military concerns of the two superpowers, the United States of America (USA) and the then Soviet Union,[3] a new space era has dawned where not only states are involved as serious actors in the space arena but also private companies.[4] Their activities include deploying communication satellites, providing launch services, transporting goods and astronauts to the International Space Station[5] and developing technologies for space tourism[6] and outer space settlements.[7] In recent years the economic value of space resources on celestial bodies has become the particular impetus for "the current space race among numerous nations and private enterprises."[8] Because of the

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1 Bridenstine 2020 https://www.usatoday.com/story/opinion/todaysdebate/2020/05/26/nasa-going-back-moon-and-beyond-editorials-debates/5259920002/.

2 See further in this regard Ferreira-Snyman 2013 *CILSA* 19-51; Ferreira-Snyman 2018 *CILSA* 141-170; Ferreira-Snyman "Environmental Responsibility for Space Debris" 391-427.

3 Venet "The Political Dimension" 73-74.

4 Chrysaki 2020 *Space Policy* 1.

5 For example, the involvement of private companies such as SpaceX in the launching of satellites and the transporting of goods and astronauts to the International Space Station. See SpaceX 2022 https://www.spacex.com/human-spaceflight/iss/index.html.

6 See Revfine Date unknown https://www.revfine.com/space-tourism/. On the legal challenges related to space tourism, see Abul Failat and Ferreira-Snyman "Regulation of the Space Tourism Sector" 301-346; Ferreira-Snyman 2014 *PELJ* 2-50.

7 Elon Musk's SpaceX and Blue Origin, established by Jeff Bezos, are currently the most active private enterprises involved in this endeavour. See further SpaceX 2022 https://www.spacex.com/human-spaceflight/iss/index.html; Blue Origin 2022 https://www.blueorigin.com/.

8 Babcock 2019 *Syracuse L Rev* 196. Babcock points out that "[s]pace exploration is heating up. Governments and private interests are on a fast track to develop technologies to send people and equipment to celestial bodies, like the moon and asteroids, to extract their untapped resources" (Babcock 2019 *Syracuse L Rev* 191).

significant increase in the number of space actors, outer space is becoming a congested and competitive environment.

It is self-evident that the significant increase in private and state-sponsored space ventures has serious implications for the protection and sustainability of the outer space environment.[9] Specifically, the proliferation of space debris and the current lack of protection of vulnerable scientific, historical, and cultural sites on celestial bodies are issues of concern. Several measures to balance the seemingly competing interests of space exploration and the sustainability of the space environment have been suggested. This article aims to discuss these measures and to assess to what extent they are in conformity with the current outer space governance regime.

2 Sustainability of the outer space environment

Sustainability is a complex and multi-faceted concept.[10] The most commonly referred to definition of "sustainability" is that used by the United Nations World Commission on Environment and Development in its Brundtland Report of 1987 as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[11] As such, "sustainability" has both present and future-directed dimensions that impact on the following three interrelated areas: ecological sustainability, which "means to preserve our (natural) environment for the benefit of ourselves and future generations"; economic sustainability, which "means to create and sustain economies such that they are a sound basis for common prosperity" and social sustainability, which "means to develop stable, liveable societies".[12] The goal of sustainability is thus "to balance environmental protection and economic development in a way that is sustainable for both present generations and the future of humankind."[13] Although the principle of sustainability has been formulated in several international documents,[14] its precise content remains vague and ambiguous.[15] In this regard, Viikari[16] submits as follows:

9 See Kramer 2014 *Space Policy* 215-216 for examples of these ventures.
10 See Viikari *Environmental Element in Space Law* 134-135.
11 UN 1987 https://www.are.admin.ch/are/en/home/sustainable-development/international-cooperation/2030agenda/un-_-milestones-in-sustainable-development/1987--brundtland-report.html (Brundtland Report).
12 Soucek "Space and Sustainability" 571.
13 Viikari *Environmental Element in Space Law* 129.
14 See Viikari *Environmental Element in Space Law* 130-133.
15 Viikari *Environmental Element in Space Law* 134.
16 Viikari *Environmental Element in Space Law* 134.

> Although sustainable development is today a goal widely accepted on both international and national levels, there is no consensus on its content, let alone on how the principle should be given practical effect. If it is not possible to identify at least a somewhat solid, commonly accepted core for a principle, states retain considerable discretion and are in practice free to determine its meaning as suits them best. Needless to say, this is likely to contribute to great divergence of policy and interpretation and render the principle in question little more than an empty shell.

A precise definition of "sustainability" specifically in the context of outer space also does not currently exist. In fact, the concept has only fairly recently, in 2010, been recognised as an agenda item of the Scientific and Technical Subcommittee of the United Nations Committee for Peaceful Uses of Outer Space (UNCOPUOS).[17] In 2019 the Committee adopted the Guidelines for the Long-term Sustainability of Outer Space Activities.[18] These voluntary Guidelines define the long-term sustainability of outer space as

> the ability to maintain the conduct of space activities indefinitely into the future in a manner that realizes the objectives of equitable access to the benefits of the exploration and use of outer space for peaceful purposes, in order to meet the needs of the present generations while preserving the outer space environment for future generations.

In conformity with the definition of terrestrial sustainability in the Brundtland Report, the Secure World Foundation[19] describes "space sustainability" as "[e]nsuring that all humanity can continue to use outer space for peaceful purposes and socioeconomic benefit now and in the long term."[20] Thus, as Schrogl[21] submits, "the concept of achieving unimpeded use of outer space for all actors today as well as in the future, seems to be underlying the term sustainability" also in outer space. However, the increase in space activities, including those engaged in by private actors,[22] is presenting several challenges to the unimpeded use of outer space. Most notably, the rapid

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17 *Report of the Scientific and Technical Committee of UNCOPUOS on its 47th Session, Vienna 8-19 February 2010* UN Doc A/AC.105/958 (2010) paras 174-203. Also see Schrogl "Space and Its Sustainable Uses" 604.

18 *Guidelines for the Long-Term Sustainability of Outer Space Activities* UN Doc A/AC.105/2018/CRP.20 (2018).

19 The Secure World Foundation "envisions the secure, sustainable and peaceful uses of outer space contributing to global stability and benefits on Earth". Its mission is therefore "to work with governments, industry, international organizations, and civil society to develop and promote ideas and actions to achieve the secure, sustainable, and peaceful uses of outer space benefiting Earth and all its peoples". See Secure World Foundation 2022 https://swfound.org/about-us/who-we-are/.

20 Secure World Foundation 2019 https://swfound.org/our-focus/space-sustainability/. Also see Chrysaki 2020 *Space Policy* 3, who points out that there is a close connection between sustainability in outer space and on Earth.

21 Schrogl "Space and Its Sustainable Uses" 604.

22 Chrysaki 2020 *Space Policy* 3.

adding of mega satellite constellations in space by SpaceX through its Starlink project is not only significantly adding to space debris and space congestion[23] but also poses environmental risks because of increased CO_2 emissions when these high volumes of satellites are launched.[24] Especially the possible recurring risk of on-orbit failures of Starlink satellites is creating concerns that the low-earth orbit is becoming littered with non-functioning satellites.[25] Therefore, as Chrysaki[26] points out,

> [g]iven that the global launch rate has more than doubled over the course of the past decade [i.e. between 2010 and 2020] and that new innovative and incremental players have been joining the industry, much more sustainable behaviour is required from now on.

Apart from the Guidelines for the Long-term Sustainability of Outer Space Activities referred to earlier, there are other non-binding, voluntary international initiatives attempting to ensure sustainability of the outer space environment. These include the European Union's *Draft International Code of Conduct on Outer Space Activities*,[27] and a Group of Governmental Experts, appointed by the UN Secretary General, with the aim of exploring possible Transparency and Confidence Building Measures (TCBMs) for outer space.[28]

The current focus of sustainability in outer space is limited mainly to the low-earth orbit, without much consideration of the wider space environment.[29]

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23 O'Callaghan 2019 https://www.scientificamerican.com/article/spacexs-starlink-could-cause-cascades-of-space-junk/.

24 Chrysaki 2002 *Space Policy* 3. Chrysaki points out that "[b]e it single space launches or future multiple launches by a reusable system, it could be said that the number of space launches has increased in general and is on an upward trend" (Chrysaki 2002 *Space Policy* 4).

25 See in this regard Foust 2019 https://spacenews.com/starlink-failures-highlight-space-sustainability-concerns/, who refers to these concerns expressed at the Secure World Foundation's Summit for Space Sustainability.

26 Chrysaki 2020 *Space Policy* 3.

27 *Draft International Code of Conduct for Outer Space Activities* (2014). EU 2014 Activities https://www.eeas.europa.eu/sites/default/files/space_code_conduct_draft_vers_31-march-2014_en.pdf.

28 *Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities* UN Doc A/68/189 (2013).

29 Newman and Williamson 2018 *Space Policy* 31, 33. The authors (Newman and Williamson 2018 *Space Policy* 33) provide the following reasons for this trend: "First, it is easier to consider short-term issues than to extrapolate into a relatively unknown future. Second, it is more acceptable (especially in a constrained financial environment) to consider practical sustainability issues rather than 'what-if' scenarios. Third, space professionals under the age of 45 years have lived only in a world bound by the limitations of human travel to LEO, much as their forebearers did before December 1968 when Apollo 8 travelled to the Moon."

However, in view of the renewed interest in lunar exploration[30] and plans to establish human settlements on the Moon and even Mars in the not-too-distant future, the long-term sustainability of the outer space environment beyond the low-earth orbit is imperative.[31] Apart from NASA's current Artemis Programme[32] to establish a permanent human base on the Moon, China and Russia are cooperating to build a lunar research facility by 2030.[33] Time is thus of the essence.

Although the *Outer Space Treaty*[34] does not contain an explicit provision dealing with the sustainable use of outer space, it may be inferred from some of its provisions. Article I of the Treaty determines that

> [t]he exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries, irrespective of their degree of economic or scientific development, and shall be the province of all mankind. Outer space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind, on a basis of equality and in accordance with international law, and there shall be free access to all areas of celestial bodies. There shall be freedom of scientific investigation in outer space, including the moon and other celestial bodies, and States shall facilitate and encourage international co-operation in such investigation.

Therefore, based on this provision, which embodies the notion of the free use and exploration of outer space, it may be argued that states and the private actors acting under their authorisation and supervision[35] are

30 The USA, China and the former Soviet Union have visited the Moon on several occasions and brought back samples of the mineral wealth on the Moon. Recently, missions by the NASA and India showed large deposits of ice water locations throughout the lunar poles. See Luxembourg Space Agency 2020 https://space-agency.public.lu/en/space-resources/ressources-in-space.html. Other countries including Japan, South Korea, Russia, India, and the United Arab Emirates also plan lunar missions in the foreseeable future. See Pickrell 2022 https://www.nature.com/articles/d41586-022-01252-7.

31 Newman and Williamson 2018 *Space Policy* 31.

32 See NASA 2021 https://www.nasa.gov/artemisprogram.

33 China National Space Administration 2021 http://www.cnsa.gov.cn/english/n6465652/n6465653/c6812150/content.html.

34 *Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, 1967 (*Outer Space Treaty*).

35 Article VI of the *Outer Space Treaty* determines as follows: "States Parties to the Treaty shall bear international responsibility for national activities in outer space, including the moon and other celestial bodies, whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The activities of non-governmental entities in outer space, including the moon and other celestial bodies, shall require authorization and continuing supervision by the appropriate State Party to the Treaty. When activities are carried on in outer space, including the moon and other celestial bodies, by an international

prohibited from engaging in space activities that will result in adverse environmental effects to the detriment of the interest and benefit of other states.[36] Article 1 thus reflects the principle of equity, which is inherent in sustainable development.[37] As Viikari[38] explains,

> the idea of equity may necessitate assistance from industrialized states to less developed countries to enable the latter to pursue sustainable development by both realizing their potential rights in outer space and protecting that environment.[39]

Article IX of the *Outer Space Treaty*, which may be regarded as the most environmentally relevant article in the Treaty, requires that states must conduct their exploration of the Moon and other celestial bodies in such a manner as "to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter."[40] It has therefore been argued that the deliberate degradation of outer space infringes on equity as it prevents other states from using outer space.[41] In this regard, mention should be made of the Committee on Space Research (COSPAR)[42] as the authoritative body to provide guidelines on the implementation of Article IX.[43] Through its regularly updated Policy on Planetary Protection, COSPAR provides soft-law guidelines on the design of space missions to protect celestial bodies

organization, responsibility for compliance with this Treaty shall be borne both by the international organization and by the States Parties to the Treaty participating in such organization."

36 Cinelli and Pogorzelska 2013 *RECIEL* 190.

37 Viikari *Environmental Element in Space Law* 135, 145.

38 Viikari *Environmental Element in Space Law* 146.

39 The extent of the international regulation that is needed to ensure the equitable use of outer space, as the "province of all mankind" has been a matter of contention between developed and developing states. See further in this regard, Ferreira-Snyman 2021 *PELJ* 6-13.

40 Article VII of the *Agreement Governing the Activities of States on the Moon and Other Celestial Bodies* (1979) (*Moon Agreement*) similarly determines that: "In exploring and using the moon, States Parties shall take measures to prevent the disruption of the existing balance of its environment, whether by introducing adverse changes in that environment, by its harmful contamination through the introduction of extra-environmental matter or otherwise. States Parties shall also take measures to avoid harmfully affecting the environment of the earth through the introduction of extraterrestrial matter or otherwise." It should, however, be noted that the Agreement has to date been signed by only a very limited number of states, which do not include the major space-faring states such as the USA and Russia.

