Environmental Obligations of Outer Space in Armed Conflicts: The Source, Interpretation and Compliance

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Abstract:
Outer space's environment is fragile and difficult to restore. The academia should conduct a comprehensive review of the environmental protection obligations of belligerents during armed

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conflicts in this domain. Although outer space is different from terrestrial environments, it falls within the general scope of "environment" in international law. International Humanitarian Law and International Law in peacetime constitute a system of rules to mitigate damage to the space environment during armed conflicts. The interpretation of the corresponding obligations must be adapted to the characteristics of both outer space and armed conflicts. This process faces numerous challenges. A practical and feasible approach to guarantee State compliance is to complete the normative framework, ensure flexible interpretation, and provide clearer guidelines for belligerents.

Keywords: outer space, environmental obligations, non-state armed groups, International Humanitarian Law, nature-centrism.

I. Introduction

While there are ongoing appeals for international collaboration to uphold peace and security in outer space, the possibility of an arms race in space remains a threat to global security.[1] The threat of militarization in outer space has lingered since the Cold War[2] Satellites launched by the United States and the Soviet Union were

[1] UNGA A/RES/76/231, 30 December 2021, p. 2; Report of the Secretary-General on Reducing Space Threats through Norms, Rules and Principles of Responsible Behaviours, UN Doc. A/76/77, 13 July 2021.

[2] The process of militarization of outer space is thought to have begun in 1959, when the United States launched its first military satellite. *See* Matthew Mowthorpe, *The Militarization and Weaponization of Space*, Lexington Books, Oxford, 2004, pp. 11–18; Paul B. Stares, *The Militarization of Space: US Policy, 1945–1984*, available at: https://www.osti.gov/biblio/5642072. (All Internet reference was accessed in August 2025). Joan Johnson-Freese and David Burbach, "The Outer Space Treaty and the Weaponization of Space", *Bulletin of the Atomic Scientists*, Vol. 75, No. 4, 2019, pp. 137–141.

predominantly for military purposes.[3] Entering the twenty-first century, the significance of space capabilities for establishing military advantages has been repeatedly confirmed in past and ongoing armed conflicts. Outer Space facilities, such as reconnaissance satellites, provide essential communications and intelligence support to belligerents.[4] Targeting assets in outer space is viewed as a feasible strategy to undermine the space capabilities of adversary states during wartime.[5] Further, an increasing number of countries use outer space for non-offensive purposes to enhance their military capabilities and bolster national security.[6]

Armed conflicts in outer space have the potential to generate diverse forms of contamination, encompassing space debris (a growing concern), chemical effluents, and radioactive waste. These pollutants can inflict damage on deployed space assets and pose significant impediments to the prospect of continued exploration and utilization of outer space.[7] Furthermore, the special environment of

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[3] Wawrzyniec Muszynski-Sulima, "Cold War in Space: Reconnaissance Satellites and US-Soviet Security Competition", *European Journal of American Studies*, 2023.

[4] Ricky Lee and Sarah Steele, "Military Use of Satellite Communications, Remote Sensing, and Global Positioning Systems in the War on Terror", *The Journal of Air Law and Commerce*, Vol. 79, Issue 1, 2014, pp. 111–112; Yun Zhao and Shengli Jiang, "Armed Conflict in Outer Space: Legal Concept, Practice and Future Regulatory Regime", *Space Policy*, Vol. 48, 2019, pp. 51–52.

[5] Clayton Swope, "The Future of Military Power Is Space Power", *Center for Strategic & International Studies*, 9 April 2025, available at: https://www.csis.org/analysis/future-military-power-space-power.

[6] Secure World Foundation, *Global Counterspace Capabilities Report (2025)*, pp. 6–7, available at: https://swfound.org/counterspace/; John R. Hoehn, *Intelligence, Surveillance, and Reconnaissance Design for Great Power Competition*, available at: https://crsreports.congress.gov/product/pdf/R/R46389/1.

[7] ICRC, Constraints under International Law on Military Operations in, or in Relation to, Outer Space during Armed Conflicts, 3 May 2022; ICRC, The Potential Human Cost of the Use of Weapons in Outer Space and the Protection Afforded by International Humanitarian Law, 08 April 2021, p. 2.

"high vacuum and micro-gravity"[8] and the limited ability to restore the space environment means that the damage is likely to be irreversible or even permanent, seriously impairing "the collective interests in the environment."[9] In modern society, the economic and cultural life of people is unsustainable without the use of Earth's orbit, or the patch of space adjacent to Earth. It is necessary to clarify and develop the legal framework to control the environmental risks posed by possible armed conflicts in outer space, to prevent potential catastrophic consequences.

For decades, scholars have been initiating efforts to elucidate the related concepts and standards and explore methods to control outer space pollution.[10] Nowadays, there is a global push to address space debris and other forms of space pollution. International organizations and states are devoted to developing technical assessments and legal documents in this area.[11] Nevertheless, a comprehensive exploration of environmental protection during armed conflicts in outer space through international legal mechanisms appears to be lacking.[12] The

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[8] Robert Thirsk, Andre Kuipers, Chiaki Mukai, and David Williams, "The Space-flight Environment: The International Space Station and beyond," *Canadian Medical Association Journal*, Vol. 180, No. 12, 2009, pp. 1216–1220.

[9] 1967 Outer Space Treaty, Preamble; Cymie R. Payne, "Defining the Environment: Environmental Integrity", in Carten Stahn, Jens Iverson, and Jennifer S. Easterday (eds.), *Environmental Protection and Transitions from Conflict to Peace*, Cambridge University Press, Cambridge, 2017, p. 55.

[10] Stephen Gorove, "Pollution and Outer Space: A Legal Analysis and Appraisal", *New York University Journal of International Law and Politics*, Vol. 5, No. 1, 1972, pp. 53–66.

[11] Vishakha Gupta, "Critique of the International Law on Protection of the Outer Space Environment", *Astropolitics*, Vol. 14, No. 1, 2016, pp. 20–43; Steven Freeland, "Up, Up and... Back: The Emergence of Space Tourism and Its Impact on the International Law of Outer Space", *Chinese Journal of International Law*, Vol. 6, 2005, pp. 20–21; Mark Williamson, "Space Ethics and Protection of the Space Environment", *Space Policy*, Vol. 19, No. 1, 2003, pp. 47–52.

