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Spaceports on Coastal Areas and Spaceflights: Legal Considerations on the Protection of Marine Environment

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Abstract

Spaceports located on coastal areas can have adverse consequences for the marine environment including acoustic disturbance (e.g. underwater noise) from launch, as well as flight paths passing over these areas affecting marine biodiversity, toxic contaminants and thermal effects from any discharges arising from these activities. Spaceport activities can also affect the displacement of animals and seabirds, as well as alter the seascape through coastal changes.

The protection of the marine environment from launch and spaceflight activities represents an unaddressed issue in the law of space activities and the law of the sea. The paper therefore aims to analyse the space legal regime and the instruments of soft law, such as the 2019 Long-term Sustainability Guidelines, which might be of relevance for safeguarding the marine environment.

Then, the paper considers the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, which constitutes the first global convention to protect the marine environment from human activities. The paper also focuses on the 1997 London Protocol which further develops and updates the Convention. The objective of these two legal instruments is to promote the effective control of all sources of marine pollution. Indeed, contracting parties shall take effective measures to prevent pollution of the marine environment caused by dumping at sea.

Furthermore, the paper deals with the policy and strategy adopted at national level considering environment and biodiversity preservation, in the specific case of spaceports located on coastal areas such as (i) the United Kingdom (Cornwall, England), (ii) Norway (Andoya), (iii) France (Kourou in French Guyana), (iv) New Zealand (Mahia Launch Complex located close to Ahuriri Point) and (v) John F. Kennedy Space Center in Florida (USA). States and regulators should consider the implementation of “marine environmental impact assessment” and foresee the adverse effects of spaceflight activities on the coastal environment, as well as including proposals to mitigate these impacts. The paper argues that these elements should be included in the authorizations and licenses that states provide for national activities (Article VI of the Outer Space Treaty).

Keywords: space law, law of the sea, regulation, launch activities, spaceflight, pollution, marine environment protection, environmental impact assessment, information sharing

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1. Introduction – Pollution of the Marine Habitat: Consequences of Launches, Emissions of Harmful Substances and Re-Entry of Spacecrafts

In recent years, a growing number of actors, both public and private, have entered the space sector and new space missions are being carried out, such as suborbital flights and exploration projects. These new programmes imply an increase in launches and the creation of additional spaceports¹. As of 31 January 2023, 35 spaceports are used for launching satellites or spacecraft for suborbital flights.² 21 of these launch pads are located on coastal areas mainly for safety and security reasons.³ Indeed, they represent the safest way to conduct launch activity in areas without populations, housing or infrastructure. However, if there is a launch failure or a spacecraft re-entry, space objects or debris can fall into the sea.⁴

Space activities, defined as launching space objects into outer space, operation, control and return of space objects to Earth,⁵ have consequences on Earth's environment, especially space transportation, even if they are seen as less pollutant than air transport. Indeed, the aviation sector is a major source of greenhouse gas (GHG) emissions worldwide⁶ and represents a significant challenge to be addressed. The impact of air transport on climate change is regularly highlighted. While the aviation sector represents the second biggest source of transport GHG emissions after road transport, the increase in space launches also raises questions.⁷ Although Earth orbit is not yet a tourist destination, it could soon become one.⁸ Thus, there is now a willingness from space agencies and companies to develop "green fuel technology", for instance the "Green Propellant Infusion Mission" (GPIM),⁹ due to the increasing number of launches¹⁰ needed to conduct new space activities, such as lunar exploration and space tourism.

1 Stephan Hobe, *Space Law* (Nomos 2019) 177-180; Annette Froehlich (ed), *Spaceports in Europe* (Springer 2021).

2 'Spaceports & Launch Sites' (*Goastronomy*, 1st November 2023) <www.go-astronomy.com/space-ports.php#:~:text=Spaceports%20%26%20Launch%20Sites,suborbit%2C%20orbit%2C%20and%20beyond> accessed 22 March 2023; 'Spaceports of the World' (*Aerospace Security*, 31 January 2023) <<https://aerospace.csis.org/data/spaceports-of-the-world/>> accessed 22 March 2023.

3 The terms 'spaceport' and 'launch pad' are used as synonym in the paper.

4 See Vito De Lucia, 'Oceanic dumping of space objects and the conservation of marine biodiversity in areas beyond national jurisdiction' in Marietta Benkő and Kai-Uwe Schrogl (eds), *Outer Space, Future for Humankind: Issues of Law and Policy* (Eleven 2021) 213-238.

5 'Space activity' (*Law Insider*) <www.lawinsider.com/dictionary/space-activity#:~:text=Space%20activity%20means%3A%20Launching%20space,essential%20activities%20in%20this%20connection> accessed 24 March 2023.

6 Hyeji Kim and Jacob Teter, 'Aviation' (IEA 11 July 2023) <www.iea.org/reports/aviation> accessed 6 November 2023.

7 European Commission, 'Reducing emissions from aviation' highlights that 'The aviation sector creates 13,9% of the emissions from transport...' <https://climate.ec.europa.eu/eu-action/transport-emissions/reducing-emissions-aviation_en> accessed 22 March 2023; Robert G. Ryan et al., 'Impact of Rocket Launch and Space Debris Air Pollutant Emissions on Stratospheric Ozone and Global Climate' (2022) 10 *Advancing Earth and Space Science* 6.

8 Katharine Gammon, 'How the billionaire space race could be one giant leap for pollution' (19 July 2021) *The Guardian* <www.theguardian.com/science/2021/jul/19/billionaires-space-tourism-environment-emissions> accessed 22 March 2023; Tereza Pultarova, 'The rise of space tourism could affect Earth's climate in unforeseen ways, scientists worry' (26 July 2021) *Space* <www.space.com/environmental-impact-space-tourism-flights> accessed 23 March 2023.

9 NASA Space Technology Mission Directorate, 'Green Propellant Infusion Mission (GPIM)' (*NASA*, 5 March 2021) <www.nasa.gov/mission_pages/tmd/green/index.html> accessed 28 March 2023; ESA, 'Testing Green Propellants with Existing Systems' (*ESA*, 10 December 2020) <www.esa.int/Enabling_Support/Space_Engineering_Technology/Shaping_the_Future/Testing_Green_Propellants_with_Existing_Systems> accessed 28 March 2023; Matthieu Delacharlery, 'Les avions... et maintenant les fusées ? La NASA s'apprête à tester un carburant "vert"' (*TF1 Info*, 17 juin 2019) <www.tflinfo.fr/sciences-et-innovation/les-avions-et-maintenant-les-fusees-la-nasa-s-apprete-a-tester-un-carburant-vert-falcon-heavy-space-x-elon-musk-2124336.html> accessed 22 March 2023.

10 'L'année spatiale 2022: le bilan des lancements orbitaux' (*Un autre regard sur la Terre*, 26 January 2023) <<https://un-regard-sur-la-terre.org/2023/01/l-annee-spatiale-2022-le-bilan-des-lancements-orbitaux.html>> accessed 22 March 2023 highlights that : '179 lancements orbitaux réussis, +33% par rapport à 2021 (135 lancements réussis en 2021)'.



Among the largest emitters of pollutants and greenhouse effect emissions are the solid rocket boosters that once propelled the Space Shuttle, which now power Ariane 5 and the Space Launch System (SLS) rockets.¹¹ The launch of a rocket generates up to 300 tons of carbon dioxide in the upper atmosphere, where it can persist for many years.¹² Moreover, several thousand space wrecks that may contain fuel residues litter the oceans.¹³

Reducing the ecological impact of space launches is a major objective of industry, as important as reducing costs¹⁴. Among the possibilities for improvement are the rehabilitation of former industrial sites, the study of local production of rocket biofuel, the reuse of the first stage of the rocket,¹⁵ no longer using toxic propellants or the replacement of previous models of European launchers, such as Ariane 5 and Vega.¹⁶

Space activities can impact Earth's environment and in particular the marine environment. Article 1(4) of the 1982 United Nations Convention on the Law of the Sea (UNCLOS)¹⁷ defines "pollution of the marine environment", such as the "introduction by man, directly or indirectly, of substances or energy into the marine environment [...] which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities [...]".