41 Viikari *Environmental Element in Space Law* 146.

42 See COSPAR Date unknown https://cosparhq.cnes.fr/.

43 Hanlon "Planetary Protection" 183.

from biological contamination, and the Earth against back-contamination in the case of Earth-return missions.[44]

Cinelli and Pogorzelska[45] argue that Article I of the *Outer Space Treaty* prioritises the protection of human interests in outer space and "possible environmental damage to outer space can be considered illegal only in the context of the damage to a state's interest." Similarly, Viikari[46] concludes that the *Outer Space Treaty* places a clear emphasis on the exploitation rather than the conservation of outer space resources and the protection it offers seems to be directed at safeguarding human activities rather than environmental concerns. According to her,

> [s]ubsequent space law instruments have not managed to rectify shortcomings of the OST [Outer Space Treaty]. Accordingly, legal protection of the environment in space law still depends on the violation of certain goods valuable to humans, as specified in the Liability Convention. Damage which does not affect the property of any entity or human health falls outside the scope of the Liability Convention – and thereby of what is even somewhat effective regulation by the international law of outer space. Hence, launching states cannot be held liable for the mere presence in outer space of any form of pollution or even for damage the pollution may have caused to the environment outside the sovereign territory of states. If the interests of states are not affected, the outer space environment is without protection.[47]

These arguments support the contention that there is an anthropocentric approach to the principle of sustainability[48] and the protection of the outer space environment.[49] In anthropocentrism "only human beings have rights" and "the basis of intrinsic value is the individual's capacity to think rationally and act morally."[50] The value of nature therefore lies only in its contribution to human welfare.[51] Consequently, in most instances the achievement of

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44 For the latest version see COSPAR 2020 https://cosparhq.cnes.fr/assets/uploads/2020/07/PPPolicyJune-2020_Final_Web.pdf.

45 Cinelli and Pogorzelska 2013 *RECIEL* 190. Also see Hanlon "Planetary Protection" 183-188.

46 Viikari *Environmental Element in Space Law* 111.

47 The liability and responsibility of states for damage caused by their space activities, have been extensively dealt with by this author in Ferreira-Snyman "Environmental Responsibility for Space Debris" 391-427; Ferreira-Snyman 2013 *CILSA* 19-51 and therefore falls outside the scope of the current contribution.

48 See Viikari *Environmental Element in Space Law* 131 who states that the formulation of the principle of sustainability in several international instruments has been criticised for its utilitarianism and anthropocentrism. She explains as follows: "In all of these formulations, the principle seems to be implicitly or explicitly based on the presumption that 'development' means economic growth. Unlimited economic growth is regarded as not only desirable, but also possible, as long as it remains 'sustainable'".

49 Cinelli and Pogorzelska 2013 *RECIEL* 189.

50 Fogg 2000 *Space Policy* 207.

51 Fogg 2000 *Space Policy* 207.

space mission objectives is given primacy over their environmental impact.[52] However, it is increasingly realised that the space environment has value in itself and that it could be negatively affected by human activities,[53] necessitating the adoption of a code for ethical conduct in outer space.[54] As Newman and Williamson stress, "the promotion of sustainability as a core value in space activity becomes ever more urgent when considering the planning and development of [space missions] beyond the low-earth orbit."[55]

The link between the protection of world heritage and sustainable development on Earth is well-established.[56] It is accepted that the preservation of cultural and natural heritage plays an important role in promoting social, environmental and economic sustainability.[57] As such, "a broader concept of sustainable development includes not only environmental, but also economic, social and cultural aspects."[58] This interconnection is also recognised by the European Union, which identifies sustainability as one of the five pillars of its Framework for Action on Cultural Heritage.[59]

Although the *World Heritage Convention*[60] does not make specific mention of sustainability,[61] the notion is firmly entrenched in the Operational Guidelines to the Convention, which *inter alia* note that "[t]he protection and conservation of the natural and cultural heritage are a significant contribution to sustainable development".[62] Furthermore, in 2015 the 20th General Assembly to the *World Heritage Convention* specifically adopted a

52 Newman and Williamson 2018 *Space Policy* 35.
53 Williamson 2003 *Space Policy* 47.
54 See further Chrysaki 2020 *Space Policy* 1-15; Williamson 2003 *Space Policy* 47-52.
55 Newman and Williamson 2018 *Space Policy* 35.
56 Giliberto and Labadi 2022 *International Journal of Heritage Studies* 2.
57 UNESCO Date unknown https://whc.unesco.org/en/sustainabledevelopment/.
58 Gražulevičiūtė 2006 *Environmental Research, Engineering and Management* 74.
59 European Commission Date unknown https://culture.ec.europa.eu/cultural-heritage/cultural-heritage-in-eu-policies/sustainability-and-cultural-heritage#:~:text=Sustainability%20is%20one%20of%20the,achieve%20inclusive%20and%20sustainable%20development.
60 *UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage* (1972) (*World Heritage Convention*).
61 The notion "sustainability" is implied in Arts 4 and 5 of the Convention, however. See further European Commission Date unknown https://culture.ec.europa.eu/cultural-heritage/cultural-heritage-in-eu-policies/sustainability-and-cultural-heritage#:~:text=Sustainability%20is%20one%20of%20the,achieve%20inclusive%20and%20sustainable%20development.
62 *Operational Guidelines for the Implementation of the World Heritage Convention* WHC.21/01 (2021). See further on the notion "sustainability", as included in the Operational Guidelines, UNESCO https://whc.unesco.org/en/sustainable development/.

Policy on the Integration of a Sustainable Development Perspective into the Process of the World Heritage Convention.[63] The adoption of this policy is regarded as a "landmark achievement" for promoting more holistic approaches linking heritage with the planet, the people and the economy.[64]

It is submitted that the sustainable use of outer space should be interpreted broadly to include the preservation of the cultural and natural heritage on celestial bodies.[65] This may, however, give rise to a particular conflict: whilst the protection of culturally significant space objects should be regarded as part of the sustainable use of outer space, the removal of space debris objects which might be deemed culturally relevant could be equally important to ensure the sustainability of the outer space environment.

3 The environmental, historical and cultural protection of outer space

3.1 The mitigation and active removal of space debris[66]

There may be several adverse effects on the environment resulting from outer space activities.[67] As alluded to earlier, the existing outer space treaties pay very little attention to environmental issues, as these issues were not high on the agenda of spacefaring nations at the time of their conclusion.

63 Text available from UNESCO https://whc.unesco.org/en/sustainabledevelopment/.

64 Giliberto and Labadi 2022 *International Journal of Heritage Studies* 3.

65 Zajacowski "Could the Moon's Cultural Heritage be Inscribed on UNESCO's World Heritage List?" 24. Former NASA administrator, Jim Bridenstine, commented that: "As we go forward to the moon with the Artemis Program, NASA has been clear that we must do so sustainably. As part of the Artemis Accords agreements signed with partner nations, NASA has emphasized that protecting historically significant sites is critical, and I applaud the leaders of this legislation for their commitment to ensuring that future lunar science and exploration is done in a safe and transparent manner." See Pearlman 2021 https://www.space.com/one-small-step-space-heritage-act.html. Also see the paper by Canada, *Consideration of Areas for Possible New Guidelines Concerning the Long-Term Sustainability of Outer Space Activities* UN Doc A/AC.105/C.1/2023/CRP.17 (2023), which *inter alia* recommends a "discussion on the procedures for notification and coordination to avoid harmful interference, or preserving outer space heritage (i.e., historically significant landing sites, artefacts, and spacecraft)" (para 3(d)).

66 This section is based on research by this author in Ferreira-Snyman "Environmental Responsibility for Space Debris" 391-427.

67 Hofmann 2007 *SAYIL* 233. See further n 87 below for examples of environmental problems related to space activities.

Despite some of the provisions of the space treaties being environmentally relevant,[68] the obligations of states with regard to space activities are very general and, as has been mentioned earlier, tend to focus more on the safeguarding of human activities and interests than on environmental concerns.[69] As a result, outer space law is of little assistance in the environmental management of space activities.[70] Since many activities in outer space (particularly the creation of space debris) carry environmental risks, the relevance of international environmental law to space seems to be self-evident.[71] Moreover, Article III of the *Outer Space Treaty* provides that states parties shall carry out their space activities in accordance with international law, thereby confirming the applicability of international environmental law to outer space.[72] Despite this, the principles of international environmental law have not in practice been extended to apply to outer space also.[73]

In a study on the environmental element in space law, Viikari[74] examines the applicability of the key principles of international environmental law to the space sector.[75] She concludes that these principles are formulated in vague terms due to their inherent characteristic of balancing different interests. Consequently, the principles are open to different interpretations, which complicate their practical implementation.[76] These shortcomings aside, the international environmental principles apply to all areas of the human environment, including outer space, and can therefore provide the basis for the development of more detailed rules. They can, at least, serve as basic rules to revise and develop outer space law from an environmental premise, to address certain deficits in the current space treaties and to assist with problems related to the interpretation of existing space law.[77]

68 See Viikari *Environmental Element in Space Law* 58-104 for a critical discussion of these provisions.

69 See Viikari *Environmental Element in Space Law* 111.

70 See Viikari *Environmental Element in Space Law* 112.

71 Leister and Kovudhikulrungsri 2009 *Proceedings of the International Institute of Space Law* 148. The authors point out that some of the principles developed in international environmental law can also be identified in space law, eg. the principles of international co-operation, the prevention of damage, responsibility and damage reparation, sustainable development, intergenerational equity and citizen participation.

72 Viikari *Environmental Element in Space Law* 120.

73 Leister and Kovudhikulrungsri 2009 *Proceedings of the International Institute of Space Law* 148.

74 Viikari *Environmental Element in Space Law* 129-203.

75 These principles are: (1) sustainable development; (2) good neighbourliness and due diligence; (3) the precautionary principle; (4) common but differentiated responsibilities; and (5) the "polluter pays" principle.

76 Viikari *Environmental Element in Space Law* 204.

77 Viikari *Environmental Element in Space Law* 204.

International environmental law should therefore be consulted as far as possible while taking the special features of space law into account.[78] In this regard, analogies available from other areas such as the law of the air and the laws applicable to the seabed, the high seas and activities in Antarctica could provide guidance in the implementation of international environmental law in the context of outer space.[79] Lyall and Larsen[80] even argue that a general international duty towards the preservation and conservation of the environment in and outside the areas of the national sovereignty of states, thus including outer space, is developing. According to them, the reference by the International Court of Justice in its Advisory Opinion on the *Threat or Use of Nuclear Weapons*[81] to harm done to "generations unborn" may just as well include the degradation of the space environment.[82] They point out that terrestrial environmental law is applicable to the global environment[83] and not only those parts within the jurisdiction of states. They therefore argue that since environmental rights and duties go beyond national jurisdictional constraints, they constitute obligations *erga omnes*.[84] If one accepts this reasoning, it could further be argued that states and/or private companies under their jurisdiction and control should be required to perform environmental impact studies to determine the impact of their planned activities on the outer space environment.[85] This would adhere to the principle of due regard and the precautionary principle in international

78 Viikari *Environmental Element in Space Law* 204.

79 Viikari *Environmental Element in Space Law* 205-206.

80 Lyall and Larsen *Space Law* 250.

81 *Legality of the Threat or Use of Nuclear Weapons in Armed Conflict* 1996 ICJ Reports 226.

82 The ICJ confirmed the principle of state responsibility in the context of international environmental law and held that "the environment is not an abstraction, but represents the living space, the quality of life and the very health of human beings, including generations unborn. The existence of the general obligation of States to ensure that activities within their jurisdiction and control respect the environment of other States or of areas beyond national control is now part of the corpus of International Law relating to the environment" (*Legality of the Threat or Use of Nuclear Weapons in Armed Conflict* 1996 ICJ Reports 226 para 29).

83 It is suggested that the use of the term "universal" may be more appropriate here. The term "global" seems to be limited geographically to describing planet Earth (the "globe"), and it is suggested that to include outer space in its ambit would be to over-extend its literal meaning. However, geographically speaking, the term "universal" according to its literal meaning might be used to denote the entire universe (planet Earth and outer space) and need not carry only the limited meaning associated with the term "global". See Ferreira and Ferreira-Snyman "Extraterritorial Application of Human Rights Instruments in Outer Space Settlements" 489-490.

84 Lyall and Larsen *Space Law* 250. Also see Viikari *Environmental Element in Space Law* 140.

85 For a discussion on extraterrestrial environmental impact assessments, see Kramer 2014 *Space Policy* 215-222.

environmental law.[86] However, because of the unique features of the outer space environment, one cannot merely replicate terrestrial environmental managements practices. States would therefore, for example, have to agree on the process and the factors to be assessed in an outer space environmental impact study to ensure its scientific validity.

Although there are several environmental problems related to space activities,[87] the most significant of these remains space debris.[88] The damage caused by space debris could arise from space debris falling on Earth, colliding with other objects in space or interfering with telecommunications and remote sensing.[89] However, one of the biggest risks associated with space debris is the possible collision of objects that are travelling around Earth.[90] This poses a significant threat to spacecraft, space stations and astronauts.[91] In addition, the growing number of artificial satellites and space debris in low-earth orbit is increasing the overall brightness of the night sky. This places constraints on ground-based astronomy that is reliant on dark skies.[92]

The possibility of these collisions has risen significantly over the past few years because of the rapid increase in the quantity of space debris.[93] Commercial and state-sponsored launches, as well as the destruction of satellites in space,[94] have the potential to create unlimited volumes of space

86 Kramer 2014 *Space Policy* 220.

87 These include (among other things) nuclear contamination, solar power satellites, manned space stations and exobiological contamination. See Viikari *Environmental Element in Space Law* 45-54 for a discussion of these environmental problems.

88 Viikari *Environmental Element in Space Law* 31.

89 Diedericks-Verschoor and Kopal *Introduction to Space Law* 127.

90 Lyall and Larsen *Space Law* 271.

91 Lyall and *Larsen Space Law* 273.

92 Barentine *et al* 2023 https://www.nature.com/articles/s41550-023-01904-2.

93 Diedericks-Verschoor and Kopal *Introduction to Space Law* 306; Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 285.