[12] Dake Stephens and Cassandra Steer, "Conflicts in Space: International Humanitarian Law and Its Application to Space Warfare", *Annals of Air and Space*

following issues are of particular concern: are there intersections between environmental obligations and International Humanitarian Law (IHL) in outer space? Do environmental protections under IHL apply in outer space? How can they be enforced?

In addressing these issues, this paper focuses on the legal framework of environmental damage to outer space resulting from armed conflicts. It puts forth practical strategies for overseeing the military activities of warring parties to prevent catastrophic consequences before they unfold. Part II first analyses the applicability of IHL rules in outer space armed conflicts and explains the logic to support the inclusion of the unique space environment in the concept of the "environment" in IHL. Part III then examines how the unique characteristics of the outer space environment should influence the interpretation of the parties' obligations under IHL and relevant peacetime international laws. It is observed that there are gaps between the legal regime and state practice, the nature-centric pursuance, and realistic requirements, influencing the effectiveness of regulation. As a response, Part IV further analyses the difficulties in reaching a global consensus on interpreting existing obligations and formulating new ones, as well as the challenges of ensuring compliance. The paper concludes by proposing a balanced approach aimed at strengthening State protection of the space environment in situations of armed conflict.

Law, Vol. 40, 2015, pp. 1–32; Dieter Fleck (ed.), *The Handbook of International Humanitarian Law*, Oxford University Press, New York, 2021, pp. 64–68; Frans G Von Der Dunk, "Armed Conflicts in Outer Space: Which Law Applies?", *International Law Studies*, Vol. 97, 2021, pp. 188–231.

II. IHL and Outer Space

This section explores situations involving the utilization of outer space for armed conflict and assesses the applicability of IHL in such scenarios. It is crucial to emphasize that although outer space is distinct from the traditional definition of environment in IHL,[13] this paper argues that outer space can be interpreted as part of the environment and be protected under IHL, as will be established below.

2.1 General Applicability of IHL in Outer Space

We start by illustrating the rationale for applying IHL in outer space. The International Court of Justice (ICJ), in its decision *Legality of the Threat or Use of Nuclear Weapons*, observed that the core of IHL is the "humanitarian character," and has evolved to meet contemporary circumstances, it should therefore apply "to all forms of warfare and to all kinds of weapons, those of the past, the present and the future."[14] The advisory opinion of the ICJ is not legally binding, but is recognized internationally and carries significant influence on the interpretation of international law. It reaffirms the resilience of IHL and its elasticity in scope. There are no international documents or practices that negate the overall applicability of IHL in outer space.[15] At the same time, the consensus on the peaceful use of outer space does not preclude all potential attacks in outer space. The "peaceful purposes"

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[13] ICRC, Constraints under International Law on Military Operations in Outer Space during Armed Conflicts, 5 May 2022, p. 4, available at: https://www.icrc.org/en/document/constraints-under-international-law-military-space-operations.

[14] International Court of Justice, Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion of 8 July 1996, para. 86.

[15] Michael N. Schmitt, "International Law and Military Operations in Space", *Max Planck Yearbook of United Nations Law Online*, Vol. 10, No. 1, 2006, p. 115.

of Treaty on 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) is generally understood as "non-aggressive" or "non-hostile" but not "non-military," which means it does not prohibit the legal form of use of force in international law, for example, for self-defense or with the sanction by the United Nations Security Council.[16] In its position paper to the United Nations (UN) in April 2021, the International Committee of the Red Cross(ICRC) stated that military operations conducted in or related to outer space are controlled by existing rules of IHL just as those within the atmosphere.[17]

According to Article 2, paragraph 1, common to the four Geneva Conventions, IHL applies in declared war and armed conflict. Because the declared war is a formal requirement and may limit the application of IHL,[18] ICRC then introduced a fact-based assessment of armed conflicts in its commentary to the Geneva Conventions.[19] This is the substantial precondition of the applicability of IHL. The Tadić case of the International Criminal Tribunal for the former Yugoslavia (ICTY) then established a two-pronged test for the existence of armed

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[16] Haldor Mercado, "'Using the Force' Against 'Rebel Scum': The Application of International Humanitarian Law in Outer Space Against Non-State Actors", *Harvard Law School National Security Journal* (online), March 2025, available at: https://harvardnsj.org/2025/03/24/using-the-force-against-rebel-scum-the-application-of-international-humanitarian-law-in-outer-space-against-non-state-actors/.

[17] ICRC, The Potential Human Cost of the Use of Weapons in Outer Space and the Protection Afforded by International Humanitarian Law, January 2022, para. 9, available at: https://international-review.icrc.org/articles/the-potential-human-cost-weapons-in-outer-space-and-protection-afforded-by-ihl-icrc-position-paper-915.

[18] ICRC, Commentary on the First Geneva Convention: Convention (I) for the Amelioration of the Condition of the Wounded and Sick in Armed Forces in the Field, para. 207, available at: https://ihl-databases.icrc.org/ihl/full/GCI-commentary.

[19] *Ibid.*, para. 209.

conflicts, which is the intensity of violence and the organization of the belligerents. Where there is an armed conflict involving outer space, IHL is logically extended to apply. In this situation, two considerations draw our attention, which are the existence of armed conflicts and the interpretation of related articles.

In most situations, satellites and other space assets are utilized in existing armed conflicts and do not inherently determine the nature of the conflict. But if the nature of the tension and crisis is vague, the existence of an armed conflict and its nature can be determined by firstly assessing the parties involved and then comparing the circumstances of the conflict with the provisions of IHL regarding international armed conflict (IAC) and non-international armed conflicts (NIAC) separately. Compared to IACs, NIACs are governed by a limited set of treaty provisions of IHL, with parties primarily bound by customary international law.[20] The obligations of the belligerent to the environment in armed conflicts have evolved into customary international law[21] while the application of particular provisions is arguable. When the status of customary law is uncertain, parties could form *ad hoc commitments*.[22]

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[20] To confirm the nationality of a space asset, according to Article 8 of the 1967 Outer Space Treaty, 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. In the 1974 Convention on Registration of Objects Launched into Outer Space, "Launching state" refers to a state which launches or procures the launching of a space object or a state whose territory or facility a space object is launched (Art. 1). The term "State of registry" means a launching State on whose registry a space object is registered. If there is more than one launching State, they should determine which one of them to register the object (Art. 2).