Spaceflight operations can affect the marine environment in different ways: (i) by the construction of spaceports on coastal areas; or (ii) by launch or re-entry operations that may result in vehicle components falling into national and international waters. In addition, spaceports located on coastal areas can have adverse consequences for the marine environment including¹⁸: (i) effects from jettisoned objects with marine wildlife, vessels or offshore installations and infrastructure; (ii) acoustic

11 'Le spatial est-il écolo?' (12 November 2020) Radio France <www.radiofrance.fr/franceinter/podcasts/la-terre-au-carre/le-spatial-est-il-ecolo-7865971> accessed 22 March 2023; European Space Agency, 'Clean and Eco-Friendly Space' (ESA, 7 May 2019) <www.esa.int/Enabling_Support/Preparing_for_the_Future/Discovery_and_Preparation/Clean_and_eco-friendly_space> accessed 22 March 2023; Marck Piesing, 'The pollution caused by rocket launches' (15 July 2022) BBC <www.bbc.com/future/article/20220713-how-to-make-rocket-launches-less-polluting> accessed 28 March 2023.

12 Katharine Gammon (n 8).

13 Vito De Lucia and Viviana Iavicoli, 'From Outer Space to Ocean Depths: The "Spacecraft Cemetery" and the Protection of the Marine Environment in Areas Beyond National Jurisdiction' (2019) 49 California Western International Law Journal 2, 345-389.

14 Le spatial est-il écolo ? (n 11).

15 ArianeGroup, 'For the first time, ArianeGroup tests a complete reusable space launcher stage' (*Ariane Group*, 23 June 2023) <<https://press.ariane.group/arianegroup-a-teste-pour-la-premiere-fois-un-etage-complet-de-lanceur-spatial-reutilisable-8915/>> accessed 5 September 2023.

16 Le spatial est-il écolo? (n 11); see also European Space Agency, 'Ariane 6 and Vega C: new generation of European Launch Vehicles' (ESA, 6 June 2019) <www.esa.int/ESA_Multimedia/Transmissions/2019/06/Ariane_6_and_Vega_C_new_generation_of_European_Launch_Vehicles> accessed 12 August 2023.

17 United Nations Convention on the Law of the Sea (adopted 10 December 1982, entered into force 16 November 1994) 1833 UNTS 396 (UNCLOS). There are 168 States parties to the Convention which offers a comprehensive legal framework for the preservation, conservation of the marine environment.

18 UK Department for Transport, 'Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018' (2021) 24-25, <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/995153/guidance-to-the-regulator-on-environmental-objectives-relating-to-the-exercise-of-its-functions-under-the-space-industry-act-2018.pdf> accessed 22 March 2023; Alla Pozdnakova, 'Oceans as spaceports: state jurisdiction and responsibility for space launch projects at sea' (2020) 26 Journal of International Maritime Law, 268.



interference¹⁹ and disturbance (including underwater noise) due to launches, as well as the impact of the jettisoned objects on the sea surface; (iii) toxic substances;²⁰ (iv) thermal effects of jettisoned objects; (v) ingestion of objects by marine animals and seabirds; (vi) sediment quality; and (vii) displacement of mammals and seabirds²¹.

The space legal framework does not specifically refer to spaceports²² and the preservation of the marine environment because space transportation has not been considered as pollutant until now.²³ However, the issue of space debris²⁴ and the necessity to preserve the long-term sustainability of space activities²⁵ are major concerns in the space sector, compared to the problem of the preservation of the marine environment due to spaceflight activities.

The paper analyses some of the provisions of the United Nations space treaties in the field of environment protection, as well as the regime of the law of the sea that provides relevant elements for safeguarding the marine habitat. These requirements could be then incorporated into future standards or guidelines for space activities. There is a need to protect the marine environment and its biodiversity from pollution caused by the dumping of wastes and other materials, e.g. space debris when they fall into the sea, gas emissions during launch and other adverse consequences including noise impacting marine animals, where launches are procured on coastal areas or at sea. The paper addresses first the 1967 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies*²⁶ (Outer Space Treaty – OST). Then, it deals with the law of the sea as a legal foundation for the protection of the marine environment from spaceflight pollution. The paper aims to highlight the interactions between both regimes. This ‘holistic’ approach is necessary in order to determine current legal gaps and to find appropriate solutions at international and national levels for the protection of marine environments around coastal spaceports. Lastly, it analyses the regulation adopted by states at national level to resolve the lacunae in the international legal framework. In-

19 ‘What are 4 Sources of Noise Pollution by Humans in the Ocean?’ (*Sinay Maritime Data Solution*, 25 May 2022) <<https://sinay.ai/en/what-are-4-sources-of-noise-pollution-by-humans-in-the-ocean/>> accessed 8 August 2023; Ministère de la Transition Ecologique et Solidaire ‘Recommendations to limit the impacts of manmade underwater acoustic emissions on marine wildlife’ (1st June 2020).

20 Karen N Scott, ‘Ocean Acidification: A Due Diligence Obligation under the LOSC’ (2020) 35 *International Journal of Marine and Coastal Law*, 382-408.

21 UK Marine Management Organisation, ‘Displacement and habituation of seabirds in response to marine activities’ (May 2018) MMO 1139 <https://assets.publishing.service.gov.uk/media/5b1fae7b40f0b634b469faac/Displacement_and_habituation_of_seabirds_in_response_to_marine_activities.pdf> accessed 6 November 2023.

22 Michael Gerhard and Isabelle Reutzel, ‘Law related to space transportation and spaceports’, in Ram S. Jakhu and Paul S. Dempsey (eds), *Routledge Handbook of Space Law* (Routledge 2016) 268-287.

23 Alla Pozdnakova, ‘Pollution of the Marine Environment by Spaceflights’ in Froukje Maria Platjouw and Alla Pozdnakova (eds), *Environmental Rule of Law for Oceans: Designing Legal Solutions* (Cambridge University Press 2023) 2-3.

24 Christopher Newman and Thomas Cheney, ‘Barriers and Gateways to Cleaning Up Earth Orbit: the Legal, Economic and Political Dimensions of Debris Remediation’ (2023) 48 *Air&Space Law*, 113-136; Anne-Sophie Martin and Steven Freeland, ‘From One to Many: “Mega” (Constellation) Challenges to the Legal Framework for Outer Space’ (2021) XLVI *Annals of Air and Space Law*, 152 ss.

25 Minoo Rathnasabapathy and Emmanuelle David, ‘Space Sustainability Rating in Support of the Development and Adoption of Regulatory Guidelines Related to Long-Term Sustainability’ (2023) 48 *Air&Space Law*, 155-178.

26 *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies* [1967] 610 UNTS 205.



deed, states have developed policies and strategies on the preservation of marine environments around launch pads located on coastal zones, also taking into account the case of space objects' re-entry after the completion of the mission.

2. A Space Legal Framework under Test

2.1 The Outer Space Treaty and the Protection of Earth's Environment

It is first necessary to consider the Outer Space Treaty. Article III of the OST provides that “in the exploration and use of outer space, including the Moon and other celestial bodies, States shall carry on activities in accordance with international law [...]”²⁷ Thus, principles of international law might have some application to space activities²⁸ conducted on Earth, such as spaceflight activities and in outer space. States' obligations in carrying out space operations have to be examined in application of international environmental law.²⁹ In addition, states conducting space activities have to consider the protection of Earth's environment³⁰, including marine environment, and the objectives of sustainable development in order to strengthen the obligations of the protection of environment in the space legal framework.