94 In 2018 emergency repairs had to be made to the International Space Station after it was hit by a piece of space debris, resulting in a two-millimetre hole through which the oxygen inside the Space Station leaked. See Knapton 2018 https://www.telegraph.co.uk/science/2018/08/30/international-space-station-leaking-air-hit-space-debris/. According to NASA's former administrator, Jim Bridenstine, the International Space Station had to be moved to avoid space debris three times only in 2020. See Griggs 2020 https://www.theverge.com/2020/9/23/21451587/iss-space-junk-debris-avoidance-maneuverhttps://www.theverge.com/2020/9/23/21451587/iss-space-junk-debris-avoidance-maneuver. In November 2021 the International Space Station had to make a manoeuvre to avoid a possible collision with a piece of space junk from a 2007 Chinese anti-satellite test. See Rigby and Carter 2021 https://theconversation.com/a-chunk-of-chinese-satellite-almost-hit-the-international-space-station-they-dodged-it-but-the-space-junk-problem-is-getting-worse-171735. A 2021 Russian ASAT test instantly created more than 1 500 pieces

debris.[95] Even if no further space operations are undertaken, the level of fragmentation of orbital debris will continue to escalate exponentially,[96] causing a potential cascade in debris collisions (the so-called Kessler syndrome).[97] Although the chances that falling space debris could hit someone on Earth are generally fairly low,[98] the potential environmental hazards, especially those caused by radioactive material or toxic fuels, are obvious. In this regard, brief mention should be made of the so-called spacecraft cemetery. This is a large area, called Point Nemo, in the Pacific Ocean beyond any state's jurisdiction, around 3 000 miles off the eastern New Zealand coast and 2 000 miles off Antarctica. Space-faring states such as Russia, the USA, Japan, and some European states have sunken more than 263 pieces of space debris in this area since 1971 through the controlled de-orbiting of space debris. Although this area is devoid of human life, it is inhabited by marine life and likely hosts vulnerable ecosystems. It has been suggested that the pieces of debris landing in the ocean through these controlled splashdowns may contain harmful substances, in particular toxic chemicals, and radio-active material harmful to the marine environment.[99]

The issue of space debris is not mentioned in any of the space treaties,[100] and to date no legally binding definition of "space debris" has been formulated. Article 1(d) of the *Liability Convention*[101] rather vaguely defines a "space object" as including the "component parts of a space object as well as its launch vehicle and parts thereof". Consequently, commentators differ on what space debris is and when a particular piece of debris should be regarded as a space object for the purposes of the *Liability Convention*. For

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of space debris which are likely to generate significant numbers of smaller debris pieces, posing an ongoing risk for space activities. See Blinken 2021 https://www.state.gov/russia-conducts-destructive-anti-satellite-missile-test/. It is, however, a positive development that by November 2022, seven countries had followed a US-led initiative to ban ASAT weapons testing. See Arms Control Association 2022 https://www.armscontrol.org/act/2022-11/news-briefs/seven-countries-join-asat-test-ban.

95 Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 287.

96 Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 286.

97 See further Lutkevich 2020 https://www.techtarget.com/whatis/definition/Kessler-Syndrome.

98 Despite many space objects having re-entered the Earth's atmosphere in a carefully guided manner, there have been several reports (including in recent years) of objects making unguided return trips to Earth. For examples, see Ferreira-Snyman "Environmental Responsibility for Space Debris" 397-399.

99 See De Lucia and Iavicoli 2019 *Cal W Int'l LJ* 345-346, 369-367.

100 Viikari *Environmental Element in Space Law* 55.

101 *Convention on International Liability for Damage Caused by Space Objects* (1971).

example, it is debated whether the size of a piece of space debris should be considered in order to describe it as a space object, as it may be argued that a piece of fragmented debris or microparticulate matter could be regarded neither as a space object nor as a component thereof.[102] Due to their velocity, small pieces of space debris could cause significant damage, however.[103] Furthermore, it is contested whether an inactive satellite is a "space object" for the purposes of the *Liability Convention*.[104] The legal status of rockets that have not reached outer space due to launch failures is also not clear.[105] Generally, the term "space debris", as defined by the Inter-Agency Space Debris Coordination Committee (IADC) and as used in the deliberations of the UNCOPUOS, refers to "all man-made objects, including fragments and elements thereof, in earth orbit or re-entering the atmosphere, that are non-functional".[106] This could thus include anything from small paint flakes to non-functional satellites, old rockets and abandoned spacecraft.[107] As will be pointed out later, the lack of a definition of space debris also poses challenges for the identification and protection of space heritage objects.

Article IX of the *Outer Space Treaty*, referred to earlier, places certain environmentally relevant limitations on states parties in conducting their space activities by providing that states must conduct their exploration of outer space, the Moon and other celestial bodies in such a manner as to avoid both their harmful contamination and adverse changes in the environment of the Earth, resulting from the introduction of extraterrestrial matter. Although no direct reference is made to space debris, it seems that this provision includes the issue of the prevention of damage by space debris. However, since this provision is formulated in very general terms and because it does not provide any guidance on the meaning of phrases

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102 Diedericks-Verschoor and Kopal *Introduction to Space Law* 128; Viikari *Environmental Element in Space Law* 69-70.

103 Diedericks-Verschoor and Kopal *Introduction to Space Law* 128; Viikari *Environmental Element in Space Law* 70.

104 In this regard Diedericks-Verschoor and Kopal's *Introduction to Space Law* 128 states that "it is questionable whether a state will be liable for a satellite which has ceased functioning or has disintegrated." Conversely, Viikari *Environmental Element in Space Law* 69-70 is of the view that "[t]here seems to be no great difficulty in designating inactive satellites [as] … space objects."

105 Viikari *Environmental Element in Space Law* 70. Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 285 identify "spent stages of rockets, broken off pieces of spaceships or equipment, old unusable satellites and even small flecks of paint" as examples of space debris.

106 *Technical Report on Space Debris* UN Doc A/AC.105/720 (1999); IADC 2020 https://orbitaldebris.jsc.nasa.gov/library/iadc-space-debris-guidelines-revision-2.pdf.

107 Schrogl "Space and Its Sustainable Uses" 605.

such as "harmful contamination" and "adverse changes in the environment", the prohibition is neither prescriptive nor very coercive.[108]

There are thus currently no binding regulations on space debris under international law.[109] At present the mitigation of space debris is a matter for voluntary compliance by states with space debris mitigation guidelines[110] and national legislation in this regard.[111] The Space Debris Mitigation Guidelines, adopted by the Scientific and Technical Sub-Committee of the UNCOPUOS, were endorsed by the UN General Assembly in 2007.[112] These voluntary guidelines for the mitigation of space debris reflect existing practices developed by a number of national and international organisations and member states that were invited by the General Assembly to implement the guidelines through relevant national mechanisms.[113] Notwithstanding arguments that voluntary, legally non-binding guidelines would disadvantage developing countries, that a legally binding framework should be adopted, or that the guidelines should at least be presented to the General Assembly as a draft resolution,[114] the guidelines were not adopted as such a resolution.[115] It should be noted in this regard, however, that even if the Space Debris Mitigation Guidelines were adopted as a resolution of the General Assembly, they would still have had the status of non-binding recommendations only.

Since the current levels of space debris are proportionate to the number of space launches to date, it may be argued that a greater responsibility for the maintenance of the environment should be imposed on the space powers that have carried out these launches.[116] This would be in accordance with the environmental law principle of "common but differentiated responsibilities" that is expressed in a number of international

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108 Sgrosso *International Space Law* 132; Viikari *Environmental Element in Space Law* 59-60; Chrysaki 2020 *Space Policy* 3.

109 Schrogl "Space and Its Sustainable Uses" 606.

110 UNOOSA 2010 https://www.unoosa.org/pdf/publications/st_space_49E.pdf.

111 Lyall and Larsen *Space Law* 270.

112 *International Cooperation in the Peaceful Uses of Outer Space* GA Res 62/217, UN Doc A/RES/62/217 (2007) (Space Debris Mitigation Guidelines).

113 See Preface to the Space Debris Mitigation Guidelines iv. Since their adoption the guidelines have steadily been implemented by the domestic systems of such states as Russia, Japan and Germany. UNCOPUOS member states also keep each other informed about their efforts to implement the guidelines at the national level. See in this regard, Tronchetti "Soft Law" 632.

114 Lyall and Larsen *Space Law* 274; Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 287.

115 Schrogl "Space and Its Sustainable Uses" 605.

116 Prasad and Lochan 2007 *Proceedings of the International Institute of Space Law* 290.

environmental law instruments.[117] According to this principle, which is based on the idea of international equity, environmental degradation has its origin mainly in the actions of industrialised countries, so that they should be primarily responsible for eradicating environmental pollution. These countries usually have greater capacity to respond to environmental problems and should therefore assist developing countries in accessing relevant resources and technologies to achieve sustainable development.[118] As a result of the differences in social, economic, and ecological circumstances between states, the environmental standards applied to industrialised and developing countries cannot be the same. Hence the need for differentiated responsibilities.[119]

Similarly in the context of outer space, non-spacefaring nations insist that spacefaring nations (thus mainly industrialised countries) that have caused (and continue to cause) the current levels of space pollution should have the main responsibility for improving the situation, in order also to guarantee the possibility of future space activities (including those of developing states). Spacefaring nations are obviously in a better position to take the necessary action in this regard.[120]

Although the principle of "common but differentiated responsibilities" is not included in any of the outer space treaties, Viikari submits that the space sector might be more receptive to the principle in future due to a gradual

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117 See, for example, principle 7 of the *Rio Declaration on Environment and Development* (1992), which provides that "[s]tates shall cooperate in a spirit of global partnership to conserve, protect and restore the health and integrity of the Earth's ecosystem. In view of the different contributions to global environmental degradation, States have common but differentiated responsibilities. The developed countries acknowledge the responsibility that they bear in the international pursuit to [sic] sustainable development in view of the pressures their societies place on the global environment and of the technologies and financial resources they command." Under Art 3(1) of the *UN Framework Convention on Climate Change* (1992) "[t]he Parties should protect the climate system for the benefit of present and future generations of humankind, on the basis of equity and in accordance with their common but differentiated responsibilities and respective capacities. Accordingly, the developed country Parties should take the lead in combating climate change and the adverse effects thereof". See further Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 294-295.

118 Viikari *Environmental Element in Space Law* 179.

119 Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 294; Viikari *Environmental Element in Space Law* 179.

120 Viikari *Environmental Element in Space Law* 182-183; Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 287note that the view was also expressed at the UNCOPUOS meeting of February 2007 that the states largely responsible for creating space debris should contribute to space debris mitigation efforts in a more significant manner than other states.

development towards creating multilateral accountability.[121] She suggests the creation of a space fund as an expression of the ideals of common but differentiated responsibilities. The fund could be used for the benefit of future generations. Such a fund would be in conformity with the notion, that states are the trustees of common resources.[122] Sgrosso also refers to suggestions that an international fund should be created to compensate victims who have suffered damage caused by unidentified space debris. States would then have to contribute to the fund before carrying out a space launch. The amount would depend on the size, mass, and harmfulness of the space object to be launched. Sgrosso doubts, however, whether this idea is feasible, as it would be very difficult to determine the amount to be paid. Developing states that would be required to participate in the fund when they commenced space activities might be opposed to this on the basis that the harmful situation had already been created by industrialised countries carrying out past space launches.[123]

To mitigate the future creation of space debris, Prasad and Lochan[124] suggest that launch quota caps should be created for spacefaring states. These states would then be awarded "debris credits" if they were to implement the UNCOPUOS Space Debris Mitigation Guidelines. Nations with advanced space programmes would also be allowed to buy "debris credits" from other countries. Developing countries that plan to develop future space capabilities could be given fixed quotas that would lapse after a certain period if they did not realise their planned space missions. These countries could, however, sell their "debris credits" to developed countries, thereby acquiring the means to develop their own space capabilities. They also propose the creation of a trust fund that would be used to compensate victims of damage resulting from space debris.

None of the suggestions discussed above provides an ideal solution to mitigate the current and future space debris problem. Spacefaring states are reluctant to participate in space debris mitigation measures that would have negative financial implications for them. It is, therefore, doubtful whether states would be willing to contribute to the proposed trust fund.

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121 Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law* 295 are similarly of the opinion that the principle of "common but differentiated responsibilities" can be extended to apply to the environmental problems caused by space debris through the drafting of a convention on the management of and liability for space debris.

122 Viikari *Environmental Element in Space Law* 183-184.

123 Sgrosso *International Space Law* 136.

124 Prasad and Lochan 2007 *Proceedings of the International Institute of Space Law* 291.

There is also the possibility that developing states would merely sell their debris credits to industrialised countries without really utilising them as a means of developing their own space capabilities.

An even more legally and technically complex issue is the active removal (as opposed to the mere mitigation) of space debris.[125] Because space debris has reached critical levels in the low-earth orbit, the mitigation of space debris alone is no longer regarded as sufficient.[126] As mentioned earlier, even if no further space operations are undertaken, the extent of the fragmentation of orbital debris will continue to escalate exponentially. Therefore, renewed calls are being made for the active removal of debris from space to "stabilise the growth of space debris".[127] Although some states and several private companies are in the process of developing technologies to clean up space,[128] the active removal of space debris presents some legal challenges. This is mainly owed to Article VIII of the *Outer Space Treaty,* which determines that:

> A State Party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object and over any personnel thereof, while in outer space or on a celestial body. Ownership of objects launched into outer space, including objects landed or constructed on a celestial body, and of their component parts, is not affected by their presence in outer space or on a celestial body or by their return to the Earth. Such objects or component parts found beyond the limits of the State Party to the Treaty on whose registry they are carried shall be returned to that State Party, which shall, upon request, furnish identifying data prior to their return.

Thus, any state or private entity seeking to actively remove orbital space debris, would need the prior consent of the registering state (i.e., the

125 Newman and Williamson 2018 *Space Policy* 32.

126 ESA Date unknown https://www.esa.int/Safety_Security/Space_Debris/Active_debris_removal.

127 ESA Date unknown https://www.esa.int/Safety_Security/Space_Debris/Active_debris_removal.

128 For example, in 2020 the European Space Agency concluded a service contract with ClearSpace SA worth €86.2 million to remove orbital space debris. ClearSpace will develop a robot-like spacecraft with four articulated arms to remove space debris safely. Its first mission is planned for 2025 to remove *Vespa*, a second payload adapter left behind by the *Vega* rocket that was placed in orbit in 2013. The robotic arms will remove *Vespa* and move it closer to the Earth's atmosphere to burn up and disintegrate. See ESA 2020 https://www.esa.int/Newsroom/Press_Releases/Call_for_Media_ESA_and_ClearSpace_SA_sign_contract_for_world_s_first_debris_removal_mission. For further examples of the latest technologies, including a drag sail and a tethered net, see Aranca 2022 https://www.aranca.com/knowledge-library/articles/ip-research/modern-technologies-to-clean-up-space-debris.

launching state[129]).[130] The removal of space debris without such valid permission would be an internationally wrongful act.[131] However, since the launching state remains responsible for any damage caused by the space object,[132] it is doubtful whether consent would easily be granted.[133] Security concerns might further prevent states from granting permission for the active removal of their debris objects. States would obviously be unwilling to provide sensitive technical and/or military information relating to debris objects in facilitating removal processes. Moreover, because of the dual-use nature of most space technologies, the risk remains that technology developed to remove space debris could also be used to destroy or damage functional space objects.[134]

From a reading of Article VIII, it appears that the state of registry maintains jurisdiction and control over a space object when it is in outer space or on a celestial body, while ownership of a space object is perpetual.[135] Thus, at present a space object, whether it is functioning or not, "is owned by some entity in perpetuity."[136] It is not clear, however, whether a state could

129 Article II(1) of the Convention on Registration of Objects Launched into Outer Space, 1974 (*Registration Covention*) determines as follows: "When a space object is launched into earth orbit or beyond, the launching State shall register the space object by means of an entry in an appropriate registry which it shall maintain. Each launching State shall inform the Secretary-General of the United Nations of the establishment of such a registry." If there are multiple launching states in respect of a space object, they must jointly determine who will register the object (see Art II(2)).