[21] 2005 Customary International Humanitarian Law, International Committee of the Red Cross (ICRC), Rules 43, available at: https://ihl-databases.icrc.org/en/customary-ihl/v1/rule43.

[22] The *ad hoc commitments* can be special agreements under the Art. 3 common to the four Geneva Conventions or be unilateral declarations, including those provided

In recent years, two issues have attracted attention with regard to the applicability of IHL in outer space. One concerns the actions conducted by foreign private actors. Military operations in outer space exhibit a clear sovereign character. At the domestic level, the major outer space powers usually have dedicated agencies for the management of outer space activities.[23] In addition, states that permit commercial space activities have enacted specific regulatory legislation.[24] At the international level, the 1967 Outer Space Treaty stipulates that states bear international responsibility for all national activities, no matter if such activities are carried out by governmental agencies or by non-governmental entities.[25] Based on this, the involvement of private actors in armed conflicts in outer space brings two legal effects. Firstly, if they are used for military purposes, they may be legitimate military objectives in IHL. Civilian facilities provide services such as satellite communications, positioning, navigation and timing, intelligence, surveillance, and reconnaissance, and Earth observation.[26] During the Russo-Ukrainian conflict, Ukraine lacks independent space capabilities but still takes advantage of commercial providers such as SpaceX's Starlink satellite internet to

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under Article 96(3) of AP I. Thibaud de La Bourdonnaye, "Greener Insurgencies? Engaging non-State Armed Groups for the Protection of the Natural Environment during Non-international Armed Conflicts", *International Review of the Red Cross,* IRRC No.914, December 2020, pp. 579–605.

[23] E.g., the China National Space Administration and the Office of Commercial Space Transportation in the United States.

[24] E.g., the Commercial Space Launch Act of the US; Commercial Space Launch Amendments Act of 2004, available at: https://www.congress.gov/bill/108th-congress/house-bill/5382.

[25] 1967 Outer Space Treaty, Art. 6.

[26] European Defence Agency, "SPACE", 21 September 2018, available at: https://eda.europa.eu/docs/default-source/documents/eda-information-sheet-on-space.pdf.

maintain wartime communications, drone operations, and intelligence transmission. It also obtains high-resolution imagery from commercial firms.[27] A Russian official thus warned that commercial satellites from the US and Western allies could become legitimate targets if they were used in the war in Ukraine.[28]

Secondly, the launching State has an obligation to prevent the misuse of private actors. If there are two or more States jointly launching a space object, they are jointly and severally liable for any damage caused.[29] States must conduct activities in outer space with due regard to the corresponding interests of all other States.[30] If one private actor is recognized as being under governmental control, its conduct may be attributable to their launching State, thereby giving rise to State responsibility.[31] Launching States bear absolute liability for the damage caused by their space objects on the surface of the earth or to aircraft flight and the fault liability for damage caused elsewhere.[32] Even if one state may not be characterized as a party in armed conflicts,[33] it will still incur State responsibility if it knowingly

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[27] David T. Burbach, "Early Lessons from the Russia-Ukraine War as a Space Conflict", *Atlantic Council*, 30 August 2022, available at: https://www.atlanticcouncil.org/content-series/airpower-after-ukraine/early-lessons-from-the-russia-ukraine-war-as-a-space-conflict/.

[28] Kari A. Bingen, Kaitlyn Johnson and Zhanna Malekos Smith, "Russia Threatens to Target Commercial Satellites", *Center for Strategic & International Studies*, 10 November 2022, available at: https://www.csis.org/analysis/russia-threatens-target-commercial-satellites.

[29] 1972 Liability Convention, Art. 5.

[30] 1967 Outer Space Treaty, Art. 9.

[31] Draft Articles on Responsibility of States for Internationally Wrongful Acts (ARSIWA), 2001, Art. 8.

[32] 1972 Convention on International Liability for Damage Caused by Space Objects (1972 Liability Convention), Art. 2 and 3.

[33] In IHL, when referring to subjects of war, the terms "belligerent" and "party" are commonly used. "Party to the conflict" is the neutral and prevalent expression. For example, Article 2 Common to the Four Geneva Conventions provides: "the present

aids or assists another in committing a serious violation of IHL, according to Article 16 of the 2001 Articles on Responsibility of States for Internationally Wrongful Acts (ARSIWA).

The other is the applicability of the IHL to outer space attacks by new or non-conventional weapons. In addition to traditional kinetic strikes, the methods of warfare involving outer space infrastructure have become increasingly diverse.[34] The confrontation involving outer space facilities usually employs more technological factors, such as cyber-attacks on satellites.[35] IHL requires contracting parties "to respect and to ensure respect for the present Convention in all circumstances."[36] This reflects the contracting parties' intention to broadly apply the Conventions, which gives it the capability of including all forms of armed conflicts that have and have not arisen, anticipated or unanticipated.[37] The provisions on new weapons in the Protocol Additional to the Geneva Conventions of 12 August 1949 and

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Convention shall apply to all cases of declared war or of any other armed conflict which may arise between two or more of the High Contracting Parties, even if the state of war is not recognized by one of them." By contrast, "belligerent" originated from the Hague Conventions, referring to States formally in a declared state of war, such as the expression In Convention (V) respecting the Rights and Duties of Neutral Powers and Persons in Case of War on Land. The Hague, 18 October 1907.

[34] The U.S. Air Force classified attacks related to outer space into three categories: kinetic attacks (e.g., direct physical destruction), non-kinetic attacks (e.g., cyber interference), and the development of space-based weapons. This classification can be found in the Air Force Doctrine Publication 3–14, Space Support, U.S. Air Force, 1 April 2025, "Attack operations can be used to destroy, disrupt, or degrade adversary terrestrial segments and may be accomplished through kinetic or non-kinetic actions."