In addition, according to Article VI of the Outer Space Treaty,³¹ states hold international responsibility for their national governmental and non-governmental activities in outer space. It also foresees that 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”. Consequently, states are responsible for national space activities and they have to ensure that space operations are conducted in accordance with international law provisions. With this in mind, states wishing to regulate their national spaceport activities³² could introduce environmental (and more specifically marine) impact assessments (EIAs)³³ as a specific requirement for obtaining authorisation and licence, considering in particular national marine protection policy as detailed in section 4. EIA represents a tool for an initial assessment of eventual impacts of space operations on Earth's environment.³⁴

27 Olivier Ribbelink, ‘Article III’ in Stephan Hobe, Bernhard Schmidt-Tedd’ in Kai-Uwe Schrogl and Gérardine Meishan Goh (eds) *Cologne Commentary on Space Law Vol.1* (Carl Haymanns Verlag 2009) 64-69.

28 Francis Lyall and Paul B. Larsen, *Space Law A Treatise* (Routledge 2018) 246 ss; Anne-Sophie Martin and Steven Freeland, ‘Back to the Moon and Beyond: Strengthening the Legal Framework for Protection of the Space Environment’ (2021) 46 *Air and Space Law* 3, 420.

29 See Lotta Viikari, *The Environmental Element in Space Law: Assessing the Present and Charting the Future* (Martinus Nijhoff Publishers 2008); Ian H. Rowlands, ‘Atmosphere and Outer Space’ in Daniel Bodansky, Jutta Brunnée and Ellen Hey (eds.), *The Oxford Handbook of International Environmental Law* (Oxford University Press 2008) 332.

30 See Patricia Birnie, Alan Boyle and Catherine Redgwell, *International Law and the Environment* (Oxford University Press, 2021); Nicolas de Sadeleer, *Environmental Principles* (Oxford University Press 2020).

31 Michael Gerhard, ‘Article VI’ in Stephan Hobe, Bernhard Schmidt-Tedd’ in Kai-Uwe Schrogl and Gérardine Meishan Goh (eds) *Cologne Commentary on Space Law Vol.1* (Carl Haymanns Verlag 2009) 103-125.

32 Michael C. Mineiro, ‘Law and Regulation Governing U.S. Commercial Spaceports: Licensing, Liability and Legal Challenges’ (2008) 73 *Journal of air law and commerce* 4, 759-805; Steve Mirmina and Caryn Schenewerk, *International space law and space laws of the United States* (Edward Elgar Publishing 2022).

33 Convention on Environmental Impact Assessment in a Transboundary Context (adopted 25 February 1991, entered into force 10 September 1997) 1989 UNTS 309 (Espoo Convention) Article 2(3); Lotta Viikari, ‘Environmental Impact Assessment and Space Activities’ (2004) 34 *Advances in Space Research* 11, 2363-2367.

34 France : articles 8, 15, 16,17 de l'Arrêté du 23 février 2022 relatif à la composition des trois parties du dossier mentionné à l'article 1^{er} du Décret n° 2009-643 du 9 juin 2009 relatif aux autorisations délivrées en application de la loi n° 2008-518 du 3 juin 2008 modifiée relative aux opérations spatiales. See also ‘L'environnement en actes’ (CNES, 5 juin 2019) <<https://cnes.fr/fr/dossier-cnes-lenvironnement-en-actes>> accessed 22 March 2023; Belgium: article 8 of the Law of 17 Sept. 2005 on the Activities of Launching, Flight Operation or Guidance of Space Objects; Denmark: part 4 of the Executive Order No. 552 of 2016; Finland: chapter 2 – Section 10 of the 2018 Act on Space Activities; Greece: articles 4, 5 and 6 of the Law 4508/2017 on Space Activities; Australia: articles 47 (a), 50 (g), 53, 54 and 91 of the Space (Launches and Returns) (General) Rules 2019; Nigeria: sections 9 and 10 of the 2015 Regulations on Licensing and Supervision of Space Activities.



Article IX of the Outer Space Treaty³⁵ is a key provision in the space legal framework because it stresses that “in the exploration and use of outer space, States Parties shall be guided by the principle of cooperation and mutual assistance and shall conduct all their activities in outer space with due regard to the corresponding interests of all other States”. It adds that “States shall conduct exploration of outer space, including the Moon and other celestial bodies, 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”. This provision could be extended to the effects of launches on the Earth’s environment, including the atmosphere and marine environment.

The space legal framework contains relevant but broad norms such as the principle of cooperation, mutual assistance, due regard³⁶ and the duty of consultations in case of hazardous activities or harmful interference in the conduct of space activities.

The lack of specific norms on states’ obligations regarding protection of Earth’s environment in the space legal framework, apart from Article IX of the Outer Space Treaty dealing with the protection of the Earth’s environment “resulting from the introduction of extraterrestrial matter”, undermine the effective application of environmental law in the space field. Indeed, international space law does not make reference for instance to the duty to conduct an environmental impact assessment before embarking on space activity. Nevertheless, the concept is introduced at a national level through domestic space legislation and can be required by states to private entities in order to obtain authorisations and licences to carry out space activities.

It is also worth mentioning that in 1999, during UNISPACE III,³⁷ the United Nations recognized that action should be taken to protect the Earth’s environment and in particular “to ensure, to the extent possible, that all space activities, in particular those which may have harmful effects on the local and global environment, are carried out in a manner that limits such effects and to take appropriate measures to achieve that objective”.³⁸ One can admit that there is an obligation for states to adopt appropriate measures to prevent environmental harm caused by space activities, including spaceflights. This concept is linked to the precautionary principle³⁹, a principle of debatably customary nature,⁴⁰ which advocates that given the high risks associated with space activities, where there

35 Sergio Marchisio, ‘Article IX’ in Stephan Hobe, Bernhard Schmidt-Tedd, Kai-Uwe Schrogl and Gérardine Meishan Goh (eds) *Cologne Commentary on Space Law Vol.1* (Carl Haymanns Verlag 2009) 169-182.

36 Neta Palkovitz, ‘Exploring the Boundaries of Free Exploration and Use of Outer Space – Article IX and the Principle of Due Regard, Some Contemporary Considerations’ (2014) 57 Proc. Colloquium on the L. Outer Space, 93–105.

37 Given the immense potential of space technology for socioeconomic development, the United Nations organized three unique global Conferences on the Exploration and Peaceful Uses of Outer Space – UNISPACE I in 1968, UNISPACE II in 1982 and UNISPACE III in 1999, <www.unoosa.org/oosa/en/aboutus/history/unispace.html> accessed 5 October 2023.

38 UNGA ‘Resolution 1 The Space Millennium: Vienna Declaration on Space and Human Development’ of the ‘Report of the Third United Nations Conference on the Exploration and Peaceful Uses of Outer Space (UNISPACE III)’ (19-30 July 1999) UN Doc A/CONF.184/6 point 1(a)(v), 7.

39 Claudia Cinelli and Katarzyna Pogorzelska, ‘The Current International Legal Setting for the Protection of the Outer Space Environment: The Precautionary Principle Avant La Lettre’ (2013) 22 Rev. Eur. Community & Int’l Env’tl. L. 2, 186–201; Paul B. Larsen, ‘Application of the Precautionary Principle to the Moon’ (2006) 71 Journal of Air Law and Commerce 2, 295–306.

40 Paul B. Larsen, ‘Application of the Precautionary Principle to the Moon’, Journal of Air Law and Commerce, 71(2), 2006, 295-306; Olavo de O. Bittencourt Neto, ‘Preserving the Outer Space Environment: the “Precautionary Principle” Approach to Space Debris’ (2013) 56 Colloquium on the Law of Outer Space, 341–351.



are threats of serious or irreversible damage, a lack of full scientific certainty should not be used as reason for postponing the adoption of effective measures to prevent environmental degradation.⁴¹ However, the requirements for identifying the risk of environmental “harm”, including the need to adopt measures, are ambiguous.⁴² Indeed, the effectiveness of the precautionary principle in the light of scientific doubt with respect to space activities, and in particular considering the impact of spaceflights on Earth’s environment and marine pollution, is not specifically formulated in the space legal framework.⁴³ Nevertheless, it is appropriate to point out that the 1992 Principles Relevant to the Use of Nuclear Power Sources in Outer Space deals with the concept of a “safety assessment”.⁴⁴ Principle 4 provides that “A launching State [...] shall, prior to the launch, through cooperative arrangements, where relevant, with those which have designed, constructed or manufactured the nuclear power sources, or will operate the space objects [...] ensure that a thorough and comprehensive safety assessment is conducted. This assessment shall cover as well all relevant phases of the mission and shall deal with all systems involved, including the means of launching, the space platform, the nuclear power source and its equipment [...]”. This principle could be introduced in guidelines for space transportation taking into account the environmental assessment of such activities and the obligation to prevent environmental damage on Earth due to spaceflight activities.