130 Newman and Williamson 2018 *Space Policy* 32; Chatterjee 2014 *Proceedings of the International Institute of Space Law* 26.

131 Article 20 of the *ILC Articles on the Responsibility of States for Internationally Wrongful Acts, Report of the International Law Commission* UN Doc A/56/10 (2001) (*ILC Articles on State Responsibility*) determines that "[v]alid consent by a State to the commission of a given act by another State precludes the wrongfulness of that act in relation to the former State to the extent that the act remains within the limits of that consent". Also see, Haroun *et al* 2021 *New Space* 65; Chatterjee 2014 *Proceedings of the International Institute of Space Law* 26-27.

132 Chatterjee 2014 *Proceedings of the International Institute of Space Law* 25.

133 Newman and Williamson 2018 *Space Policy* 32.

134 Haroun *et al* 2021 *New Space* 65. In this regard, the Vice-Commander of the United States Space Force's Space Operations Command, Major General DeAnna Burt, expressed the view that orbital removal should be undertaken by the private sector, because government-led efforts could create concerns that the technology would also be used as weapons to disable active satellites. According to her, "[w]hen you say the military is going to develop a capability to pick up trash or pick up debris, it's automatically seen as dual use." See Foust 2021 https://spacenews.com/space-force-backs-development-of-commercial-orbital-debris-removal-systems/. For a comprehensive discussion on the interrelatedness of active space removal and space weaponisation, see Frigoli "Between Active Space Debris and Space-Based Weapons" 49-70.

135 See Chatterjee 2014 *Proceedings of the International Institute of Space Law* 33; Carns, 2017 *Air Force Law Review* 174.

136 Carns 2017 *AF L Rev* 190.

relinquish its jurisdiction and control once a space object becomes non-functional "and thus a potential target for remediation".[137] Chung[138] submits that a literal reading of Article VIII suggests that a space object cannot be abandoned and become a *res nullius*, since it permanently remains the property of the registering state.[139] Hence, the doctrine of "permanent jurisdiction and control" seems to apply to space debris.[140] Chung,[141] however, favours a more restrictive interpretation of Article VIII and suggests that the "apparent absolute nature of jurisdiction and control" may be circumvented in instances where the space object is expressly or impliedly abandoned by the registering state, or in instances where the space object poses a danger for other states (a so-called "state of peril" circumstance). These exceptions are in conformity with the "due regard" principle in Article IX[142] and the "no detriment requirement" in Article I of the *Outer Space Treaty*. Although international space law does not explicitly provide for transferring the registry of a space object, Chatterjee[143] argues that Article VIII should not be an impediment to the active removal of space debris. Based on an analysis of international jurisprudence and state practice, she reiterates that states can enter into separate agreements to transfer jurisdiction and control over space objects.[144] Chatzipanagiotis,[145] however, points out that the in-orbit transfer of ownership becomes challenging when the acquiring state is not an original launching state, as this creates a discrepancy between the factual and legal exercise of jurisdiction and control:

> [I]n cases of transfer of ownership in orbit the transferring State will remain the State of registry and retain de jure jurisdiction and control over the space object, although it will not have the capacity to exercise it. Moreover, this State, as a launching State will remain liable for damages caused by the space object pursuant to Art VII OST and Art II of the Liability Convention (LC). At the same

137 Chatterjee 2014 *Proceedings of the International Institute of Space Law* 33.
138 Chung "Jurisdiction and Control Aspects of Space Debris Removal" 40.
139 Also see Chatterjee 2014 *Proceedings of the International Institute of Space Law* 33.
140 Chatterjee 2014 *Proceedings of the International Institute of Space Law* 33.
141 Chatterjee 2014 *Proceedings of the International Institute of Space Law* 41-46.
142 Article IX *inter alia* determines that "[i]n the exploration and use of outer space, including the moon and other celestial bodies, States Parties to the Treaty shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space, including the moon and other celestial bodies, with due regard to the corresponding interests of all other States Parties to the Treaty. States Parties to the Treaty shall pursue studies of outer space, including the moon and other celestial bodies, and conduct exploration of them so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose."
143 Chatterjee 2014 *Proceedings of the International Institute of Space Law* 33.
144 Chatterjee 2014 *Proceedings of the International Institute of Space Law* 30.
145 Chatzipanagiotis 2007 *German Journal of Air and Space Law* 229-230.

> time, the State to which the ownership is transferred will have de facto control over the space object, but will not either register it or be held liable for damage caused by it.[146]

By employing a dynamic interpretation of the outer space treaties in view of their object and purpose, Chatzipanagiotis concludes that in the case of an in-orbit transfer of ownership, the acquiring state, or the state that supervises the acquiring private entity, "should be regarded as a launching state and allowed by means of change of registration to register the space object obtained."[147] Such a change in registration could thus theoretically provide an avenue for the active removal of space debris by a state or a private company. However, since the (new) registering state would be responsible for damages caused by the space object, it remains to be seen whether states would be prepared to register space objects acquired by private companies under their supervision for the sole purpose of removal, especially due to the risk of causing damage to other space objects during the removal process.

Contrary to the above submissions on the interpretation of Article VIII, Gupta[148] argues that the regulation of the removal of space debris should be kept "outside the scope of Article VIII" by excluding "space debris" from the definition of "space object".[149] He therefore suggests the creation of a *sui generis* law in the form of a treaty or module law by the UNCOPUOS to specifically address space debris.[150] Several further suggestions have been made to circumvent the requirement of prior permission by the registering state by employing existing international law concepts:

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146 Chatzipanagiotis 2007 *German Journal of Air and Space Law* 230. Also see Yun 2004 *Australian Journal of International Law* 110.

147 Chatzipanagiotis 2007 *German Journal of Air and Space Law* 238. He suggests (Chatzipanagiotis 2007 *German Journal of Air and Space Law* 237) as follows: "The Space Treaties wanted to link the responsibility for damage caused by space activities with the State which carries them out, has factual control on them and obtains advantages from them, Given that the 'State procuring the launch' has the strongest connection with the operation of the space object, it would be logical and compatible with the spirit of the Space Treaties to extend the notion of the State procuring the launch to also include successor States."

148 Gupta 2019 *U Pa J Int'l L* 241.

149 Gupta 2019 *U Pa J Int'l L* 241 argues that: "if space debris is included under the definition of space object, Article VIII of the OST makes removal of space debris much more legally problematic than salvage in law of the seas. States retain control and ownership over space objects, and there are no provisions to declare these objects as derelict or wrecks. Even when a state removes the space debris of another state from orbit due to the danger posed by it to active space objects or even astronauts, the action may be considered against international law, and may even be considered an act of piracy."

150 Gupta 2019 *U Pa J Int'l L* 248.

As mentioned earlier, it is uncertain whether the size of a piece of space debris should be a factor in determining whether it is a space object. In this regard Carns[151] submits that in the case of space debris smaller than 10 cm² it is unlikely that ownership could be determined and that such objects may therefore unilaterally be removed from space without consent. According to Carns, the unilateral removal of space debris smaller than 10 cm² may be justified as constituting instant customary law,[152] thereby making the removal legal. Although it may be argued that the duty to mitigate space debris has attained the status of customary international law, it remains to be seen if state practice would indicate a general recognition of the active removal of space debris within a short period of time, as suggested by Carns.[153]

Because space debris has implications for a state's security interests, Carns[154] suggests that the right to self-defence in Article 51 of the *United Nations Charter* may further support the unilateral removal of space debris. Although it holds true that states are increasingly prepared to defend their space assets,[155] it is not clear how the unilateral removal of space debris would satisfy the requirements of self-defence, in particular the existence of an armed attack. In this context Froelich[156] points out that paragraph 4.2 of the European Union's International Code of Conduct on Outer Space Activities controversially provides for the possibility of "'anticipatory intervention' that uses the right of self-defence to avoid the creation of space debris before they damage other space assets".[157] In terms of the Code, states are prohibited from taking action in space that would directly or indirectly damage or destroy space objects, unless such action is justified. Such justification includes protecting the safety of human life or health, reducing the creation of space debris and actions provided for in the *United Nations Charter*, including the right to self-defence.[158] Several states have expressed concern that the Code's language on self-defence could

151 Carns 2017 *AF L Rev* 171, 191.
152 Carns 2017 *AF L Rev* 207-220.
153 It should be noted that the concept of "instant customary law" is a contested one amongst academics. See, for example, the criticism by Krivokapi 2017 *Acta Universitatis Danubius. Administratio* 81-98, who cautions that "various ideas on instant customs hide unimaginable possibilities of abuse, i.e. wide and at the same time very slippery space for the imposition of the will of individual states" (Krivokapi 2017 *Acta Universitatis Danubius. Administratio* 96).
154 Carns 2017 *AF L Rev* 225.
155 See in this regard, Ferreira-Snyman "Military Activities in Outer Space" 65-94.
156 Froelich "Right to (Anticipatory) Self-Defence in Outer Space" 79.
157 Froelich "Right to (Anticipatory) Self-Defence in Outer Space" 79.
158 Paragraph 2.4.

encourage an arms race in space,[159] and it is therefore doubtful whether the right to self-defence would easily be accepted by states as a justification for damaging or destroying space objects to avoid space debris.[160] Moreover, it is still contested whether the right to self-defence could be exercised in outer space, given the requirement in the *Outer Space Treaty* that outer space must be used for peaceful purposes.[161]

3.2 Planetary parks and heritage sites

The sustainable use of outer space includes the preservation of cultural and natural heritage on celestial bodies.[162] The Moon in particular has immense cultural, natural and scientific significance worthy of preservation. It is estimated that there are currently at least 170 000 kilograms of cultural material on the Moon, which should be preserved for future generations because of their scientific, technical, and social significance in the arena of space exploration.[163] Not only are there artefacts and equipment on the lunar surface recording humankind's achievements and providing scientific data, but it also has unique typographical features, natural resources such as water and helium-3, and rare metals such as titanium.[164] As activities on the Moon increase, the lunar landing heritage sites may be impacted

159 See further Ford 2017 *Hous J Int'l L* 237, 257; Irsten 2021 https://www.reachingcriticalwill.org/news/latest-news/8907-the-consultation-process-for-the-international-code-of-conduct-for-outer-space-activities-ends.

160 Froelich "Right to (Anticipatory) Self-Defence in Outer Space" 79 points out that "the right to self-defence, or the possibility of avoiding debris by destroying a space object, had been questioned especially by Russia, which sees it as a pretext to destroy the space objects of other states".

161 For a further discussion by this author on the right to self-defence in outer space, see Ferreira-Snyman "Military Activities in Outer Space" 78-84.

162 Zajackowski "Could the Moon's Cultural Heritage be Inscribed on UNESCO's World Heritage List?" 24. NASA administrator, Jim Bridenstine, commented that: "As we go forward to the moon with the Artemis Program, NASA has been clear that we must do so sustainably. As part of the Artemis Accords agreements signed with partner nations, NASA has emphasized that protecting historically significant sites is critical, and I applaud the leaders of this legislation for their commitment to ensuring that future lunar science and exploration is done in a safe and transparent manner." See Pearlman 2021 https://www.space.com/one-small-step-space-heritage-act.htm. Zajackowski "Could the Moon's Cultural Heritage be Inscribed on UNESCO's World Heritage List?" 25 also links the identification of heritage sites in space with sustainable development.

163 Rotola "Legal Framework Protecting Cultural Heritage Sites on the Moon" 1. The US-based non-profit organisation, For All Moonkind, keeps a registry of sites on the Moon that "host evidence of human activity and ingenuity", including objects, bootprints and space vehicle tracks. See For All Moonkind Date unknown https://moonregistry.forallmoonkind.org/about-us/.

164 Rosendal 2019 *Wm & Mary Envtl L & Pol'y Rev* 843-846.

negatively.[165] Plans to exploit the resources on Mars and to terraform it for human settlement in future also necessitate the protection of the biological and natural heritage on the Red Planet.[166] It has been calculated that there are already 7 119 kilograms of human-made objects on the surface of Mars, consisting of "discarded hardware, inactive spacecraft and crashed spacecraft" as the remains of more than 50 years' robotic missions. However, these debris objects also have important cultural and historical value, as the discarded objects are evidence of "the early milestones for human planetary exploration".[167]

Calls for the protection of heritage in outer space have been made in several documents. The Hague *Building Blocks for the Development of an International Framework on Space Resource Activities*[168] proposes that a future international framework on space resource activities should avoid and mitigate "adverse changes to designated and internationally endorsed outer space natural or cultural heritage sites"[169] as well as to "designated and internationally endorsed outer space sites of scientific interest."[170] The Artemis Accords[171] also specifically determines that "NASA and partner nations will commit to the protection of sites and artifacts with historic value". There are, however, currently no binding international law rules that are specifically aimed at protecting the cultural and natural heritage on the Moon and Mars. Two treaties were adopted to protect the terrestrial and maritime heritage on Earth, namely the *World Heritage Convention* and the *Underwater Heritage Convention.*[172] These treaties are not applicable to heritage sites in outer space, however, due to their obvious geographical limitations. Whilst the *Underwater Heritage Convention* is particularly aimed at the protection of cultural heritage below the Earth's oceans, the World *Heritage Convention* obliges a state party to identify and protect the cultural

165 Pham "Does the Outer Space Treaty Permit the Protection and Preservation of Cultural Heritage Sites on the Moon?" 36-37.