[35] Walter Peeters, "Cyberattacks on Satellites An Underestimated Political Thre at", *London School of Economics and Political Science*, available at: https://w ww.lse.ac.uk/ideas/projects/space-policy/publications/Cyberattacks-on-Satellites.

[36] Art. 1 Common to the four Geneva Conventions.

[37] Dale Stephens and Cassandra Steer, "Conflicts in Space: International Humanitarian Law and Its Application to Space Warfare", *Annals of Air and Space Law*, Vol. 40, 2015, p. 10.

relating to the Protection of Victims of International Armed Conflicts (AP I) reflects precisely this inclusiveness.[38] The rules for precaution and limitation of methods and means of warfare have obtained the force of customary international law and therefore would apply in NIAC. The broad scope of application of IHL is also determined by its fundamental purpose, which is to mitigate the dangers of armed conflicts. It reflects human society's commitment to upholding the sanctity of human life and dignity. Therefore, IHL applies to all attacks in armed conflicts, no matter the techniques or tools of the attacks, as long as they pose significant risks to the near-earth environment or may cause damage to space's environment.

2.2 The Legal Nature of Outer Space in IHL

When discussing environmental protection, people instinctively think of terrestrial landscapes—plains, mountains, rivers, and oceans—where human populations and other living organisms exist. Compared with them, outer space presents a unique environment characterized by high vacuum, microgravity, extreme temperatures, space debris, ionospheric plasma, and exposure to ultraviolet and ionizing radiation. Its condition is vastly different from that of the Earth, making it uninhabitable. What constitutes outer space is yet to be settled. At present, the international community lacks a unified standard for outer space, and states rarely define it in official documents. The Woomera Manual of the international law of military space activities and operations, which is a summary of professional opinions like the Tallinn Manual on the International Law Applicable to Cyber Warfare in cyberspace,[39] mentioned the uncertainty

[38] E.g., AP I, Art. 49.3.

[39] Michael N. Schmitt (ed.), *Tallinn Manual on the International Law Applicable to Cyber Warfare*, Cambridge University Press, Cambridge, 2013.

regarding the definition of outer space. Its main focus is to delimit the airspace and outer space.[40] Based on the efforts for a universal consensus of the legal Sub-Committee of the UN Committee on the peaceful uses of Outer Space (UNCOPUS) of 1967, this manual points out the specialist approach and functional approach. Each approach connotes different criteria. One representative conclusion under the specialist approach is the Karman line, which is located between 83 or 84 kilometres (km) and 100 km.[41] The functional approach distinguishes based on the aeronautical and astronautical activities instead of making a physical demarcation. The paper takes the delimitation of the Karman line and acknowledges the developing nature of the concept of outer space to retain the flexible extension of it.

The next question is whether outer space falls within the scope of the "environment" according to existing laws. The significance of this issue lies in the fact that if outer space does not fall within the "environment," then the general norm for environmental protection in IHL and customary international law will not be applied. Only the outer space law system, or any future specialized treaties concluded in this regard, can be applied. The geographic area in contemporary IHL usually refers to atmospheres such as the land, sea, or air, while outer space is not expressly included. The AP I merely introduces the term "natural environment" in Articles 35.3 and 55 without a clear definition. The Rome Statute does not specifically define the term as

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[40] Jack Beard and Dale Stephens, *The Woomera Manual on the International Law of Military Space Operations* (Woomera Manual), Oxford University Press, 2024, p. 28.
[41] Committee on the Peaceful Uses of Outer Space Legal Subcommittee Sixty-first session, Vienna, 28 March–8 April 2022, Definition and delimitation of outer space Additional contributions received from States members of the Committee A/AC.105/C.2/2022/CRP.24.

well.[42] However, Article 2 of the Convention on the Prohibition of Military or Any Other Hostile Use of Environmental Modification Techniques (ENMOD) defines the natural environment as "the dynamics, composition or structure of the Earth, including its biota, lithosphere, hydrosphere and atmosphere, or of outer space."[43] Such express recognition indicates that a significant number of countries placed outer space within the scope of "environment" under IHL nearly fifty years ago.

Basically, outer space is part of the environment in international law. Although the concept of environment is subtly different in other branches of law,[44] it is generally recognized as a complex system of interconnections between human civilization and the natural world.[45] Through outer space, we enjoy global communication and navigation services, develop scientific research, monitor solar and meteorological, and conduct earth sensing for agriculture, the economy, and disaster relief, which are all crucial to human development. In the future, outer space may become a potential place for human settlement. Out of the apparent existence of "interconnections" between human living and outer space, protecting the space environment reflects "the common interest of all mankind,"[46] just like the natural environment within the atmosphere

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[42] Rome Statute, Art. 8.2(b)(iv): Other Serious Violations of the laws and customs applicable in international armed conflicts, "Intentionally launching an attack in the knowledge that such attack will cause incidental loss of life or injury to civilians or damage to civilian objects or widespread, long-term and severe damage to the natural environment which would be clearly excessive in relation to the concrete and direct overall military advantage anticipated."

[43] ENMOD, Art. 2.

[44] ILC, "Second Report on Protection of the Environment in Relation to Armed Conflicts by Special Rapporteur Marja Lehto", 27 March 2019, A/CN.4/728, pp. 82–86.

[45] *Ibid.*, para. 196.

[46] 1967 Outer Space Treaty, Preamble.

does. In most disciplines, outer space has been explicitly considered as part of the natural environment due to its close connection to human society. Article 3 of the 1967 Outer Space Treaty specifically obliges states to conduct space activities "in accordance with international law...in the interest of maintaining international peace and security and promoting international cooperation and understanding."[47]

More specifically, outer space belongs to the environment in IHL. According to the Vienna Convention on the Law of Treaties (VCLT), provisions shall be interpreted "in accordance with the ordinary meaning," in consideration of the context as well as the object and purpose.[48] There is sometimes a blurred but always non-negligible boundary between the interpretation and development of international law. Generally, in determining whether an understanding of a legal text crosses the boundaries of legal interpretation, it should be examined whether it is contrary to the purpose of the contracting parties in making the provision or exceeds its maximum extension possible. For example, if an international legal rule aims to protect all plants in the oceans, an emerging species of maritime plant, although undiscovered by all contracting parties by the time of its making, could be interpreted into the scope of the treaty. Conversely, protecting a new species of maritime animal will be rejected.[49]

Moreover, the ICRC Commentary to the Additional Geneva

[47] 1967 Outer Space Treaty, Art. 4.
[48] VCLT, Art. 31.
[49] Xidi Chen and Qi Xu, "Mitigating Effects of Sea-level Rise on Maritime Features through the International Law-making Process in the Law of the Sea", *Frontiers in Marine Science*, Vol. 9, 2022.