2.2 Overview of the Guidelines for the Long-term Sustainability of Outer Space Activities: Food for Thoughts on Preserving Marine Ecosystem

This part focuses on the Guidelines for the Long-term Sustainability of Outer Space Activities⁴⁵ (LTS Guidelines) adopted in 2019 by the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)⁴⁶. The LTS Guidelines are a set of 21 voluntary principles. They represent a non-legally binding instrument but they are an important tool for the protection of space environment and to ensure that space activities are conducted in a safer manner for present and future generations. They contain relevant elements that could be taken into consideration for the protection of the marine environment, in particular regarding the sharing of information about the impact of spaceflights on ocean areas. Indeed, an important obstacle is the lack of adequate scientific data and information on

41 Anne-Sophie Martin and Steven Freeland (n 28) 423; Jinyuan Su, ‘Control Over Activities Harmful to the Environment’, in Ram S. Jakhu and Paul S. Dempsey (eds) *Routledge Handbook of Space Law* (Routledge 2017) 73–89.

42 Martha Mejia-Kaiser, ‘Space Law and Hazardous Space Debris’ (30 January 2020) Planetary Science.

43 Lotta Viikari (n 33) 172.

44 UNGA Res 47/68 (14 December 1992) UN Doc A/RES/47/68, Principle 4 ‘Safety assessment’; see Daniel A. Porras, ‘The United Nations Principles Relevant to the Use of Nuclear Power Sources in Outer Space: the Significance of a Soft Law Instrument after nearly 20 Years in Force’, in Irmgard Marboe (ed), *Soft Law in Outer Space* (Böhlau 2012) 205-232.

45 UNGA ‘Report of the Committee on the Peaceful Uses of Outer Space, Sixty-second session’ (12-21 June 2019) UN Doc A/74/20; Peter Martinez, ‘The UNCOPUOS Guidelines for the Long-Term Sustainability of Outer Space Activities’ (2021) 8 *Journal of Space Safety Engineering* 1, 98-107; Peter Martinez, ‘Implementing the Long-Term Sustainability Guidelines: What’s Next?’ (2023) 48 *Air&Space Law*, 41-58.

46 UNGA Res 1348 (XIII) (13 December 1958) UN Doc A/RES/1348(XIII) lead to the creation of the United Nations Committee on the Peaceful Uses of Outer Space as an ad hoc Committee. In 1959, the UNGA converted the UNCOPUOS into a permanent subsidiary body, reaffirming its mandate in UNGA Res 1472 (XIV) (12 December 1959) UN Doc A/RES/1472; see Tanja Masson-Zwaan and Mahulena Hofmann, *Introduction to Space Law* (Wolters Kluwer 2019) 10-11.



the environmental effects of spaceflight operations.⁴⁷ Some elements mention in the LTS Guidelines dealing in particular with the collection, sharing and dissemination on data and information space debris,⁴⁸ space weather, and orbital events might be of relevance for the development of standards or best practices related for instance to the sharing of operational data, the development of models and tools on the mitigation of spaceflights effects on marine environment.

Guideline A.2 deals with the elements to consider when developing, revising or amending national regulatory framework for outer space activities. In particular, it promotes the creation of “(d) regulations and policies that support the idea of minimizing the impacts of human activities on Earth [...]”.

Guidelines B.2 and B.3 focus on the improvement of orbital data on space objects and the enhancement of practice and utility of sharing orbital information on space objects, as well as the promotion of the collection, and the sharing and dissemination of space debris monitoring information. Those elements could be taken into consideration in the development of guidelines addressing the impact of space launches on marine environments and biodiversity, as well as the case of space objects’ re-entry by encouraging the sharing of information and data on the various areas affected by launches. Soft law instruments, such as guidelines, even they are not legally binding, pressure states politically and their violation could be contrary to “best practice” in space activities. Unlike hard law, soft law is more readily accepted by states and private entities⁴⁹ as it is easier to adapt and is also much more effective by virtue of “peer pressure”⁵⁰, including its subsequent implementation in national space legislation.

Guideline B.5 emphasizes the need to develop practical approaches for pre-launch conjunction assessment. In particular, states and international intergovernmental organizations are encouraged to consider developing and using mechanisms to provide information on launch schedules, to assess the future population of space objects, and to inform mariners and pilots on restricted zones at sea and in airspace.⁵¹ This Guideline could be applied to the risk of marine pollution by spaceflights with the duty to provide information on the extent of pollution after a certain number of launches.

Guideline B.6 on the sharing of operational space weather data stresses that “States should monitor, to the extent feasible, space weather continuously and to share data and information with the aim of establishing an international space weather database network”.⁵² These elements of sharing information and data on the consequences of spaceflight activities would also be relevant in the field of the protection of marine environment, fauna and flora, and on the importance of providing information

47 See Greenpeace, ‘Concerns relating to de facto disposal at sea of jettisoned space vehicle components’ (LC/SG 41/8/2) (September 2018) <www.greenpeace.to/greenpeace/wp-content/uploads/2018/09/LC-SG-41-8-2.pdf> accessed 22 March 2023.

48 See the Inter-Agency Space Debris Coordination Committee (IADC) ‘Space Debris Mitigation Guidelines’ (IADC-02-01) (Rev 2 2020, first version adopted in 2002); COPUOS ‘Space Debris Mitigation Guidelines’ (2007).

49 Peter Martinez, ‘The Role of Soft Law in Promoting the Sustainability and Security of Space Activities’ (2020) 44 *Journal of Space Law*, 522-564; see also Irmgard Marboe (ed), *Soft Law in Outer Space* (Böhlau 2012).

50 Irmgard Marboe, ‘Space Law Treaties and Soft Law Development’ (Speech at the United Nations/China/APSCO Workshop on Space Law, Beijing, China, 17 to 20 November 2014) <www.unoosa.org/documents/pdf/spacelaw/activities/2014/pres02E.pdf> accessed 9 October 2023.

51 LTS Guidelines B.5 (6).

52 LTS Guidelines B.6 (2).



on pollution components affecting this ecosystem in order for states to adopt adequate measures for preserving and safeguarding marine habitat. In addition, states and international intergovernmental organizations should also consider sharing real-time and near-real-time critical space weather data and data products in a common format, promoting and adopting common access protocols for their critical space weather data and data products, and promoting the interoperability of space weather data portals, thus promoting ease of data access for users and researchers.⁵³ It is interesting here to note the importance of real-time information, that is, accurate and recent data, including in the case of pollution due to spaceflight activities, considering marine streams and migration of mammals.

LTS Guidelines do not specifically deal with the effects of space activities on Earth and specifically on the marine environment but they contain elements that might be useful in the development of future guidelines and standards for mitigating and remediating marine pollution due to launch activities and re-entry of objects. What is being developed in terms of practical approaches to space debris and space weather could also be adapted to the marine environment, particularly in terms of information sharing. It is crucial to strengthen the exchange of information and data on the consequences of spaceflight on ocean areas. Those elements on the sustainability of space activities are useful and necessary in order to mitigate and remediate space debris, it could also be relevant in the field of marine environment. Furthermore, some elements are present in the UNCLOS, as mentioned in the following part.