166 See further Rosendal 2019 *Wm & Mary Envtl L & Pol'y Rev* 847-851.

167 Kilic 2022 https://www.space.com/mars-littered-with-human-trash.

168 Adopted on 12 November 2019 by The Hague International Space Resources Governance Working Group (Leiden University 2019 https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group).

169 Leiden University 2019 https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group para 10(h).

170 Leiden University 2019 https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group para 10(i).

171 The Artemis Accords 2022 https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf.

172 *UNESCO Convention on the Protection of the Underwater Cultural Heritage* (2001).

and natural heritage situated in its territory.[173] Although it could be argued that space objects of outstanding cultural value could fit into the definitions provided in the Convention,[174] its provisions pertain to heritage in a state's territory, making it incompatible with the *Outer Space Treaty* that explicitly determines in Article II that

> [o]uter space, including the moon and other celestial bodies, is not subject to *national appropriation by claim of sovereignty, by means of use or occupation, or by any other means*.[175]

This prohibition on establishing property rights in outer space is premised on the notion that outer space is the common heritage of humankind and therefore, as a *res communis*,[176] not subject to appropriation. Although the outer space treaties do not explicitly provide for the protection of outer space heritage, some provisions might assist to some extent in arguing for the protection of space heritage objects and sites:

It has been argued that the phrase "freedom of use" in Article 1 of the *Outer Space Treaty* should be broadly interpreted to include the freedom to protect and preserve cultural heritage in outer space.[177] It could further be argued that the preservation of cultural heritage sites in outer space, as the "province of all mankind", is for the benefit of all nations and subsequent generations.[178] However, as will be pointed out below, the unilateral protection of heritage sites by one state could simultaneously result in preventing the use and exploration of that outer space location by other states.

As discussed earlier, Article VIII of the *Outer Space Treaty* determines that the state of registry of a space object retains perpetual ownership of such an object in outer space or on a celestial body. This obviously refers to the movable objects of a state. This raises the question whether control over immovable objects in outer space, such as the boot prints of Neil Armstrong on the Moon, could be construed as some form of appropriation, which

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173 Rosendal 2019 *Wm & Mary Envtl L & Pol'y Rev* 860.

174 Rotola "Legal Framework Protecting Cultural Heritage Sites on the Moon" 7. See Art 1 of the *World Heritage Convention* for the definition of "cultural heritage". The *Operational Guidelines for the Implementation of the World Heritage Convention* WHC.21/01 (2021*)* 29 lists the criteria to identify cultural heritage of outstanding universal value. Also see Martin "The 'Outstanding Universal Value' Concept" 53.

175 Own emphasis.

176 Freeland and Jakhu "Article II" 49.

177 Pham "Does the Outer Space Treaty Permit the Protection and Preservation of Cultural Heritage Sites on the Moon?" 27.

178 Pham "Does the Outer Space Treaty Permit the Protection and Preservation of Cultural Heritage Sites on the Moon?" 31.

would be in contravention of Article II of the *Outer Space Treaty*.[179] Moreover, because of the uncertainties regarding the meaning of the term "space object", it will have to be established whether a particular cultural object indeed falls within the definition of a "space object" in the *Liability Convention* referred to earlier. It is clear, however, that in terms of the Convention's definition, Armstrong's boot prints will not be regarded as a space object of which the USA has ownership of.

As previously alluded to, Article IX of the *Outer Space Treaty* provides that in their exploration of outer space, including the Moon and other celestial bodies, states must have due regard for the interests of other states and avoid the harmful contamination of the space environment. It could thus be argued that states, or the private companies acting under their authorisation and supervision, may not intentionally or negligently cause damage to cultural sites or objects on the Moon or Mars. Article IX furthermore provides that in the event of such possible "harmful interference" international consultations must be undertaken before proceeding with the activity. A state could therefore assert that the activities of another state or a private company endanger its objects or sites with a cultural value, and request consultations before the activities continue. The precise meaning of the standard "due regard" and the phrase "harmful contamination" is not clear,[180] however, and would thus probably have to be determined on a case-to-case basis by balancing the interests of the stakeholders involved.[181] In this regard Hanlon[182] stresses that "[t]he concept of harmful contamination can and must now be interpreted to include more esoteric contamination considerations including aesthetic and historic."

It is self-evident that heritage sites such as the lunar landing sites should be preserved *in situ*. Not only would it be very expensive and technologically challenging to safely dismantle and remove these objects, but the scientific value of the sites would be compromised should the objects be removed from their "context and associated environment".[183] Consequently, access to these sites would have to be significantly limited or even prohibited which,

179 Rotola "Legal Framework Protecting Cultural Heritage Sites on the Moon" 7.

180 Hanlon 2021 https://theconversation.com/apollo-landers-neil-armstrongs-bootprint-and-other-human-artifacts-on-moon-officially-protected-by-new-us-law-152661. Hanlon 2021 *The Global Business Law Review* 130; 147; Rotola "The Legal Framework Protecting Cultural Heritage Sites on the Moon and in situ Preservation" 8.

181 See Hanlon 2021 *Global Business Law Review* 147-148.

182 Hanlon "Planetary Protection" 196.

183 Pham "Does the Outer Space Treaty Permit the Protection and Preservation of Cultural Heritage Sites on the Moon?" 35-36.

in turn, could be contrary to the *Outer Space Treaty*. Several suggestions to limit access to outer space heritage sites have, however, been made by legal commentators, non-governmental organisations and national legislators:

Because of the special scientific, aesthetic and/or historical value of celestial bodies such as Mars, the Moon and asteroids, suggestions have been made to protect these regions as planetary parks.[184] Cockell and Horneck[185] explain that

> The concept of a 'planetary park' bears some similarities to the UNESCO 'Geopark' system, in that, the preservation or conservation of extraterrestrial land will be strongly motivated by geoconservation. However, the presence of life on some bodies such as Mars would obviously expand the preservation or conservation motive to beyond purely geological resources.

The reasons for establishing planetary parks include the preservation of an area for scientific interest and use, the preservation of its historic value or natural beauty, or the preservation of the site for future generations.[186] At a first glance, the idea of planetary parks relates well to the notion that states are the trustees of outer space (as a global commons).[187] This implies, however, that all states should be involved in the identification and administration of the park (including the regulation of access to it) as opposed to states unilaterally declaring certain areas as national parks. In 2013 the United States' Congress introduced the *Apollo Lunar Landing Legacy Act*[188] to declare Tranquillity Base as a national park, and to nominate it for inclusion in UNESCO's list of sites of outstanding universal value. However, because the application of the *World Heritage Convention* is limited to Earth, and since Article II of the *Outer Space Treaty* prohibits appropriation in space, the Bill did not pass.[189] More recently, in 2021 the USA succeeded in passing the *One Small Step to Protect Human Heritage in Space Act*.[190] The Act determines that "the landing of the Apollo 11 spacecraft was made on behalf of all humankind", and that the lunar landing sites of the Apollo 11 spacecraft and of subsequent crewed and robotic spacecraft are, in the language of the *World Heritage Convention*, of "outstanding universal value to humanity".[191] It is the aim of the Act to

184 Cockell and Horneck 2006 *Space Policy* 256.
185 Cockell and Horneck 2006 *Space Policy* 259.
186 David 2013 https://www.space.com/19302-planetary-parks-space-wilderness-protection.html. Also see Cockell and Horneck 2006 *Space Policy* 258-260.
187 Cockell and Horneck 2006 *Space Policy* 260.
188 *Apollo Lunar Landing Legacy Act*, 2013.
189 Rotola "Legal Framework Protecting Cultural Heritage Sites on the Moon" 5.
190 *One Small Step to Protect Human Heritage in Space Act*, 2021.
191 Section 2(6) of the *One Small Step to Protect Human Heritage in Space Act*, 2021.

protect the lunar landing sites from risks due to the increase in activities on the Moon.[192] The Act therefore requires companies working with NASA to agree to be bound by NASA's (otherwise voluntary) Recommendations to Space-Faring Entities: How to Protect and Preserve the Historic and Scientific Value of U.S. Government Lunar Artifacts.[193] Whilst the scope of the Act is limited, applying only to lunar landing sites and to US nationals and companies that are working with NASA, Hanlon[194] submits that "[a]s small a step as it may be, recognizing and protecting historic sites is the first step to developing a peaceful, sustainable and successful lunar governance model." This unilateral act by the USA has, however, not escaped criticism. In this regard Persoz[195] argues that the passing of the Act is indicative of the USA's "space dominance policy" and may result in the *de facto* bypassing of key space norms such as the freedom of all states to access and use outer space, the non-appropriation principle, and the principle that outer space shall be used and explored on an equal basis by all states.[196]

This brings the discussion to a particularly contentious issue related to the *in situ* protection of heritage sites in outer space, namely so-called "exclusion zones" or "safety zones".[197] The NASA Recommendations to

192 Persoz "One Small Step to Protect Human Heritage in Space Act" 45.

193 NASA 2011 https://www.nasa.gov/sites/default/files/617743main_NASA-USG_LUNAR_HISTORIC_SITES_RevA-508.pdf.

194 Hanlon 2021 https://theconversation.com/apollo-landers-neil-armstrongs-bootprint-and-other-human-artifacts-on-moon-officially-protected-by-new-us-law-152661.

195 Persoz "One Small Step to Protect Human Heritage in Space Act" 46-51.

196 Also see Farsaris "How to Preserve Humanity's Lunar Heritage" 77, which refers to the criticism that the USA's efforts to protect the Apollo sites could be interpreted as a form of political appropriation.

197 The establishment of safety zones to avoid harmful interference with space mining activities has been suggested in the *Building Blocks for the Development of an International Framework on Space Resource Activities* that was adopted on 12 November 2019 by the Hague International Space Resources Governance Working Group. See Leiden University 2020 https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group. Paragraph 11.3 detemines that: "Taking into account the principle of non-appropriation under Article II OST [Outer Space Treaty], the international framework should permit States and international organizations responsible for space resource activities to establish a safety zone, or other area-based safety measure, around an area identified for a space resource activity as necessary to assure safety and to avoid any harmful interference with that space resource activity. Such safety measure shall not impede the free access, in accordance with international law, to any area of outer space by personnel, vehicles and equipment of another operator. In accordance with the area-based safety measure, a State or international organization may restrict access for a limited period of time, provided that timely public notice has been given setting out the reasons for such restriction." In a similar vein the Artemis Accords makes provision for safety zones to prevent harmful interference with space-based activities. See s 11 of the Artemis Accords (Artemis Accords 2022 https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf).

Space-Faring Entities: How to Protect and Preserve the Historic and Scientific Value of U.S. Government Lunar Artifacts, that is incorporated in the *One Small Step to Protect Human Heritage in Space Act*, provides for an "exclusion radius" of two kilometers around lunar heritage sites.[198] Although there is little doubt that the establishment of safety or exclusion zones would be necessary to protect historic heritage sites in outer space from harmful interference, there is still debate whether the protection of heritage sites through the creation of such zones would be violating the non-appropriation principle in the *Outer Space Treaty*.

In terms of international law, "occupation" involves both the effective occupation of a location and the intention to act as sovereign in relation to the occupied location.[199] For the occupation to be effective, it requires "a continuous and peaceful display of state sovereignty".[200] However, because states parties to the *Outer Space Treaty* are bound by the principle of freedom of use and exploration in Article II, they cannot in a legal sense intentionally act as sovereign of a location in outer space.[201] If it is accepted that Article II has attained the status of customary international law (a viewpoint which this author supports), non-states parties would equally be banned from claiming sovereignty in outer space.[202]

However, the establishment of safety or exclusion zones complicates the argument. Because states would be excluded from exploring and using the sites on a celestial body that has been declared a safety or exclusion zone by another state, it could be regarded as a violation of Articles I and II of the *Outer Space Treaty*. As Erlank points out, someone would have *de facto* ownership of a space object "if that person [or state] was able to exert control over the object and exclude others from it."[203] Furthermore, the way these sites would be protected is not clear. For example, could the United States use its space force to protect its safety zones from intrusion by other

198 NASA 2011 https://www.nasa.gov/sites/default/files/617743main_NASA-USG_LUNAR_HISTORIC_SITES_RevA-508.pdf 9.

199 Lyall and Larsen *Space Law* 55.

200 Pham "Does the Outer Space Treaty Permit the Protection and Preservation of Cultural Heritage Sites on the Moon?" 38.

201 Freeland and Jakhu "Article II" 53-54.

202 In this regard Freeland and Jakhu "Article II" 63 submit that the principle of non-appropriation in Article II "has become a rule of customary international law (in the form of a *jus cogens* norm) and is thus applicable to all States, whether or not they are parties to the Outer Space Treaty."

203 Erlank "Property and Ownership in Outer Space" 156. Similarly, Reinstein 1999 *Northwestern Journal of International Law and Business* 74-75 submits that "long-term use and permanent occupation to the exclusion of all others" constitute *de facto* appropriation.

states or private companies? Would this be in contravention of the prohibition on the use of force in outer space? It has therefore been said that the protection and preservation of cultural heritage on celestial bodies such as the Moon "does not mean creating exclusion zones with political interests, limiting the freedom of exploration."[204] To avoid such a scenario, it is imperative that the protection of cultural sites in space should rather be protected through state cooperation than by taking unilateral actions through the adoption of domestic legislation and guidelines.[205]

4 The way forward?

It appears from the above discussion that there is currently an uneasy relationship between the exploration of outer space on the one hand and the preservation of the outer space environment on the other. It is clear, however, that the measures suggested to actively address the space debris problem and to protect the cultural heritage in space may contravene the *Outer Space Treaty*, especially the rules and prohibitions regarding property rights in space.