Protocols (1977) observes that "the concept of the natural environment should be understood in the widest sense to cover the biological environment in which a population is living."[50] The ILC also noted that the concept of the natural environment is inherently malleable due to the growing awareness of human society and the changing nature of the environment *per se*.[51] In this case, there appears to be no basis for arguing that the IHL's environment deviates from the ordinary understanding of international law and specifically excludes outer space.

In general, the "environment" in IHL is considered to be expandable for the sustainable development of human society. The meaning given to the term "natural environment" in the context of IHL should be understood as broadly as possible.[52] The ICRC guidelines share this systemic interpretation and further argue that the concept of "natural environment" in IHL includes everything that exists naturally and rejects the setting of an unnecessarily strict threshold.[53]

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[50] Commentary on the Additional Protocols of 8 June 1977, p. 662.

[51] Andrew S. Goudie, *The Nature of the Environment,* 4th ed., Wiley-Blackwell, Oxford, 2001, p. 503.

[52] Yves Sandoz, Christophe Swinarski and Bruno Zimmermann (eds.), Commentary on the Additional Protocols of 8 June 1977 to the Geneva Conventions of 12 August 1949, ICRC (1986), 20 May 2016, para. 2126, p. 662, available at: https://www.legal-tools.org/doc/6d222c/; Jean-Marie Henckaerts, Dana Constantin "Protection of the Natural Environment", in Andrew Clapham and Paola Gaeta (eds.), *The Oxford Handbook of International Law in Armed Conflict,* Oxford University Press, Oxford, 2014, p. 471; Cordula Droege and Marie-Louise Tougas, "The Protection of the Natural Environment in Armed Conflict: Existing Rules and Need for Further Legal Protection", *Nordic Journal of International Law*, 01 January 2013, p. 25.

[53] ICRC, Guidelines on Protection of Natural Environment in Armed Conflict, Rules and Recommendations relating to the Protection of the Natural Environment under International Humanitarian Law, with commentary, 2020, paras.15–17, available at: https://www.icrc.org/sites/default/files/document_new/file_list/guidelines_on_the_protection_of_the_natural_environment_in_armed_conflict_advance-copy.pdf.

To minimize collateral damage in armed conflicts, the functional approach to identifying the "environment" has gained acceptance.[54] These comments again prove that it is the interactions with human life and the benefits provided that are important for the outer space being regarded as a part of the environment, not the presence of a particular "element."

2.3 The Factors Influencing Interpretation

The focus of our discussion is not on creating new Outer Space responsibilities for States, but on interpreting existing international law to fit the characteristics of the outer space environment. We address this question in two parts: first, by analysing the characteristics of outer space, and second, by explaining how these characteristics influence the interpretation of international obligations.

2.3.1 The Characteristics of Space Environment

The outer space environment is particularly fragile. Human activities and unrestrained military activities may lead to significant and long-term damage to it. For example, the use of destructive weapons against one particular space facility would result in space debris. This creates a risk to other space facilities and will take up a number of available orbits for prolonged periods of time. Consequences of space warfare present potential damage on Earth, leading to a risk of damage on the ground or in the air for all nations below the trajectories of both damaged satellites and the debris. The Kessler syndrome, which is a theoretical scenario that a sufficient mass of space debris can launch

[54] Michael N. Schmitt, "Green War: An Assessment of the Environmental Law of International Armed Conflict", *Yale Journal of International Law*, Vol. 22, 1997, p. 5.

a self-sustaining, harmful cycle of further and further impacts against space objects, damaging the environment even more.[55]

Therefore, the same technique or tool for attack will have different effects when used in outer space and on Earth. A missile attack of a certain yield, for instance, which happens within the atmosphere, may not cause much damage to the surrounding environment, but the consequences of the explosion it triggers may be significant if it occurred in outer space. Such differences can systematically affect the legal obligations and liabilities of belligerents in multiple aspects. Because of the potential damage, academia has emphasized the role of IHL in mitigating direct and collateral damage from possible armed conflicts in outer space.[56]

For the outer space environment, protection is more important than governance. The space orbits, especially at specific distances, are limited and are a scarce resource.[57] At present, the lack of effective methods of recovery and removal means that debris, chemical substances, and radiation will continue to have a long-standing impact on the availability of outer space orbits. Further, uncontrolled outer space debris could cause damage to satellites and astronauts or even trigger a chain reaction that could lead to more debris, especially

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[55] Mike Wall, Kessler, "Syndrome and the Space Cebris", *Space*, 15 July 2022, available at: https://www.space.com/kessler-syndrome-space-debris.

[56] Steven Freeland, "In Heaven as on Earth? The International Legal Regulation of the Military Use of Outer Space", *US-China Law Review*, Vol. 8, 2011, pp. 272–287; Caitlyn Georgeson and Matthew Stubbs, "Targeting in Outer Space: An Exploration of Regime Interactions in the Final Frontier", *The Journal of Air Law and Commerce*, Vol. 85, 2020, pp. 623–628.

[57] World Economic Forum, Global Risks Report 2022, Chapter 5, available at: https://www.weforum.org/reports/global-risks-report-2022/in-full/chapter-5-crowding-and-competition-in-space.

with the increasingly dense deployment of outer space facilities. Finally, outer space facilities, such as communications satellites, often operate as multi-unit systems. Damage to individual facilities can constitute a significant impediment to the entire system, affecting its function of supporting people's lives and production. This requirement of protecting the space environment is in accordance with the function of IHL. This connection explains why IHL is at the centre of outer space protection.