3. Space Activities and the Protection of the Marine Environment: a Perspective from the Law of the Sea

3.1 The United Nations Convention on the Law of the Sea: a Key Legal Instrument for Tackling Marine Pollution

Part XII of the UNCLOS deals specifically with the protection and preservation of the marine environment.⁵⁴ Article 192 provides that “States have the obligation to protect and preserve the marine environment”. Article 194 highlights that “States shall take all measures consistent with this Convention that are necessary to prevent, reduce and control pollution of the marine environment from any source [...]”.⁵⁵ In addition, para 2 mentions that “States shall take all measures necessary to ensure that activities under their jurisdiction or control are so conducted as not to cause damage by pollution to other States and their environment, and that pollution arising from incidents or activities under their jurisdiction or control does not spread beyond the areas where they exercise sovereign rights [...]”. From these provisions there derives the obligation for states to protect the marine environment from the adverse effects of their activities, including any space activities and launches. States should

⁵³ LTS Guidelines B.6 (4).

⁵⁴ The legal regime of the law of the sea is consolidated by the High Seas Treaty agreed in March 2023. The agreement supports global collaboration to tackle the ocean’s persistent threats like biodiversity loss, pollution and climate change. See Agreement under the United Nations Convention on the Law of the Sea on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ) (adopted on 19 June 2023) <https://treaties.un.org/Pages/ViewDetails.aspx?src=TREATY&mtdsg_no=XXI-10&chapter=21&clang=_en> accessed 9 October 2023; ‘UN delegates reach historic agreement on protecting marine biodiversity in international waters’ (*UN News*, 5 March 2023) <<https://news.un.org/en/story/2023/03/1134157>> accessed 23 March 2023.

⁵⁵ See Request for an Advisory Opinion Submitted by the Commission of Small Island States on Climate Change and International Law to the International Tribunal for the Law of the Sea (12 December 2022).



act with due diligence⁵⁶ by adopting appropriate measures to protect the marine environment⁵⁷ from their national activities in order to “minimize the release of toxic, harmful or noxious substances; pollution from vessels; pollution from installations and devices”⁵⁸ Para 5 of the Article 194 also emphasizes that measures adopted by states should encompass elements to protect and preserve rare or fragile ecosystems. Thus, states should include measures for the protection of marine environment in the launch authorization process.⁵⁹ In addition, they could introduce specific requirements concerning the protection of Earth environment and marine habitat in their national space legislation⁶⁰.

Article 194 specifies that the responsibility to adopt measures lies with the state that has ‘jurisdiction or control’ over the activities that may cause damage to the marine environment of other states. In accordance with Article 194, the state in whose territory the spaceport is located would maintain “jurisdiction or control” over spaceflight activities. This is in line with Article VI of the Outer Space Treaty, which confers international responsibilities on the “appropriate” State which must authorize and continuously supervise activities conducted by non-governmental entities in outer space. The duty to take appropriate measures to protect the marine environment thus also applies to spaceflight activities conducted by operators from the state’s territory, from another state’s territory or from the high seas.⁶¹ States should take measures to preserve and safeguard marine environment during the launch and in the re-entry phase of space objects on Earth,⁶² including space debris⁶³. Furthermore, it is also important to obtain accurate information on space objects’ return, as mentioned in the LTS Guidelines mentioned above.

Although UNCLOS does not specifically refer to pollution from spaceflights,⁶⁴ it covers all matters relating to the law of the sea and requires states to protect and preserve the marine environment against all forms of pollution, including launch and re-entry activities. Nevertheless, the adoption

56 Samantha Besson, *Due Diligence in International Law (The Hague Academy of International Law)* (Brill 2023).

57 Irini Papanicolopulu, ‘Due Diligence in the Law of the Sea’ in Heike Krieger, Anne Peters and Leonhard Kreuzer (eds) *Due Diligence in the International Legal Order* (Oxford University Press 2020).

58 Article 194 (3) (a) and (c) UNCLOS (n 17).

59 Joosung J. Lee, ‘Legal analysis of Sea Launch license: National security and environmental concerns’ (2008) 24 *Space Policy* 2, 104-112.

60 Annette Froehlich and Vincent Seffinga, *National Space Legislation – A Comparative and Evaluative Analysis* (Springer 2018).

61 Alla Pozdnakova (n 23) 7.

62 Carmen Pardini and Luciano Anselmo, ‘Uncontrolled re-entries of spacecraft and rocket bodies: A statistical overview over the last decade’ (2019) 6 *Journal of Space Safety Engineering* 1, 30-47.

63 See Vito De Lucia, ‘Splashing down the International Space Station in the Pacific Ocean: Safe Disposal or Trashing the Ocean Commons?’ (2022) *EJIL: Talk!* <www.ejiltalk.org/splashing-down-the-international-space-station-in-the-pacific-ocean-safe-disposal-or-trashing-the-ocean-commons/> accessed 22 March 2023.

64 The types of pollution covered under UNCLOS, is a longstanding debate. See Sen Wang, ‘International law-making process of combating plastic pollution: Status Quo, debates and prospects’ (2023) 147 *Marine Policy*; Gemma Andreone (ed), *The Future of the Law of the Sea* (Springer 2017); Donald Rothwell, Alex Oude Elferink, Karen Scott and Tim Stephens (eds), *The Oxford Handbook of the Law of the Sea* (Oxford University Press 2015); Elena M. Mc Carthy, ‘International Regulation of Transboundary Pollutants: the Emerging Challenge of Ocean Noise’ (2001) 6 *Ocean and Coastal Law Journal* 2, 257-292; Amy DeGeneres Berret, ‘UNCLOS III: Pollution Control in the Exclusive Economic Zone’ (1995) 55 *Louisiana Law Review* 6, 1165-1190; Alan E. Boyle, ‘Marine Pollution under the Law of the Sea Convention’ (1985) *The American Journal of International Law*, 79(2) 347-372; Colin M. De La Rue (ed), *Liability for Damage to the Marine Environment* (Lloyd’s of London Press 1993).



of adequate measures by states is conditioned by the availability of data and scientific information concerning the effects of spaceflights on ocean environment.⁶⁵

The UNCLOS' provisions provide some relevant elements to improve the sharing of information concerning the impact of spaceports' activities on the marine environment, such as research cooperation (Article 200), establishment of scientific criteria (Article 201), monitoring the risks or effects of pollution and publishing reports (Articles 204 and 205), and assessing the potential effects of activities on the marine environment (Article 206). These elements could be incorporated in standards on the protection of marine environments from spaceflight activities by taking into account all phases of launch. It is necessary to further develop a system of information sharing between states conducting spaceflights and states exposed to pollution resulting from space activities,⁶⁶ in conjunction with Article IX of the OST, which implies that states shall conduct their space activities with due regard to the corresponding interests of other states.

Following the wording of Article 204 "States shall [...] observe, measure, evaluate and analyse [...] the risks or effects of pollution of the marine environment. States shall keep under surveillance the effects of any activities which they permit or in which they engage in order to determine whether these activities are likely to pollute the marine environment". This provision recalls Article VI of the OST and the necessity of continuous supervision by the state on national space activity. With this in mind, the regulator could require an assessment of the risks and effects of pollution on marine environment in the launch authorisation.

Article 206 provides that "when States have reasonable grounds for believing that planned activities under their jurisdiction or control may cause substantial pollution of or significant and harmful changes to the marine environment, they shall [...] assess the potential effects of such activities on the marine environment [...]". In the space sector, states have to authorize activities conducted by private entities, including spaceflight operations,⁶⁷ and they have to conduct missions so as to avoid harmful contamination of outer space and adverse changes in the environment of the Earth.⁶⁸ One can think that there is a duty to conduct environmental impact assessment before carrying out a launch activity that its operator should undertake an assessment of environment effects (AEE)⁶⁹ of such space operation. EIA is introduced in national space legislation and some states require an EIA for launch activities as previously mentioned. UNCLOS also requires states to publish reports with the results of such an assessment or to communicate the results to a competent international organization⁷⁰.

65 Greenpeace (n 50): 'Lack of publicly available information on the types of engines and fuels used and the quantities and hazards of the materials expected to be jettisoned fundamentally limits any independent assessment of impacts'.

66 Alla Pozdnakova (n 23) 11.

67 OST, article VI.

68 OST, article IX.

69 Auckland Council affirmed that 'An AEE is a written statement which identifies the effects of your proposed activity or activities on the environment...' <www.aucklandcouncil.govt.nz/building-and-consents/resource-consents/prepare-resource-consent-application/Pages/assessment-of-environmental-effects.aspx> accessed 22 March 2023.