Because of the severity of the space debris problem, the mere mitigation of space debris is no longer sufficient. The proliferation of space debris is a global problem which has serious implications for current and for future generations, and it is therefore imperative that clear legal rules regarding the planned active removal of space debris be adopted by the international community of states. At the same time, the protection and preservation of heritage sites in outer space must be agreed upon as a matter of urgency. The removal of space debris and the simultaneous protection of cultural heritage objects could give rise to a particular conundrum, however. Whilst the removal of orbital debris is essential to ensure the sustainable use of the outer space environment, some space junk (e.g., defunct satellites) may have cultural significance and may be worthy of protection.[206] A balance should thus be struck between preserving cultural heritage and managing the risks posed by space debris. This issue is aptly illustrated by Lopez[207] with reference to the organic waste bags that were left by astronauts on the lunar landing sites. Because of the environmental risks that these bags may

204 Farsaris "How to Preserve Humanity's Lunar Heritage" 83.
205 Farsaris "How to Preserve Humanity's Lunar Heritage" 84.
206 Gorman "Not All Space Debris is Junk" 2.
207 Lopez "Protection of Cultural Heritage Sites on the Moon" 131-143. Lopez "Protection of Cultural Heritage Sites on the Moon" 137 states that "[a] bag full of organic wastes should not, in itself, be considered as a cultural heritage, but it is arguable that its very presence in the heart of a cultural site, since its origin, is enough to convey its qualification."

pose to the site, it may be argued that they should be considered space junk which should be removed. Conversely, it could be argued that the low risk of biological contamination does not justify compromising the integrity of the cultural site.[208] Similarly, when considering actively removing spacecraft with significant cultural value, it should be assessed whether the in-orbit locations of these debris objects, which are part of their cultural significance, pose a high risk for collisions with other space objects.[209]

The formulation of international rules for the active removal of space debris and the preservation of cultural heritage in outer space need a cooperative bottom-up approach by involving states, international organisations, industry, NGOs and academia. There are several pressing issues that need to be addressed in these rules, including the definitions of "space object", and "space debris", as well as the identification of space heritage objects and sites. In this regard, justifiable limitations on property rights of space objects should be agreed on to allow for the removal of hazardous space debris under certain circumstances without the prior consent of the owner of such objects. In addition, agreement should be reached on which space objects and sites have the status of cultural and/or scientific heritage worthy of protection. In identifying heritage sites on the Moon, the Moon Registry by the NGO, For All Moonkind,[210] could at least already serve as the basis for further discussion. It is also imperative that clear rules be established on the creation of safety zones around agreed-upon heritage sites, as well as the extent to which access to and the use of these sites may be limited. For example, it should be agreed upon whether heritage sites could be accessed for historic, scientific, and archaeological reasons only, or also for tourist-related reasons.

It is self-evident that the above issues to be agreed upon do not constitute an exhaustive list, but they are at least indicative of the kinds of issues that would need to be addressed by the various stakeholders in formulating rules

208 Lopez "Protection of Cultural Heritage Sites on the Moon" 143.

209 Gorman 2017 https://theconversation.com/trash-or-treasure-a-lot-of-space-debris-is-junk-but-some-is-precious-heritage-82832 submits that because of the high risk of collisions with ESA's Envisat and the consequent creation of further space debris, the protection of this culturally significant satellite would in all probability not outweigh the risk of keeping it in orbit. Also see Wall 2012 https://www.space.com/15640-envisat-satellite-space-junk-150years.html.

210 It is the mission of For All Moonkind to "[e]nsure the six Apollo Lunar Landing and similar sites in outer space are recognized for their outstanding value to humanity and consequently preserved and protected for posterity as part of our common human heritage." The NGO has identified a significant number of historical sites on the Moon worthy of protection. See For All Moonkind Date unknown https://www.forallmoonkind.org/.

of the road. The question remains *how* these issues should be regulated. Several suggestions have been made by commentators in this regard, including, revising the *World Heritage Convention*[211] and its Operational Guidelines, the adoption of an Optional Protocol to the World Heritage Convention,[212] the adoption of a new Treaty aimed at the protection of outer space heritage, the adoption of bilateral or multilateral agreements amongst space-faring nations, and the creation of an international body to regulate the protection of outer space heritage.[213] Although it is agreed with the proponents of a hard law approach that a legally binding instrument should be adopted to regulate the sustainable use of outer space, including the mitigation and remediation of space debris and the protection of space heritage, it is unlikely that such a binding instrument will be concluded soon. Soft law[214] documents are currently the main instruments for further developing and defining outer space norms.[215] Because of their non-mandatory character, these instruments are generally easier negotiated by states than is the case with treaties.[216] It should be pointed out, however, that despite its non-mandatory character, soft-law guidelines have a political and moral value as there is the expectation that states will comply with their provisions.[217] Non-compliance may be viewed in a negative light by international partners and thus damage the political reputation of the state.[218] It could, therefore, also be argued that the soft law guidelines have a legal value as they impact on the international law-making process by providing the premise on which customary international law may develop, and which may eventually lead to the conclusion of a treaty.[219] In this regard, it has been suggested that states could be prompted in a resolution of the General Assembly to implement soft-law guidelines such as the Long-Term

211 Bohdan "Necessity of Special Regulation for Protection of Cultural Heritage Sites on the Moon" 69-70.

212 Martin "The 'Outstanding Universal Value' Concept" 60-61.

213 Farsaris "How to Preserve Humanity's Lunar Heritage" 81-82; Lixinski, Losier and Schreiber 2021 *Journal of Space Law* 1-45.

214 Dugard and Tladi "Sources of International Law" 41 describe soft law as "imprecise standards, generated by declarations adopted by diplomatic conferences or resolutions of international organizations, that are intended to serve as guidelines to states in their conduct, but which lack the status of 'law'". Tronchetti "Soft Law" 624 summarises the role of soft law in the general system of international law as follows: "1) it can give guidance on how to interpret and implement existing treaty provisions; 2) it may represent the beginning of a process leading to an international treaty; 3) it may contribute to the formation of customary law; 4) it may be declaratory of existing unwritten rules."

215 Tronchetti "Soft Law" 627.

216 Tronchetti "Soft Law" 625-626.

217 Welly 2010 *J Space L* 307; Tronchetti "Soft Law" 620.

218 Welly 2010 *J Space L* 307.

219 Tronchetti "Soft Law" 621; Welly 2010 *J Space* 311.

Sustainability Guidelines in their national legislation.[220] The legislation could be regarded "as a general practice of states accepted as law, i.e. CIL [Customary International Law]."[221] It should be noted, however, that the suggested resolution by the General Assembly will have the status of a non-binding recommendation only. Nevertheless, as an expression of the view of the international community of states the resolution would at least have symbolic and political value as it could "stigmatize or isolate the practice of states that do not conform" with the resolution, and thus be used as an "instrument of persuasion".[222]

Because of the urgency of the need to regulate the issues discussed in this article, it is suggested that soft-law guidelines should in the interim be developed to provide a framework for the eventual creation of a consolidated and binding legal instrument on all aspects relating to the sustainable use of outer space. Existing guidelines such as the NASA Recommendations to Space-Faring Entities, the Long-Term Sustainability Guidelines, the COSPAR policy document, the Space Debris Mitigation Guidelines and the World Heritage Convention's Operational Guidelines could provide a premise for further international discussions specifically on the remediation of space debris and the protection of space heritage. It is furthermore suggested that the development of these soft-law rules and an eventual treaty should take place under the auspices of existing United Nations bodies, namely the UNCOPUOS and UNESCO. Although it may be argued that the UNCOPUOS's decision-making processes, which are based on the rule of consensus, are too slow, the UNCOPUOS is currently the only multilateral forum for the discussion of outer space matters.[223] UNESCO could play an important role in this process in formulating criteria for identifying and classifying natural and cultural heritage worthy of protection on celestial bodies, such as the Moon and Mars. The recent

220 Martinez 2019 *Global Sustainability* 4 explains that "the non-binding LTS Guidelines could be approved by the UN General Assembly (UNGA) in a resolution that instructs states to implement the LTS Guidelines with national legislation. States then, would not be required to sign or ratify 'hard' law international agreements, but would instead signal their compliance with the non-binding UNGA resolutions through passage and implementation of national legislation. Such regulatory rules and agencies operating on the national level would ensure governmental or commercial entity compliance with international 'hard' and 'soft' agreements."

221 Martinez 2019 *Global Sustainability* 4.

222 Van den Rul 2016 https://www.e-ir.info/2016/06/16/why-have-resolutions-of-the-un-general-assembly-if-they-are-not-legally-binding/.

223 Neger and Walter "Space Law" 241; Soucek "International Law" 304; Sarang 2019 https://spacegeneration.org/oped-thoughts-on-un-copuos.

launch of NASA's Artemis I,[224] 50 years after the end of the Apollo programme, in many respects signals the dawn of a new space race.[225] However, this time around the space race includes not only the major spacefaring nations but also private entities.[226] To avoid Hardin's "tragedy of the commons",[227] a cooperative effort by all stakeholders must urgently be undertaken to ensure the sustainable use of outer space in the interest of current and future generations.

Bibliography

Literature

Abul Failat and Ferreira-Snyman "Regulation of the Space Tourism Sector"
Abul Failat Y and Ferreira-Snyman A "Regulation of the Space Tourism Sector" in Abul Failat Y and Ferreira-Snyman A (eds) *Outer Space Law: Legal Policy and Practice* 2nd ed (Globe Law and Business London 2022) 301-346

Babcock 2019 *Syracuse L Rev*
Babcock HM "The Public Trust Doctrine, Outer Space, and the Global Commons: Time to Call Home ET" 2019 *Syracuse L Rev* 191-262

Bohdan "Necessity of Special Regulation for Protection of Cultural Heritage Sites on the Moon"
Bohdan D "Necessity of Special Regulation for Protection of Cultural Heritage Sites on the Moon" in Froelich A (ed) *Protection of Cultural Heritage Sites on the Moon* (Springer Vienna 2020) 65-71

Carns 2017 *AF L Rev*
Carns MG "Consent not Required: Making the Case that Consent is not Required under Customary International Law for Removal of Outer Space Debris Smaller than 10cm" 2017 *AF L Rev* 173-234

224 On 16 November 2022, NASA launched its Artemis 1 mission by sending the Orion Spacecraft on an uncrewed test flight around the Moon. Orion successfully returned to Earth on 11 December 2022. See further NASA 2022 https://www.nasa.gov/press-release/splashdown-nasa-s-orion-returns-to-earth-after-historic-moon-mission.

225 Arrieche 2022 https://www.business2community.com/tech-news/nasa-artemis-signals-the-us-v-china-race-to-build-a-moon-base-is-go-02541751.

226 Hanlon 2021 https://theconversation.com/apollo-landers-neil-armstrongs-bootprint-and-other-human-artifacts-on-moon-officially-protected-by-new-us-law-152661.

227 Garreth Hardin cautioned in the 1960s that: "Ruin is the destination to which all men rush, each pursuing his own best interest in a society that beliefs in the freedom of the commons." See Hardin 1968 *Science* 1245.

Chatterjee 2014 *Proceedings of the International Institute of Space Law*
Chatterjee J "Legal Issues Relating to Unauthorised Space Debris Remediation" 2014 *Proceedings of the International Institute of Space Law* 13-34

Chatzipanagiotis 2007 *German Journal of Air and Space Law*
Chatzipanagiotis M "Registration of Space Objects and Transfer of Ownership in Orbit" 2007 *German Journal of Air and Space Law* 229-238

Chrysaki 2020 *Space Policy*
Chrysaki M "The Sustainable Commercialisation of Space: The Case for a Voluntary Code for the Space Industry" 2020 *Space Policy* 1-15

Chung "Jurisdiction and Control Aspects of Space Debris Removal"
Chung G "Jurisdiction and Control Aspects of Space Debris Removal" in Froelich A (ed) *Space Security and Legal Aspects of Active Debris Removal* (Springer Vienna 2019) 31-47

Cinelli and Pogorzelska 2013 *RECIEL*
Cinelli C and Pogorzelska K "The Current International Legal Setting for the Protection of the Outer Space Environment: The Precautionary Principle Avant La Lettre" 2013 *RECIEL* 186-201

Cockell and Horneck 2006 *Space Policy*
Cockell CC and Horneck G "Planetary Parks: Formulating a Wilderness Policy for Planetary Bodies" 2006 *Space Policy* 256-261

De Lucia and Iavicoli 2019 *Cal W Int'l LJ*
De Lucia V and Iavicoli V "From Outer Space to Ocean Depths: The 'Spacecraft Cemetery' and the Protection of the Marine Environment in Areas Beyond National Jurisdiction" 2019 *Cal W Int'l LJ* 345-389

Diedericks-Verschoor and Kopal *Introduction to Space Law*
Diedericks-Verschoor IH Ph and Kopal V *An Introduction to Space Law* 3rd ed (Kluwer International Alphen aan den Rijn 2008)

Dugard and Tladi "Sources of International Law"
Dugard J and Tladi D "Sources of International Law" in Dugard J *et al Dugard's International Law* 5th ed (Juta Claremont 2018) 28-56

Erlank "Property and Ownership in Outer Space"
Erlank W "Property and Ownership in Outer Space" in Abul Failat Y and Ferreira-Snyman A (eds) *Outer Space Law: Law, Policy and Practice* 2nd ed (Globe Law and Business London 2022) 129-160

Farsaris "How to Preserve Humanity's Lunar Heritage"
Farsaris AE "How to Preserve Humanity's Lunar Heritage" in Froelich A (ed) *Protection of Cultural Heritage Sites on the Moon* (Springer Vienna 2020) 73-84

Ferreira and Ferreira-Snyman "Extraterritorial Application of Human Rights Instruments in Outer Space Settlements"
Ferreira G and Ferreira-Snyman A "The Extraterritorial Application of Human Rights Instruments in Outer Space Settlements" in Abul Failat Y and Ferreira-Snyman A (eds) *Outer Space Law: Law, Policy and Practice* 2nd ed (Globe Law and Business London 2022) 475-503

Ferreira-Snyman 2013 *CILSA*
Ferreira-Snyman A "The Environmental Responsibility for Space Debris and the Implications for Developing Countries in Africa" 2013 *CILSA* 19-51

Ferreira-Snyman 2014 *PELJ*
Ferreira-Snyman A "Legal Challenges Relating to the Commercial Use of Outer Space with Specific Reference to Space Tourism" 2014 *PELJ* 2-50