2.3.2 The Influence on Interpretation

Over the past 50 years, international law regarding environmental protection in armed conflicts has been increasingly developed, and specific rules were successively incorporated into three major legal documents in this field, i.e., ENMOD, AP I, and the Rome Statute. Among them, the AP I prohibits States from employing methods or means of warfare "to cause widespread, long-term and severe damage to the natural environment", and it was widely accepted as a core provision for the environmental obligations under IHL after its adoption.[58] The Rome Statute adopts a similar rule, but incorporates the subjective element and proportionality requirements.[59] ENMOD is intended to prohibit States from using environmental modification techniques that can have widespread, long-lasting, or severe effects as the means of destruction, damage, injury, or "assist, encourage, or induce" such activities.[60]

Despite divergences about the meaning of similar terminologies,

[58] AP I, Art. 35.3.
[59] Rome Statute, Art. 8.2(b)(iv).
[60] ENMOD, Art. 1.

"widespread, long-term and severe damage" and "widespread, long-lasting or severe" since their negotiations,[61] some basic consensus can be found in this regard.[62] In terms of "widespread," a potential impact of several hundred square kilometres is considered sufficient under the two norms. And a duration of more than ten years is satisfactory to most commentators, both for "long-term" and "long-lasting."[63] The terms "serious" and "severe" are sometimes ambiguous, but normally cover the disruption or damage to the natural environment on a large scale.[64] Although the three legal instruments mentioned above may differ in their purposes, armed conflicts in and about outer space are likely to cross the "most lenient standard" set by IHL, taking into account the characteristics of the space environment and human activities there.

Due to the lack of air resistance and gravity, the debris from any type of attack can be expected to cause unpredictable damage, including the immediate risk to other facilities and astronauts, as well as the indirect impact of orbital occupation on future uses of outer space, on a scale well beyond "a few hundred square kilometres."[65]

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[61] Jean-Marie Henckaerts and Louise Doswald-Beck (eds.), *ICRC Study on Customary International Humanitarian Law*, Cambridge University Press, New York, Vol. I, 2009, pp. 151–158.

[62] Countries have incorporated this criterion into their military operation manuals. Federal Ministry of Defence of Germany, the Joint Service Regulation on Law of Armed Conflict, para. 436, available at: https://www.bmvg.de/resource/blob/93610/ae27428ce99dfa6bbd8897c269e7d214/b-02-02-10-download-manual-law-of-armed-conflict-data.pdf.

[63] Official Records of the Diplomatic Conference of Geneva of 1974–1977, Vol. XV, CDDH/215/Rev. I, para. 27.

[64] UNEP, Protecting the Environment during Armed Conflict: An Inventory and Analysis of International Law, p. 52. *See*, Federal Ministry of Defence of Germany, above note 62, para. 403.

[65] Nickolay N. Smirnov, Space Debris: Hazard Evaluation and Debris. CRC Press, London, 2001, pp. 1–16.

For example, the generation of very large clouds of orbital debris could easily satisfy the requirement of time and severity. In the absence of special circumstances, the debris will remain in outer space for decades or even permanently, causing environmental damage.[66] In outer space, a single small-yield missile attack could cause "widespread, long-term, and severe" environmental damage, thereby exposing the attacking party to state responsibility for violations of paragraph 1, Article 55 of AP I, and the use of most kinetic energy weapons, as the means and methods of warfare, are in the legal risk.[67] In fact, even if a non-kinetic attack is used to cause other belligerents to lose control of their outer space facilities, it could lead to collisions with other objects and ultimately cause similar collateral damage to the natural environment.

The unique nature of the outer space environment makes activities in outer space more likely to constitute violations of IHL rules on environmental protection as compared to those of similar intensity conducted in the traditional environment and expose States to potential breaches of obligations. It means that some environmental obligations of States are to some extent "enhanced" in conducting military activities in outer space as compared with regular military activities. Belligerents must be cognisant of their international legal obligations before conducting operations in or related to outer space. [68] In this sense, the potential environmental and legal consequences of warfare normally considered "conventional" must be more closely scrutinized.

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[66] Shenyan Chen, "The Space Debris Problem", *Asian Perspective*, Vol. 35, No. 4, 2011, pp. 537–558.

[67] AP I, Art. 35.3 and 55.1.

[68] It does not mean that all environmental obligations are automatically applicable to armed conflicts in outer space.

III. State Obligations in Outer Space

This section examines applicable provisions in the context of outer space in relation to existing environmental obligations. They include specific norms dedicated to the protection of the environment in armed conflict, as well as more general norms from a broader scope, which can be used to directly control or indirectly implicate damage to the space environment from armed conflicts. In the available system of provisions, IHL is the main force to realize the aim of environmental protection.

3.1 Specific Environmental Obligations in IHL

States hold divergent views as to whether the specific environmental obligations in IHL reflect customary international law, with some States having explicitly denied that these articles embody customary international law.[69] The view of the ICRC is that this obligation of API still is customary international law, while rejections and reservations of some states could be evidence of "persistent dissenters."[70] Same as the ENMOD, it cannot be assumed that the signature of the majority of countries automatically confers on the obligations the force of customary international law to be applied to the entire international community. The three specific environmental obligations in IHL in this part mainly apply to states that are party to the respondent treaty. For NIACs or non-party States, these obligations (subject to their recognition as customary international law) serve primarily as

[69] Related practices include the United States, which has not accepted the provisions due to their broad scope, and France and the United Kingdom, which are disputing the application of the rule to the use of nuclear weapons. *See* ICRC, Guidelines on the Protection of the Natural Environment in Armed Conflicts (2020) and the Woomera Manual pp. 373–375.

[70] *Ibid.*, Woomera Manual, p. 374.

guidance for conduct and rely on the voluntary compliance of the belligerents.