70 UNCLOS, article 205.



Lastly, Section 5 of Part XII UNCLOS addresses specific sources of marine pollution and details the general rules of Article 194. In particular, the section encourages states to adopt national laws and regulations to prevent, reduce and control pollution of the marine environment resulting in, for instance, dumping (Article 210), as well as pollution from or through the atmosphere (Article 212). Arguably, some of these provisions may provide a relevant normative basis to strengthen marine environmental protection from spaceflight pollution, for example, soft law instruments dealing with marine pollution resulting from spaceflight activities could be developed at an international level, and they could then be implemented at a domestic level through national space legislation. In addition, the recently adopted agreement under UNCLOS on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction (BBNJ Agreement)⁷¹ also contains provisions on marine pollution and unsustainable use that could be introduced in future guidelines related to the protection of marine environment and space activities. Indeed, it recognises in its preamble that states have the obligation to assess the potential effects of their national activities on the marine environment. Finally, it reaffirms the obligation to conduct environmental impact assessments (Articles 28, 30), which constitute an element that could be introduced in national space legislation.

3.2 The Dumping Regime at Stake

The UNCLOS addresses the issue of dumping regimes⁷² as a tool for tackling marine pollution. Article 1 (5) (a) of the UNCLOS defines “dumping” as (i) any deliberate disposal of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea; (ii) any deliberate disposal of vessels, aircraft, platforms or other man-made structures at sea; (b) “dumping” does not include: (i) the disposal of wastes or other matter incidental to, or derived from the normal operations of vessels, aircraft, platforms or other man-made structures at sea and their equipment, other than wastes or other matter transported by or to vessels, aircraft, platforms or other man-made structures at sea, operating for the purpose of disposal of such matter or derived from the treatment of such wastes or other matter on such vessels, aircraft, platforms or structures; (ii) placement of matter for a purpose other than the mere disposal thereof, provided that such placement is not contrary to the aims of this convention.

Article 210(1) of the UNCLOS requires “States to adopt laws and regulations to prevent, reduce and control pollution of the marine environment by dumping”. States shall take measures to prevent, reduce and control pollution of the marine environment by dumping (para 2). With this in mind, some states have implemented policy and action plans for the preservation of marine environment as examined in section 4. They also provide data and information resulting from research on the spaceports’ impact for environment and biodiversity.

Article 216 of the UNCLOS deals with the enforcement mechanisms with respect to pollution by dumping. It provides that “laws and regulations adopted in accordance with this Convention and

⁷¹See BBNJ (n 54).

⁷² Dumping is also regulated at the regional level by: (i) the 1974 Convention for the Protection of the Marine Environment of the Baltic Sea Area (22 March 1974); (ii) the 1976 Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (16 February 1976) and its Protocol; (iii) the 1992 Convention for the Protection of the Marine Environment of the North-East Atlantic (22 September 1992).



applicable international rules and standards established through competent international organizations or diplomatic conference for the prevention, reduction and control of pollution of the marine environment by dumping shall be enforced: (a) by the coastal State with regard to dumping within its territorial sea or its exclusive economic zone or onto its continental shelf; (b) by the flag State with regard to vessels flying its flag or vessels or aircraft of its registry; (c) by any State with regard to acts of loading of wastes or other matter occurring within its territory or at its off-shore terminals". One can assume that regulations regarding the protection of marine environment from spaceflight missions should be applied by the state where the spaceport is located, by the operator of the launcher, as well as by the State of registry⁷³ of the space objects in case of re-entry that might cause pollution on Earth's environment.

These rules are detailed in the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Convention)⁷⁴ and in the 1996 London Protocol⁷⁵. Article III of the London Convention provides that "dumping" means "any deliberate disposal at sea of wastes or other matter from vessels, aircraft, platforms or other man-made structures at sea", or "any deliberate disposal at sea of vessels, aircraft, platforms or other man-made structures". Under the London Protocol, which updated the Convention,⁷⁶ all dumping is prohibited, except for possibly acceptable wastes on the so-called "reverse list" (see Articles I and II of the Convention and Article 2 of the Protocol). The purpose of the London Convention is to control all sources of marine pollution and prevent pollution of the sea through regulation of dumping into the sea of waste materials. One solution might be a protocol to the Outer Space Treaty dealing specifically with the protection of marine environment to fill the existing gap in the field of spaceflight and marine habitat.

4. Path Forward in the Protection of Marine Environment: Interactions between Space Law and the Law of the Sea

International norms addressing the protection of the marine environment against pollution by dumping are in some ways pertinent and applicable to pollution caused by spaceflight. Indeed, marine dumping rules may be useful for regulating launch and de-orbited space objects operations, as well as for managing pollution caused by space objects released into the high seas.⁷⁷ Furthermore, the legal framework on marine dumping may also be relevant in governing pollution caused by spaceport activities within the maritime zones under jurisdiction of a coastal state, in particular in

73 Article VIII OST states 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...'; Article I (c) of the 1975 Convention on Registration of Objects Launched into Outer Space "the term "State of Registry" means a launching State on whose registry a space object is carried in accordance with article II'.

74 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (Adopted 13 November 1972, entered into force 30 August 1975) 1046 UNTS 120.

75 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Protocol) (adopted 7 November 1996, entered into force on 24 March 2006, as amended in 2006).

76 Andrew Birchenough and Fredrik Haag, 'The London Convention and London Protocol and Their Expanding Mandate' in Aldo Chircop, Scott Coffen-Smout and Moira L. McConnell, *Ocean Yearbook Online* (Brill 2020) 255-278.

77 Vito De Lucia and Viviana Iavicoli (n 15) 379.



the case of spaceflight residues from launches of space objects from another state's territory falling into maritime zones under national jurisdiction of the coastal State.⁷⁸

Pollution caused by spaceflights is not contained in the definition of dumping in UNCLOS and the London Convention. The current legal framework only covers dumping from ships, platforms or from aircraft at sea. The regime could be extended to space launch operations because launch vehicles and re-entry of space objects could be viewed as "aircraft" in a broad interpretation of the term.⁷⁹ It is worth considering the exclusion from the definition of dumping of the elimination of wastes or other materials "incidental to, or derived from, the normal operations of vessels, aircraft, platforms or other structures at sea and their equipment".⁸⁰ However, spaceflight pollution from launch activities is part of a normal operation⁸¹ in the same vein as "operational" discharges from aircraft. There is a distinction between "deliberate" and "incidental" pollution, and consequently the current legal regime does not consider "pollution" from "normal operations". In addition, an accident during the launch phase that causes pollution is not covered by the legal framework because it could be considered an "incidental operation".⁸²

With this in mind, this regime could be adapted to take into account the rise in space launch activities in order to include "operational" (or normal) pollution from dropped components of space objects and pollution by "incidental operation", thus enhancing the legal framework on the protection of the marine environment against pollution from space activities.⁸³ Based on the LTS guidelines previously mentioned, some standards could be developed considering elements of space law including, for instance, Articles VI and IX; as well as provisions of the law of the sea in the field of marine protection, EIA, data sharing and dumping.

Given the fact that the international legal framework does not specifically mention the preservation of marine environment from spaceflight activities, states on whose territories a spaceport is located on coastal areas have developed national policy and environmental plans for the preservation of marine habitats. In the next part, the paper considers some spaceports located near the sea⁸⁴ which represent recently established spaceports or historic ones: Cornwall in the United Kingdom, Andoya in Norway, Ahuriri Point in New Zealand, Kourou in French Guyana, and John F. Kennedy Space Center in Florida (USA).

78 Michael Byers and Cameron Byers, 'Toxic Splash: Russian Rocket Stages Dropped in Arctic Waters Raise Health, Environmental and Legal Concerns' (2017) 53 *Polar Record* 6, 580-591.

79 Alla Pozdnakova (n 23) 9; According to the Oxford Dictionary, an aircraft represents 'any vehicle that can fly and carry goods or passengers' <www.oxfordlearnersdictionaries.com/definition/american_english/aircraft> accessed 22 March 2023.