Ferreira-Snyman 2018 *CILSA*
Ferreira-Snyman A "Cooperation in Outer Space Activities: South Africa's Role as a Member State of the African Union and BRICS" 2018 *CILSA* 141-170

Ferreira-Snyman 2021 *PELJ*
Ferreira-Snyman A "Challenges to the Prohibition on Sovereignty in Outer Space – A New Frontier for Space Governance" 2021 *PELJ* 1-50

Ferreira-Snyman "Environmental Responsibility for Space Debris"
Ferreira-Snyman A "Environmental Responsibility for Space Debris" in Abul Failat Y and Ferreira-Snyman A (eds) *Outer Space Law: Law, Policy and Practice* 2nd ed (Globe Law and Business London 2022) 391-427

Ferreira-Snyman "Military Activities in Outer Space"
Ferreira-Snyman A "Military Activities in Outer Space" in Abul Failat Y and Ferreira-Snyman A (eds) *Outer Space Law: Law, Policy and Practice* 2nd ed (Globe Law and Business London 2022) 65-94

Fogg 2000 *Space Policy*
Fogg MJ "The Ethical Dimensions of Space Settlement" 2000 *Space Policy* 205-211

Ford 2017 *Hous J Int'l L*
Ford M "War on the Final Frontier: Can Twentieth Century Space Law Combat Twentieth Century Warfare?" 2017 *Hous J Int'l L* 237-261

Freeland and Jakhu "Article II"
Freeland S and Jakhu R "Article II" in Hobe S *et al* (eds) *Cologne Commentary on Space Law* Vol 1 (Carl Heymann Verlag 2009) 44-63

Frigoli "Between Active Space Debris and Space-Based Weapons"
Frigoli M "Between Active Space Debris and Space-Based Weapons: A Comprehensive Legal Approach" in Froelich A (ed) *Space Security and Legal Aspects of Active Debris Removal* (Springer Vienna 2019) 49-70

Froelich "Right to (Anticipatory) Self-Defence in Outer Space"
Froelich A "The Right to (Anticipatory) Self-Defence in Outer Space to Reduce Space Debris" in Froelich A (ed) *Space Security and Legal Aspects of Active Debris Removal* (Springer Vienna 2019) 71-92

Gilberto and Labadi 2022 *International Journal of Heritage Studies*
Giliberto F and Labadi S "Harnessing Cultural Heritage for Sustainable Development: An Analysis of Three Internationally Funded Projects In MENA Countries" 2022 *International Journal of Heritage Studies* 1-14

Gorman "Not All Space Debris is Junk"
Alice Gorman "Not All Space Debris is Junk: A Comprehensive Management Strategy for Culturally Significant Spacecraft" in *68th International Astronautics Conference* (25-29 September 2017 Adelaide) 1-10

Gražulevičiūtė 2006 *Environmental Research, Engineering and Management*
Gražulevičiūtė I "Cultural Heritage in the Context of Sustainable Development" 2006 *Environmental Research, Engineering and Management* 74-79

Gupta 2019 *U Pa J Int'l L*
Gupta A "Regulating Space Debris as Separate from Space Objects" 2019 *U Pa J Int'l L* 223-248

Hanlon 2021 *Global Business Law Review*
Hanlon M "Due Regard for Commercial Space Must Start with Historic Preservation" 2021 *The Global Business Law Review* 130-156

Hanlon "Planetary Protection"
Hanlon MLD "Planetary Protection" in Abul Failat Y and Ferreira-Snyman A (eds) *Outer Space Law: Legal Policy and Practice* 2nd ed (Globe Law and Business London 2022) 175-197

Hardin 1968 *Science*
Hardin G "The Tragedy of the Commons" 1968 *Science* 1243-1248

Haroun *et al* 2021 *New Space*
Haroun F *et al* "Toward the Sustainability of Outer Space: Addressing the Issue of Space Debris" 2021 *New Space* 63-71

Hofmann 2007 *SAYIL*
Hofmann M "Environmental Criteria as a Condition for Space Activities of Non-Entities" 2007 *SAYIL* 233-246

Kramer 2014 *Space Policy*
Kramer WR "Extraterrestrial Environmental Impact Assessments: A Foreseeable Prerequisite for Wise Decisions Regarding Outer Space Exploration, Research and Development" 2014 *Space Policy* 215-222

Krivokapi 2017 *Acta Universitatis Danubius. Administratio*
Krivokapi B "On the Issue of So-Called 'Instant' Customs in International Law" 2017 *Acta Universitatis Danubius. Administratio* 81-98

Leister and Kovudhikulrungsri 2009 *Proceedings of the International Institute of Space Law*
Leister V and Kovudhikulrungsri L "Outer Space: Of the People, by the People, and for the People" 2009 *Proceedings of the International Institute of Space Law* 145-149

Lixinski, Losier and Schreiber 2021 *J Space L*
Lixinski L, Losier MM and Schreiber H "Envisioning a Legal Framework for Outer Space Cultural Heritage" 2021 *J Space L* 1-45

Lopez "Protection of Cultural Heritage Sites on the Moon"
Lopez H "The Protection of Cultural Heritage Sites on the Moon: The Poo Bag Paradox" in Froelich A (ed) *Protection of Cultural Heritage Sites on the Moon* (Springer Vienna 2020) 131-143

Lyall and Larsen *Space Law*
Lyall F and Larsen PB *Space Law: A Treatise* 2nd ed (Routledge London 2020)

Martin "The 'Outstanding Universal Value' Concept"
Martin A-S "The 'Outstanding Universal Value' Concept of the UNESCO World Heritage Convention: Food for Thought to Preserve Lunar Artefacts" in Froelich A (ed) *Protection of Cultural Heritage Sites on the Moon* (Springer Vienna 2020) 53-64

Martinez 2019 *Global Sustainability*
Martinez LF "Legal Regime Sustainability in Outer Space: Theory and Practice" 2019 *Global Sustainability* 1-6

Mukherjee and Mokkapati 2009 *Proceedings of the International Institute of Space Law*
Mukherjee U and Mokkapati A "Determining Liability for Damage Caused Due to Debris in Outer Space: Portal to a New Regime" 2009 *Proceedings of the International Institute of Space Law* 285-296

Neger and Walter "Space Law"
Neger T and Walter E "Space Law: An Independent Branch of the Legal System" in Brünner C and Soucek A (eds) *Outer Space in Society, Politics and Law* (Springer-Verlag Vienna 2011) 234-245

Newman and Williamson 2018 *Space Policy*
Newman CJ and Williamson M "Space Sustainability: Reframing the Debate" 2018 *Space Policy* 30-37

Persoz "One Small Step to Protect Human Heritage in Space Act"
Persoz G "One Small Step to Protect Human Heritage in Space Act as One Small Step Towards US Space Dominance? The Case for a Multilateral Treaty Protection Regime" in Froelich A (ed) *Protection of Cultural Heritage Sites on the Moon* (Springer Vienna 2020) 41-52

Pham "Does the Outer Space Treaty Permit the Protection and Preservation of Cultural Heritage Sites on the Moon?"
Pham LBN "Does the Outer Space Treaty Permit the Protection and Preservation of Cultural Heritage Sites on the Moon?" in Froelich A (ed) *Protection of Cultural Heritage Sites on the Moon* (Springer Vienna 2020) 27-39

Prasad and Lochan 2007 *Proceedings of the International Institute of Space Law*
Prasad MYS and Lochan R "Common but Differentiated Responsibility: A Principle to Maintain Space Environment with Respect to Space Debris" 2007 *Proceedings of the International Institute of Space Law* 284-292

Reinstein 1999 *Northwestern Journal of International Law and Business*
Reinstein EJ "Owning Outer Space" 1999 *Northwestern Journal of International Law and Business* 59-98

Rosendal 2019 *Wm & Mary Envtl L & Pol'y Rev*
Rosendal M "Galactic Preservation and Beyond: A Framework for Protecting Cultural, Natural, and Scientific Heritage in Space" 2019 *Wm & Mary Envtl L & Pol'y Rev* 839-870

Rotola "Legal Framework Protecting Cultural Heritage Sites on the Moon"
Rotola G "The Legal Framework Protecting Cultural Heritage Sites on the Moon and In Situ Preservation" in Froelich A (ed) *Protection of Cultural Heritage Sites on the Moon* (Springer Vienna 2020) 1-12

Schrogl "Space and Its Sustainable Uses"
Schrogl K-U "Space and Its Sustainable Uses" in Brünner C and Soucek A (eds) *Outer Space in Society, Politics and Law* (Springer-Verlag Vienna 2011) 604-618

Sgrosso *International Space Law*
Sgrosso GC *International Space Law* (LoGisma Florence 2011)

Soucek "International Law"
Soucek A "International Law" in Brünner C and Soucek A (eds) *Outer Space in Society, Politics and Law* (Springer-Verlag Vienna 2011) 294-405

Soucek "Space and Sustainability"
Soucek A "Space and Sustainability: Improving Life on Earth" in Brünner C and Soucek A (eds) *Outer Space in Society, Politics and Law* (Springer-Verlag Vienna 2011) 569-603

Tronchetti "Soft Law"
Tronchetti F "Soft Law" in Brünner C and Soucek A (eds) *Outer Space in Society, Politics and Law* (Springer-Verlag Vienna 2011) 619-632

Venet "The Political Dimension"
Venet C "The Political Dimension" in Brünner C and Soucek A (eds) *Outer Space in Society, Politics and Law* (Springer-Verlag Vienna 2011) 73-91

Viikari *Environmental Element in Space Law*
Viikari L *The Environmental Element in Space Law: Assessing the Present and Charting the Future* (Martninus Nijhoff Leiden 2008)

Welly 2010 *J Space L*
Welly ND "Enlightened State-Interest: A Legal Framework for Protecting the 'Common Interest of All Mankind' from Hardinian Tragedy" 2010 *J Space L* 273-313

Williamson 2003 *Space Policy*
Williamson M "Space Ethics and the Protection of the Space Environment" 2003 *Space Policy* 47-52

Yun 2004 *Australian Journal of International Law*
Yun Z "Revisiting the 1975 Registration Convention: Time for Revision?" 2004 *Australian Journal of International Law* 106-127

Zajacowski "Could the Moon's Cultural Heritage be Inscribed on UNESCO's World Heritage List?"
Zajackowski D "Could the Moon's Cultural Heritage be Inscribed on UNESCO's World Heritage List?" in Froelich A (ed) *Protection of Cultural Heritage Sites on the Moon* (Springer Vienna 2020) 13-26

Case law

International Court of Justice

Legality of the Threat or Use of Nuclear Weapons in Armed Conflict 1996 ICJ Reports 226

Legislation

United States of America

Apollo Lunar Landing Legacy Act, 2013

One Small Step to Protect Human Heritage in Space Act, 2021

International law documents and instruments

Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979)

Charter of the United Nations (1945)

Consideration of Areas for Possible New Guidelines Concerning the Long-Term Sustainability of Outer Space Activities UN Doc A/AC.105/C.1/2023/CRP.17 (2023)

Convention on International Liability for Damage Caused by Space Objects (1971)

Convention on Registration of Objects Launched into Outer Space (1974)

Draft International Code of Conduct for Outer Space Activities (2014)

Group of Governmental Experts on Transparency and Confidence-Building Measures in Outer Space Activities UN Doc A/68/189 (2013)

Guidelines for the Long-Term Sustainability of Outer Space Activities UN Doc A/AC.105/2018/CRP.20 (2018)

ILC Articles on the Responsibility of States for Internationally Wrongful Acts, Report of the International Law Commission UN Doc A/56/10 (2001)

International Cooperation in the Peaceful Uses of Outer Space GA Res 62/217, UN Doc A/RES/62/217 (2007)

Operational Guidelines for the Implementation of the World Heritage Convention WHC.21/01 (2021)

Report of the Scientific and Technical Committee of UNCOPUOS on its 47th Session, *Vienna 8-19 February 2010* UN Doc A/AC.105/958 (2010)

Rio Declaration on Environment and Development (1992)

Technical Report on Space Debris UN Doc A/AC.105/720 (1999)

Treaty on the Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1967)

UN Framework Convention on Climate Change (1992)

UNESCO Convention Concerning the Protection of the World Cultural and Natural Heritage (1972)

UNESCO Convention on the Protection of the Underwater Cultural Heritage (2001)

Internet sources

Aranca 2022 https://www.aranca.com/knowledge-library/articles/ip-research/modern-technologies-to-clean-up-space-debris
Aranca 2022 *Modern Technologies to Clean Up Space Debris* https://www.aranca.com/knowledge-library/articles/ip-research/modern-technologies-to-clean-up-space-debris accessed 31 July 2022

Arms Control Association 2022 https://www.armscontrol.org/act/2022-11/news-briefs/seven-countries-join-asat-test-ban
Arms Control Association 2022 *Seven Countries Join ASAT Test Ban* https://www.armscontrol.org/act/2022-11/news-briefs/seven-countries-join-asat-test-ban accessed 12 May 2023

Arrieche 2022 https://www.business2community.com/tech-news/nasa-artemis-signals-the-us-v-china-race-to-build-a-moon-base-is-go-02541751
Arrieche A 2022 *NASA Artemis Signals the US v China Race to Build a Moon Base is Go* https://www.business2community.com/tech-news/nasa-artemis-signals-the-us-v-china-race-to-build-a-moon-base-is-go-02541751 accessed 1 September 2022

Artemis Accords 2022 https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf
Artemis Accords 2022 *The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars Comets and Asteroids for Peaceful Purposes* https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf accessed 1 September 2022

Barentine *et al* 2023 https://www.nature.com/articles/s41550-023-01904-2
Barentine JC *et al* 2023 *Aggregate Effects of Proliferating Low-Earth-Orbit Objects and Implications for Astronomical Data Lost in the Noise* https://www.nature.com/articles/s41550-023-01904-2 accessed 8 May 2023

Blinken 2021 https://www.state.gov/russia-conducts-destructive-anti-satellite-missile-test/
Blinken A 2021 *Secretary of State, Press Statement: Russia Conducts Destructive Anti-Satellite Missile Test* https://www.state.gov/russia-conducts-destructive-anti-satellite-missile-test/ accessed 3 August 2022

Blue Origin 2022 https://www.blueorigin.com/
Blue Origin 2022 *Home* https://www.blueorigin.com/ accessed 29 July 2022