Prohibition on widespread, long-term, and severe damage. Articles 35.3 and 55.1 of AP I provide for this prohibition. It means that once the belligerent causes "widespread, long-term, and severe damage," they will not be able to invoke considerations of military necessity or proportionality to argue that their conduct does not constitute an international wrongful act.[71] These three conditions are conjunctive. Only in the circumstance that all of them are met is one hostile activity conducted by a belligerent regarded as violating this norm.[72] Some countries have sought to read down this regulation. For example, Germany claimed that only damage to the natural environment that "significantly" exceeds what any kind of normal combat can cause will be determined as a violation of the prohibition.[73] Because of this, some voices note that this threshold may be set too high to exempt belligerents from state responsibility most of the time, except for those most extreme and reckless actions.[74]

Prohibition on environmental modification techniques is widespread, long-lasting, and has severe effects.[75] The term "environmental modification techniques" specifically refers to

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[71] ICRC, Guidelines on protection of natural environment in armed conflict, para. 49.
[72] ICTY, Final Report to the Prosecutor by the Committee Established to Review the NATO Bombing Campaign Against the Federal Republic of Yugoslavia, paras. 16–17.
[73] Federal Ministry of Defense of Germany, the Joint Service Regulation on Law of Armed Conflict, para. 453.
[74] Karen Hulme, *War-torn Environment*: *Interpreting the Legal Threshold*, Brill, Leiden, 2004, pp. 292–293.
[75] This rule also shows in the 1967 Outer Space Treaty, Art. 4 and 9: 1979 Moon Agreement, Art. 7.

techniques for deliberately manipulating natural processes. [76] Compared with the prohibition on widespread, long-term, and severe damage under AP I or the Rome Statute, this norm in ENMOD is intended to identify accountability by methods and means of actions. [77] A state's use of environmental modification techniques, which satisfy all three conditions, i.e., widespread. long-lasting and severe, in an armed conflict, would lead to state responsibility. For example, the U.S. Air Force's Project Popeye aimed to disrupt North Vietnamese supply lines by extending the monsoon season over specific areas of the Ho Chi Minh Trail from 1967 to 1972, during the Vietnam War. This project was conducted before the ENMOD took effect in 1977 and was regarded as promoting the conclusion of the treaty.[78]

In the modern sense, ENMOD only applies to the State Parties but is not customary international law. However, its advantage is that the scope of the ENMOD Convention is not limited to the conduct of armed conflicts but extends to militarized actions, including space capability tests and effects experiments. At present, the weaponization of the space environment, such as exploiting natural phenomena or modifying asteroid orbits for offensive purposes, remains theoretical but demands scrutiny. [79] If a state to the

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[76] ENMOD, Art. 2.

[77] Vincze, Viola, "The Role of Customary Principles of International Humanitarian Law in Environmental Protection", *Pecs Journal of International and European Law*, No. 2, 2017, p. 35.

[78] Pamela McElwee, "The Origins of Ecocide: Revisiting the Ho Chi Minh Trail in the Vietnam War", *Environment & Society Portal*, 2020, available at: https://www.environmentandsociety.org/arcadia/origins-ecocide-revisiting-ho-chi-minh-trail-vietnam-war.

[79] For example, the deflection technology of the small solar system body (SSSB) and the "Ivan's Hammer" projects. Related research proved that SSSBs are not an operationally useful class of weapons. *See* Christian Ruhl, "Why We Don't Worry

Convention conducts outer space satellite experiments that violate its provisions, it should bear legal consequences.

Prohibition of using the destruction of the natural environment as a weapon. This prohibition from Article 55.2 of AP I states that attacks against the natural environment by way of reprisals are prohibited. In addition to the obligation under ENMOD to avoid the use of environmental modification techniques that have serious effects, States are prohibited from using the destruction of the natural environment as a tactic or method of warfare under customary international law.[80] This prohibition prohibits the belligerent from specifically aiming to destroy the natural environment. The difference between this obligation and the ENMOD obligation is that it prohibits the destruction of the environment as a consequence, as opposed to being a tool. The term "destruction" is also understood as serious environmental damage. Whether a state violates the rule is also subject to discussion under other rules, including the principles of proportionality or distinction. If States were to sabotage outer space orbits with large amounts of debris or radioactive materials to impede the enemy's deployment of its facilities in outer space, such an operation may fall under the scope of the prohibition on environmental modification techniques.

3.2 General Environmental Obligations in IHL

Besides specific norms that are geared toward environmental damage

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About Asteroid Weapons: Assessing the Risks of Dual-Use SSSB Deflections", *Founders Pledge*, 5 December 2024, available at: https://www.founderspledge.com/research/why-we-don-t-worry-about-asteroid-weapons?utm_source.

[80] Jean-Marie Henckaerts and Louise Doswald-Beck (eds.), above note 61, p. 439.

control, general norms with a wider scope of application can contribute to the protection of the environment during armed conflicts in outer space, through direct application or interpretation, or as "references" for the development of relevant legal rules. Those provisions highlight the precautions and the limitations of means and methods of warfare in and before attacks. They are generally accepted as customary international law.[81] Given the vast number of general norms that may be applicable, this paper only delves into those that are significant at the current stage.

Prohibition on indiscriminate attacks. Article 51.4 of AP I prohibits indiscriminate attacks, which do not distinguish between military targets and civilians, and encompass three specific patterns: "a) those which are not directed at a specific military objective; b) those which employ a method or means of combat which cannot be directed at a specific military objective; or c) those which employ a method or means of combat the effects of which cannot be limited as required by this Protocol." Outer space, like other kinds of environment, is a civilian object, making indiscriminate attacks on this area a violation of the prohibition.[82] This means that belligerents shall not strike military objectives blindly, uncontrollably, or indiscriminately, with no regard to the potential damage to the outer space environment.[83]

At the same time, paragraph 2 and paragraph 3 of this Article restrict the method or means of combat, in particular by prohibiting weapons that are deemed incapable of being directed at specific military targets or whose consequences cannot be effectively limited

[81] The Woomera Manual, Sections 3 and 4.
[82] Jean-Marie Henckaerts and Louise Doswald Beck (eds.), above note 61, pp. 144–146.
[83] *Ibid.*, p. 143.

as prescribed. In conventional warfare, the objects prohibited by this provision are relatively clear, mainly including chemical weapons, biological weapons, or cluster bombs. The question of what means or methods should be prohibited in the context of hostilities in outer space seems more difficult because of the lack of experimentation and valid assessments, but weapons that potentially cause large amounts of uncontrollable outer space debris or other space junk are likely to be relevant to the prohibition.