80 London Protocol, article 2 (1).

81 Report of the Scientific Group of the London Protocol, 'Progress of the Correspondence Group on the Marine Environmental Effects of Jettisoned Waste from Commercial Spaceflight Activities' (March 2019) LC/SG 42/8/1.

82 Alla Pozdnakova (n 23) 10.

83 Alla Pozdnakova (n 23) 13.

84 In Europe, Sweden is also developing its spaceport in Esrange. In the same vein, Portugal envision building a spaceport on the Azores islands.



5. Development of Policy and Environmental Plans at National Level

5.1 Spaceports Recently Established in the European Area

The United Kingdom is developing its space transportation industry, in particular with the establishment of its first operational launch site at Cornwall Airport.⁸⁵ In this context, in 2021 the Department for Transport issued *Guidance to the regulator on environmental objectives relating to the exercise of its function under the Space Industry Act 2018*, clarifying the government's environmental objectives relating to spaceflight and associated activities in the country.⁸⁶ The environmental objectives for spaceflight activities aim to: (i) minimise emissions contributing to climate change resulting from spaceflight activities; (ii) protect human health and the environment from the impacts of emissions on local air quality arising from spaceflight activities; (iii) protect people and wildlife from the impacts of noise from spaceflight activities; (iv) protect the marine environment from the impact of spaceflight activities.

The guiding document completes the 2011 Marine Policy Statement⁸⁷, updated in 2020, which provides for: (i) protection of marine ecology and biodiversity; (ii) consideration of impacts on air quality resulting from increased coastal activity; (iii) consideration of man-made noise sources and assessment of the potential cumulative effects of noise and vibration across sensitive receptors in the marine and coastal area, balancing these against the potential socio-economic benefits; (iv) consideration of impacts on water quality, quantity and physical modifications to the water environment; (v) taking into account the impacts of climate change on the marine environment (relative sea level rise, increased seawater temperatures, ocean acidification and changes in ocean circulation) over the lifetime of a project, facilitating adoption of mitigation measures.

The documents set a framework for taking actions while considering the main environmental effects of UK spaceflight activities, including⁸⁸: (i) impacts of spaceflight emissions on climate change and on levels of ozone in the upper troposphere and stratosphere; (ii) impacts on local air quality around the spaceport; (iii) noise impacts on wildlife at the spaceports and under flightpaths; (iv) impacts on the marine environment from jettisoned objects, as well as coastal spaceports and launch activities.

Norway is currently building its spaceport in Andoya in the Barents Sea-Lofoten area and in this perspective the country is developing policy documents for the protection of the environment, an ocean management plan to limit pollution effects as well as the protection of the Arctic in terms of

85 See 'Spaceport Cornwall' <<https://spaceportcornwall.com/>> accessed 8 September 2023; Jemma-Anne Lonsdale and Claire Phillips, 'Space Launches and the UK Marine Environment' (2021) 129 *Marine Policy*.

86 *Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018* (n 18).

87 UK Marine Policy Statement (adopted in 2011, updated in 2020) <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/69322/pb3654-marine-policy-statement-110316.pdf> accessed 22 March 2023.

88 *Guidance to the regulator on environmental objectives relating to the exercise of its functions under the Space Industry Act 2018* (n 18).



security, climate and environment⁸⁹. Norway also integrated an ocean management plan⁹⁰ because the country has developed many activities that can affect marine life, including space activities. The plans take into consideration the fact that human activity, at sea and on land, puts pressure on marine ecosystems. There is a necessity to develop a comprehensive understanding of the cumulative impacts of all activities, as well as the need for more knowledge about ecosystem impacts of climate change, ocean acidification and underwater noise.⁹¹

5.2 Other Spaceports Worldwide

In French Guyana, at Kourou, home of the Europe's historic spaceport, the Guyana Space Center, the French space agency (CNES – *Centre National d'Etudes Spatiales*), in cooperation with the Center, has established a *Plan de Gestion de la Biodiversité du domaine du Centre Spatial Guyanais* (2021-2030).⁹² This is an environmental policy that aims to examine, prevent and provide measures to limit the impact of spaceflight activities on Guyanese biodiversity, including marine environment. In addition, launch activities within the spaceport depend on the 2008 French Space Act,⁹³ as well as its implementing decrees⁹⁴. The environmental impacts of launches are covered by an environmental measures plan (PME) with the following objectives⁹⁵: (i) assessing the impact of a launch/test/burning on the environment; (ii) ensuring compliance with the requirements of the prefectural decree authorising the operation of the installation: measuring atmospheric concentrations of hydrochloric acid and aluminium chloride; measuring chemical and particulate deposition; assessing the impact on the quality of surface water; monitoring the impact on vegetation; (iii) confirming the conclusions of the impact study through the monitoring of aqueous and gaseous effluents; through the monitoring of water and soil quality. Lastly, a specific protocol and methodology are put in place for each launcher, including Ariane 5, Ariane 6 and Vega. So far, studies on these indicators show positive results with no particular environmental impact.

89 'The Norwegian Government's Arctic Policy' (2021) <www.regjeringen.no/no/dokumenter/arctic_policy/id2830120/> accessed 22 March 2023; see also Alla Pozdnakova, 'Space Infrastructure for a Sustainable Arctic: Opportunities and Challenges of Spaceport Development in the High North' (*The Arctic Institute*, 31 May 2022) <www.thearcticinstitute.org/space-infrastructure-sustainable-arctic-opportunities-and-challenges-spaceport-development-high-north/> accessed 22 March 2023.

90 Norwegian Ministry of Climate and Environment, 'Norway's integrated ocean management plans' (White Paper, 2019-2020).

91 *ibid.*

92 CNES, 'Plan de Gestion de la Biodiversité du Centre Spatial Guyanais' (2021-2030) <https://cnes.fr/sites/default/files/drupal/202102/default/plan_de_gestion_t1_161220.pdf> accessed 22 March 2023.

93 Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (JORF n° 0129 du 4 juin 2008).

94 Arrêté du 23 février 2022 relatif à la composition des trois parties du dossier mentionné à l'article 1^{er} du décret n° 2009-643 du 9 juin 2009 relatif aux autorisations délivrées en application de la loi n° 2008-518 du 3 juin 2008 modifiée relative aux opérations spatiales (JORF n° 0048 du 26 février 2022); Décret n° 2022-233 du 24 février 2022 modifiant le décret n° 2009-640 du 9 juin 2009 portant application des dispositions prévues au titre VII de la loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (JORF n° 0047 du 25 février 2022); Décret n° 2022-234 du 24 février 2022 modifiant le décret n° 2009-643 du 9 juin 2009 relatif aux autorisations délivrées en application de la loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (JORF n° 0047 du 25 février 2022).

95 Célie Losada, 'Synthèse des mesures environnementales au CNES/CSG' (*SPPPI*, 18 January 2018), <www.guyane.developpement-durable.gouv.fr/IMG/pdf/annexe_6_-_presentation_cnes_-_bilan_pme.pdf> accessed 6 November 2023.



In the United States, one of the first policy documents⁹⁶ dealing with space launches and environment was NASA's Final Constellation Programmatic Environmental Impact Statement (PEIS),⁹⁷ adopted in 2008 regarding potential environmental impacts at US Government facilities. Chapter 4 on "Environmental Consequences of Alternatives" deals with the John F. Kennedy Space Center in Florida, which also represents a historic launch site in the United States. The document focuses on water resources and the impacts of launch noise on wildlife, as well as biological impacts of launch area accidents and potential impacts on ocean environment⁹⁸, providing information on impacts of un-burned propellant on the ocean environment.⁹⁹

The policy highlights the potential impacts of space launches on ocean environment. The predominant impacts of an early ascent accident or mission abort on the ocean environment would be due to unspent fuel and unrecoverable accident debris. The magnitude of the impact would depend on the physical characteristics of the materials (e.g. size, composition, quantity) and the physical oceanography of the impact region. The policy indicates that it is unlikely that launcher fragments will fall on a marine mammal due to the extent of the open ocean and the relatively low density of marine mammals on the surface waters of open ocean areas.