Bridenstine 2020 https://www.usatoday.com/story/opinion/todaysdebate/2020/05/26/nasa-going-back-moon-and-beyond-editorials-debates/5259920002/
Bridenstine J 2020 *NASA: We're Going Back to the Moon, and Beyond* https://www.usatoday.com/story/opinion/todaysdebate/2020/05/26/nasa-going-back-moon-and-beyond-editorials-debates/5259920002/ accessed 4 August 2020

China National Space Administration 2021 http://www.cnsa.gov.cn/english/n6465652/n6465653/c6812150/content.html
China National Space Administration 2021 *International Lunar Research Station – Guide for Partnership* http://www.cnsa.gov.cn/english/n6465652/n6465653/c6812150/content.html accessed 1 September 2022

COSPAR Date unknown https://cosparhq.cnes.fr/
COSPAR Date unknown *Committee on Space Research* https://cosparhq.cnes.fr/ accessed 21 July 2022

COSPAR 2020 https://cosparhq.cnes.fr/assets/uploads/2020/07/PPPolicyJune-2020_Final_Web.pdf
COSPAR 2020 *Policy on Planetary Protection* https://cosparhq.cnes.fr/assets/uploads/2020/07/PPPolicyJune-2020_Final_Web.pdf accessed 21 July 2021

David 2013 https://www.space.com/19302-planetary-parks-space-wilderness-protection.html
David L 2013 *Planetary Parks Could Protect Space Wilderness* https://www.space.com/19302-planetary-parks-space-wilderness-protection.html accessed 21 July 2021

ESA Date unknown https://www.esa.int/Safety_Security/Space_Debris/Active_debris_removal

European Space Agency Date unknown *Active Debris Removal* https://www.esa.int/Safety_Security/Space_Debris/Active_debris_removal accessed 31 July 2022

ESA 2020 https://www.esa.int/Newsroom/Press_Releases/Call_for_Media_ESA_and_ClearSpace_SA_sign_contract_for_world_s_first_debris_removal_mission
European Space Agency 2020 *N° 26–2020: Call for Media: ESA and Clearspace SA Sign Contract for World's First Debris Removal Mission* https://www.esa.int/Newsroom/Press_Releases/Call_for_Media_ESA_and_ClearSpace_SA_sign_contract_for_world_s_first_debris_removal_mission accessed 31 July 2022

EU 2014 *Activities* https://www.eeas.europa.eu/sites/default/files/space_code_conduct_draft_vers_31-march-2014_en.pdf
European Union 2014 *The Fifth Revised International Draft Code of Conduct for Outer Space Activities* https://www.eeas.europa.eu/sites/default/files/space_code_conduct_draft_vers_31-march-2014_en.pdf accessed 31 July 2022

European Commission Date unknown https://culture.ec.europa.eu/cultural-heritage/cultural-heritage-in-eu-policies/sustainability-and-cultural-heritage#:~:text=Sustainability%20is%20one%20of%20the,achieve%20inclusive%20and%20sustainable%20development
European Commission Date unknown *Sustainability and Cultural Heritage* https://culture.ec.europa.eu/cultural-heritage/cultural-heritage-in-eu-policies/sustainability-and-cultural-heritage#:~:text=Sustainability%20is%20one%20of%20the,achieve%20inclusive%20and%20sustainable%20development accessed 3 February 2023

For All Moonkind Date unknown https://www.forallmoonkind.org/
For All Moonkind Date unknown *Home* https://www.forallmoonkind.org/ accessed 1 August 2022

For All Moonkind Date unknown https://moonregistry.forallmoonkind.org/about-us/
For All Moonkind Date unknown *Moon Registry* https://moonregistry.forallmoonkind.org/about-us/ accessed 1 August 2022

Foust 2019 https://spacenews.com/starlink-failures-highlight-space-sustainability-concerns/

Foust J 2019 *Starlink Failures Highlight Space Sustainability Concerns* https://spacenews.com/starlink-failures-highlight-space-sustainability-concerns/ accessed 29 July 2022

Foust 2021 https://spacenews.com/space-force-backs-development-of-commercial-orbital-debris-removal-systems/
Foust J 2021 *Space Force Backs Development of Commercial Orbital Debris Removal Systems* https://spacenews.com/space-force-backs-development-of-commercial-orbital-debris-removal-systems/ accessed 1 August 2022

Gorman 2017 https://theconversation.com/trash-or-treasure-a-lot-of-space-debris-is-junk-but-some-is-precious-heritage-82832
Gorman A 2017 *Trash or Treasure? A Lot of Space Debris is Junk, but Some is Precious Heritage* https://theconversation.com/trash-or-treasure-a-lot-of-space-debris-is-junk-but-some-is-precious-heritage-82832 accessed 11 December 2022

Griggs 2020 https://www.theverge.com/2020/9/23/21451587/iss-space-junk-debris-avoidance-maneuverhttps://www.theverge.com/2020/9/23/21451587/iss-space-junk-debris-avoidance-maneuver
Griggs MB 200 *The ISS Just Avoided a "Piece of Unknown Space Debris"* https://www.theverge.com/2020/9/23/21451587/iss-space-junk-debris-avoidance-maneuverhttps://www.theverge.com/2020/9/23/21451587/iss-space-junk-debris-avoidance-maneuver accessed 4 August 2022

Hanlon 2021 https://theconversation.com/apollo-landers-neil-armstrongs-bootprint-and-other-human-artifacts-on-moon-officially-protected-by-new-us-law-152661
Hanlon MLD 2021 *Apollo Landers, Neil Armstrong's Bootprint and Other Human Artifacts on Moon Officially Protected by New US Law* https://theconversation.com/apollo-landers-neil-armstrongs-bootprint-and-other-human-artifacts-on-moon-officially-protected-by-new-us-law-152661 accessed 27 May 2022

IADC 2020 https://orbitaldebris.jsc.nasa.gov/library/iadc-space-debris-guidelines-revision-2.pdf
Inter-Agency Space Debris Coordination Committee 2020 *Space Debris Mitigation Guidelines* https://orbitaldebris.jsc.nasa.gov/library/iadc-space-debris-guidelines-revision-2.pdf accessed 27 May 2022

Irsten 2021 https://www.reachingcriticalwill.org/news/latest-news/8907-the-consultation-process-for-the-international-code-of-conduct-for-outer-space-activities-ends
Irsten G 2021 *The Consultation Process for the International Code of Conduct for Outer Space Activities Ends* https://www.reachingcriticalwill.org/news/latest-news/8907-the-consultation-process-for-the-international-code-of-conduct-for-outer-space-activities-ends accessed 1 August 2022

Kilic 2022 https://www.space.com/mars-littered-with-human-trash
Kilic C 2022 *Mars Littered with 15 694 Pounds of Human Trash from 50 Years of Robotic Exploration* https://www.space.com/mars-littered-with-human-trash accessed 4 October 2022

Knapton 2018 https://www.telegraph.co.uk/science/2018/08/30/international-space-station-leaking-air-hit-space-debris/
Knapton S 2018 *International Space Station Astronauts Plug Leak with Finger and Tape after Being Hit with Debris* https://www.telegraph.co.uk/science/2018/08/30/international-space-station-leaking-air-hit-space-debris/ accessed 3 August 2022

Leiden University 2019 https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group
Leiden University 2019 *The Hague Building Blocks for the Development of an International Framework on Space Resources Activities* https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group accessed 22 July 2022

Lutkevich 2020 https://www.techtarget.com/whatis/definition/Kessler-Syndrome
Lutkevich B 2020 *Kessler Syndrome* https://www.techtarget.com/whatis/definition/Kessler-Syndrome accessed 4 August 2022 accessed 1 September 2022

Luxembourg Space Agency 2020 https://space-agency.public.lu/en/space-resources/ressources-in-space.html
Luxembourg Space Agency 2020 *Resources in Space* https://space-agency.public.lu/en/space-resources/ressources-in-space.html accessed 8 May 2023

NASA 2011 https://www.nasa.gov/sites/default/files/617743main_NASA-USG_LUNAR_HISTORIC_SITES_RevA-508.pdf
NASA 2011 *Recommendations to Space-Faring Entities: How to Protect and Preserve the Historic and Scientific Value of U.S. Government Lunar Artifacts* https://www.nasa.gov/sites/default/files/617743main_NASA-USG_LUNAR_HISTORIC_SITES_RevA-508.pdf accessed 4 August 2022

NASA 2021 https://www.nasa.gov/artemisprogram
NASA 2021 *Artemis* https://www.nasa.gov/artemisprogram accessed 1 September 2022

NASA 2022 https://www.nasa.gov/press-release/splashdown-nasa-s-orion-returns-to-earth-after-historic-moon-mission
NASA 2022 *Splashdown! NASA's Orion Returns to Earth After Historic Moon Mission* https://www.nasa.gov/press-release/splashdown-nasa-s-orion-returns-to-earth-after-historic-moon-mission accessed 11 December 2022.

O'Callaghan 2019 https://www.scientificamerican.com/article/spacexs-starlink-could-cause-cascades-of-space-junk/
O'Callaghan J 2019 *SpaceX's Starlink Could Cause Cascades of Space Junk* https://www.scientificamerican.com/article/spacexs-starlink-could-cause-cascades-of-space-junk/ accessed 29 July 2022

Pearlman 2021 https://www.space.com/one-small-step-space-heritage-act.htm
Pearlman RZ 2021 *New Law is First to Protect Apollo Sites from Future Moon Missions* https://www.space.com/one-small-step-space-heritage-act.htm accessed 1 August 2022

Pickrell 2022 https://www.nature.com/articles/d41586-022-01252-7
Pickrell J 2022 *These Six Countries are About to Go to the Moon — Here's Why* https://www.nature.com/articles/d41586-022-01252-7 accessed 29 July 2022

Revfine Date unknown https://www.revfine.com/space-tourism/
Revfine Date unknown *Space Tourism: 7 Space Companies That Will Make You an Astronaut* https://www.revfine.com/space-tourism/ accessed 11 May 2023

Rigby and Carter 2021 https://theconversation.com/a-chunk-of-chinese-satellite-almost-hit-the-international-space-station-they-dodged-it-but-the-space-junk-problem-is-getting-worse-171735

Rigby M and Carter B 2021 *A Chunk of Chinese Satellite Almost Hit the International Space Station. They Dodged It – But the Space Junk Problem is Getting Worse* https://theconversation.com/a-chunk-of-chinese-satellite-almost-hit-the-international-space-station-they-dodged-it-but-the-space-junk-problem-is-getting-worse-171735 accessed 3 August 2022

Sarang 2019 https://spacegeneration.org/oped-thoughts-on-un-copuos
Sarang M 2019 *Thoughts on UN COPUOS* https://spacegeneration.org/oped-thoughts-on-un-copuos accessed 20 September 2022

Secure World Foundation 2019 https://swfound.org/our-focus/space-sustainability/
Secure World Foundation 2019 *Space Sustainability* https://swfound.org/our-focus/space-sustainability/ accessed 29 July 2022

Secure World Foundation 2022 https://swfound.org/about-us/who-we-are/
Secure World Foundation 2022 *Who We Are* https://swfound.org/about-us/who-we-are/ accessed 29 July 2022

SpaceX 2022 https://www.spacex.com/human-spaceflight/iss/index.html
SpaceX 2022 *Human Spaceflight* https://www.spacex.com/human-spaceflight/iss/index.html accessed 29 July 2022

UN 1987 https://www.are.admin.ch/are/en/home/sustainable-development/international-cooperation/2030agenda/un-_-milestones-in-sustainable-development/1987--brundtland-report.html
United Nations 1987 *Our Common Future: Report of the World Commission on Environment and Development (Brundtland Report)* https://www.are.admin.ch/are/en/home/sustainable-development/international-cooperation/2030agenda/un-_-milestones-in-sustainable-development/1987--brundtland-report.html accessed 29 July 2022

UNESCO Date unknown https://whc.unesco.org/en/sustainabledevelopment/
UNESCO Date unknown *World Heritage and Sustainable Development* https://whc.unesco.org/en/sustainabledevelopment/ accessed 3 February 2023

UNOOSA 2010 https://www.unoosa.org/pdf/publications/st_space_49E.pdf
United Nations Office for Outer Space Affairs 2010 *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*

https://www.unoosa.org/pdf/publications/st_space_49E.pdf accessed 5 August 2022

Van den Rul 2016 https://www.e-ir.info/2016/06/16/why-have-resolutions-of-the-un-general-assembly-if-they-are-not-legally-binding/
Van den Rul C 2016 *Why Have Resolutions of the UN General Assembly if They are not Legally Binding?* https://www.e-ir.info/2016/06/16/why-have-resolutions-of-the-un-general-assembly-if-they-are-not-legally-binding/ accessed 29 September 2022

Wall 2012 https://www.space.com/15640-envisat-satellite-space-junk-150years.html
Wall M 2012 *Huge Dead Satellite May be Space Junk for 150 Years* https://www.space.com/15640-envisat-satellite-space-junk-150years.html accessed 2 December 2022

List of Abbreviations

AF L Rev	Air Force Law Review
ASAT	anti-satellite weapon
Cal W Int'l LJ	California Western International Law Journal
CILSA	Comparative and International Law Journal of Southern Africa
COSPAR	Committee on Space Research
ESA	European Space Agency
EU	European Union
Hous J Int'l L	Houston Journal of International Law
IADC	Inter-Agency Space Debris Coordination Committee
ICJ	International Court of Justice
ILC	International Law Commission
J Space L	Journal of Space Law
NASA	National Aeronautics and Space Administration
NGO	non-governmental organisation
PELJ	Potchefstroom Electronic Law Journal
RECIEL	Review of European Comparative and International Environmental Law
SAYIL	South African Yearbook of International Law
Syracuse L Rev	Syracuse Law Review

TCBMs	Transparency and Confidence Building Measures
U Pa J Int'l L	University of Pennsylvania Journal of International Law
UN	United Nations
UNCOPUOS	United Nations Committee for Peaceful Uses of Outer Space
UNESCO	United Nations Educational, Scientific and Cultural Organisation
UNOOSA	United Nations Office for Outer Space Affairs
USA	United States of America
Wm & Mary Envtl L & Pol'y Rev	William and Mary Environmental Law and Policy Review