US regulation¹⁰⁰ and policy¹⁰¹ provide elements for the protection of marine environment in case of launch accidents,¹⁰² negative impacts during the re-entry of modules in the Pacific Ocean,¹⁰³ as well as environmental compliance.¹⁰⁴

In New Zealand, the Wairoa District coastline is home to Rocket Lab Launch Complex 1, the world's first and only private orbital launch site.¹⁰⁵ Consequently, there are now more frequent launches and space objects re-entering to Earth. There is therefore a need for further research on the cumulative effects that these space activities have on air, land and sea. With regard to the assessment of impacts on the maritime domain, there is the issue of rocket launch debris, and the consequences that launch and debris have on marine environment. Between 2016 and 2017, the National Institute of Water and Atmospheric Research (NIWA) released two reports: (i) the Marine ecological risk assessment of the

96 Other documents: NASA Policy Directive 8500.1B: NASA Environmental Management ; NASA Procedural Requirements 8553.1B: NASA Environmental Management System; NASA Procedural Requirements 8570.1: Energy Efficiency and Water Conservation; NASA Procedural Requirements 8580.1: Implementing The National Environmental Policy Act And Executive Order 12114; NASA Procedural Requirements 8590.1: NASA Environmental Compliance and Restoration (ECR) Program; Title 40 of the Code of Federal Regulations: Protection of Environment (Chapter I, subchapter H "ocean dumping").

97 'NASA's Final Constellation Programmatic Environmental Impact Statement (PEIS)' (NASA, 2008) <www.nasa.gov/pdf/207909main_Cx_PEIS_final.pdf> accessed 22 March 2023.

98 *ibid*, 4-29.

99 *ibid*, 4-96.

100 See the 1972 Marine Mammal Protection Act (MMPA).

101 See Federal Aviation Administration (FAA), 'Final Environmental Assessment for the SpaceX Starship and Super Heavy Launch Vehicle at Kennedy Space Center' (KSC) (19 September 2019).

102 NASA's Final Constellation Programmatic Environmental Impact Statement (PEIS) (n 97), 4-16.

103 *ibid*, 4-103.

104 *ibid*, 4-121.

105 Rocket Lab <www.rocketlabusa.com/launch/launch-with-us/> accessed 22 March 2023.



cumulative impact of electron rocket launches;¹⁰⁶ (ii) the ecological risks assessment of the impact of debris from space launches on the marine environment.¹⁰⁷ The report recognised that direct strike of debris can cause mortality of seabirds and marine mammals, cause noise disturbance, toxic contaminants, the risks of ingestion of debris and the smothering of seafloor organisms.¹⁰⁸ Thus, the report provides a classification of ecological risk.¹⁰⁹ Furthermore, prior to any space launches occurring in New Zealand with the potential to deposit material in the waters of the EEZ, the government undertook an environmental risk assessment¹¹⁰ of the proposed activity in order to determine the level of risk associated with the activity and to mitigate them. Given the very little information about the impacts of this activity, and the uncertainty about if and where the debris will fall on the seabed, New Zealand chose a precautionary approach and placed a limit on the amount of launches to undertake before a review of the regulations (100 in total).¹¹¹ This is a trigger for the environmental effects to be reconsidered so that the regulatory approach can be modified if necessary.

6. Conclusion – Implementing Norms in the Legal Framework dealing with Marine Pollution and Spaceflight Activities

So far, the space legal framework and international environmental law do not adequately regulate state responsibility for spaceflight activities and their impact on marine habitat.

Pollution of the marine environment by spaceflights is not yet perceived by the space community as a problem requiring the adoption of specific measures, probably due to the lack of data and information on the short and long-term effects of space launches on the oceans. This can be explained to some extent by the lack of specific environmental expertise within the UNCOPUOS, the leading international forum to discuss issues on space law and cooperation in space activities¹¹². These issues must be addressed in a coordinated and holistic approach considering legal regimes, as well as the fragility of marine environment and the long-term sustainability of space activities. One possible option could be to add an agenda item to the work of one of the subcommittees; alternatively, to initiate debate on the impact of space transportation and spaceflights on Earth's environment, especially on the ocean habitats, within the agenda items of the Scientific and Technical Subcommittee or within the Legal Subcommittee.

At the international level, the integration of environmental law norms into the space law regime

106 New Zealand Ministry of Environment, 'Marine Ecological Risk Assessment of the cumulative impact of Electron Rocket launches' (NIWA, 2016) <https://environment.govt.nz/assets/Publications/Files/NIWA-marine-ecological-risk-assessment-of-the-cumulative-impact-of-space-rocket-launches_0.pdf> accessed 22 March 2023.

107 New Zealand Ministry of Environment, 'Ecological Risk Assessment of the impact of debris from space launches on the marine environment' (NIWA, April 2017) <<https://environment.govt.nz/assets/Publications/Files/Ecological-Risk-Assessment-of-the-impact-of-debris-from-space-launches-on-the-marine-environment.pdf>> accessed 22 March 2023.

108 *ibid*, 17 ss.

109 *ibid*, 26 ss.

110 New Zealand Ministry of the Environment Regulatory Impact Statement: Regulation of deposit of jettisoned material from space vehicle launches under the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (3 April 2018), 8.

111 *ibid*, 12.

112 David Kendall and Gérard Brachet, 'COPUOS: Current and Future Challenges' (2023) 48 *Air&Space Law*, 7-18.



is still at an initial stage. There is a need to develop a more comprehensive international framework to address the impact of spaceflight on the environment, and in particular the marine environment, as more and more spaceports are established on coastal areas. Furthermore, a common approach should be determined for the conduct of an environmental impact assessment before carrying out spaceflight activities.

In this context, debates on spaceflight activities, pollution and marine environment protection should be extended within the UNCOPUOS, and it should a mandate should be given to the Committee to further discuss, along with the International Maritime Organisation (IMO),¹¹³ the question of the protection of the marine environment. Space institutions could take advantage of the lessons learnt in this field from maritime organisation and from states' practice with the organisation of workshops or the sharing of data and information on the consequences of launch activities on marine habitat. Given that the current space legal framework is limited in this regard, it is necessary to consider some elements from the law of the sea and to extend the dumping regime to launch activities located in coastal areas or at sea.

It may also be feasible to adjust and adapt the existing regulatory and institutional framework for spaceflight activities, considering the pollution of coastal areas near spaceports, by expanding the marine dumping regime to space activities through the adoption of an additional protocol to the Outer Space Treaty, or otherwise developing international standards with the consensus of governments whose jurisdiction coastal launch pads and operators come under.

At the national level, states are adopting policies and environmental plans to limit the pollution of marine areas around spaceports, including by providing relevant data and sharing information, as is also mentioned in the 2019 Long-term Sustainability Guidelines. Where spaceports are located on coastal areas, the regulator should ensure that a marine environment assessment be submitted as part of a launch operator authorisation, pursuant to Article VI of the OST, considering the likely impacts of spaceflight on the coastal environment, as well as proposals to mitigate these impacts by taking into account the nature of dumping and space debris, their trajectories and whether there are nearby protected marine areas.

113 UNGA Report of the Committee on the Peaceful Uses of Outer Space, Sixty-second session (12-21 June 2019), A/74/20: '309. The Committee agreed that the Office for Outer Space Affairs should liaise with the secretariat of the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter and its 1996 Protocol, at the International Maritime Organization, on matters relating to the effects on the marine environment of waste jettisoned from commercial spaceflight activities and report on the status of those matters to the Committee at its sixty-third session, in June 2020. In that regard, the Committee noted that it was the responsibility of member States to liaise and coordinate nationally with their respective authorities and departments responsible for the processes under those intergovernmental bodies'; see also Committee on the Peaceful Uses of Outer Space Marine environmental effects of jettisoned waste from commercial spaceflight activities (17 June 2019) A/AC.105/2019/CRP.11.