Principle of distinction. The rule of distinction between civilian and military objectives, as well as between civilians and combatants, is one of the oldest and most fundamental norms of customary international law in IHL. The principle of distinction can complement the normative gaps beyond the "absolute prohibitions." Before deciding on a military operation in outer space, the parties should identify the legal status of the objects involved and confirm that it has been or will be used for military purposes.[84] This not only contributes to avoiding attacks on civilian objects but also reduces collateral damage to the environment. Just as an entire forest cannot be considered a military target because a small force is stationed in it, so an orbit cannot be considered a military target because one or several military installations exist. Given the length of the outer space orbit, it is difficult to imagine any orbit being so fully used militarily as to be considered a military target. Thus, the preliminary observation is that all military actions aimed at destroying the availability of an orbit are likely to violate this rule.[85]

Principle of proportionality. Article 51 of AP I prohibits

[84] *Ibid.*, pp. 29–32.
[85] AP I, Art. 52.2.

indiscriminate attacks and protects the civilian population. It is prohibited to launch an attack against a military objective if the expected incidental damage to the environment, including the natural environment, would be excessive in relation to the concrete and direct military advantage anticipated.[86] Belligerents shall, as a matter of priority, consider whether alternative means exist to achieve the military advantage obtained through kinetic strikes against space objects in armed conflict. When seeking to interfere with satellite communications, if the same objective can be achieved by targeting ground-based infrastructure, then direct attacks on space assets should not be conducted. This rule can be seen as complementary to other principles, like the military necessity principle, when applied in outer space, and is also frequently used in the application of other principles, like the precaution principle in Article 57 AP I. There is no established approach in assessing whether the potential environmental damage is excessive in outer space armed conflict, and the answer may still be a case-by-case approach and rely on the accumulation of precedents.[87]

Principle of precaution. The attacking party is required to take all possible precautions to avoid or minimize damage to the natural environment as a civilian object.[88] Specifically, belligerents should

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[86] ICRC, Guidelines on Protection of Natural Environment in Armed Conflict, Rule 7.

[87] ICTY, Final Report to the Prosecutor by the Committee Established to Review the NATO Bombing Campaign Against the Federal Republic of Yugoslavia, paras. 19–20; Laurent Gisel (ed.), *The Principle of Proportionality in the Rules Governing the Conduct of Hostilities under International Humanitarian Law: International Expert Meeting 22–23 June 2016*, ICRC, 2018, pp. 52–65; Vincze Viola, "The Role of Customary Principles of International Humanitarian Law in Environmental Protection", *Pécs Journal of International and European Law - 2017/II,* No. 2, 2017, p. 26.

[88] Jean-Marie Henckaerts and Louise Doswald Beck (eds.), *Customary International Humanitarian Law*, Vol. I, Rule 15 and commentary, p. 51, available at: https://ihl-databases.icrc.org/customary-ihl/eng/docs/v1_rul_rule15 and related practice.

assess the potential damage to the outer space environment before conducting military activities and consider whether it is excessive in relation to the anticipated military advantage and, if so, cancel or suspend the attack; take all possible measures to avoid or minimize collateral damage when selecting means and methods of attack; and take into account the respective potential environmental impacts when selecting alternative military targets with the similar military advantage.[89]

Secondly, belligerents are required to take all feasible precautions to protect the environment "under their control against the dangers resulting from military operations."[90] The application of this principle in outer space can be difficult because of the difficulty of identifying which areas of outer space are under the control of belligerents. Of particular note, the expression "take all feasible precautions" in the rule implies that effective warning of attacks that may affect the natural environment should be given, unless circumstances do not permit, so that measures can be taken in a timely manner to protect the natural environment. Although this is not explicitly established as an obligation, it may be of significant value in the outer space environment, especially given that other outer space facilities require sufficient time to take evasive action to avoid further expansion of collateral damage.

Martens clause. The Martens Clause stipulates that a belligerent must be guided by the "laws of humanity" and "the dictates of public

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[89] Cordula Droege and Marie-Louise Touges, "The Protection of the Natural Environment in Armed Conflict: Existing Rules and Need for Further Legal Protection", *Nordic Journal of International Law,* 2013, 82(1), p. 34.
[90] AP I, Art. 58.1(c).

conscience" in cases where there are no established or applicable rules to follow.[91] Despite the fact that a range of international laws govern armed conflicts and so encompass armed conflicts in or related to outer space, the potential for environmental devastation resulting from future conflicts in outer space is unpredictable. Given the vital importance of outer space to the current and future development of humanity, States and other entities must recognize the significance of preserving and protecting the space environment and must act accordingly by refraining from any military activity that could undermine the exploration and utilization of outer space.

Due regard. In various branches of international law, such as the law of the sea and international environmental law(IEL), the term "due regard" is often used to describe a general obligation to include certain factors in the application of legislation, policy—making, or enforcement, and it is often connected with due diligence in the process of legal interpretation.[92] Under IHL, States are also required to give due regard to the natural environment in armed conflicts, which specifically includes "constant care" for the environment as well as preventing or reducing the damage with all measures.[93] In the advisory opinion on *the legality of the threat or Use of Nuclear Weapons*, the ICJ confirmed that states shall take environmental considerations into account when assessing what is necessary and proportionate in the pursuit of legitimate military objectives.[94]

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[91] AP II, Preamble. *See* the commentary to Art. 18 of the Articles on the Law of Transboundary Aquifers, *Yearbook of the International Law Commission 2008*, Vol. II, Part Two, paras. 53–54.

[92] Bernard H. Oxman, "The Principle of Due Regard"*, In the Contribution of the International Tribunal for the Law of the Sea to the Rule of Law: 1996–2016*, Brill Nijhoff, Leiden, 2018, pp. 108–117.

[93] ICRC, Guidelines on Protection of Natural Environment in Armed Conflict, Rule 8.

[94] ICJ, Legality of the Threat or Use of Nuclear Weapons, Advisory Opinion of 8 July

In the context of armed conflict in outer space, when determining whether States have given "due regard" to the environment, we must consider whether they have acted in conformity with the specific norms described above, as well as general norms, including the principles of distinction, proportionality, and precaution in good faith. Simultaneously, the implementation of measures geared toward environmental protection and conservation above and beyond legal requirements can also be regarded as a demonstration of its compliance with the due regard rule, for example, taking measures to recycle space junk from attacks.[95]

3.3 Obligations of International Law in Peacetime

International law in peacetime is not terminated or suspended during an armed conflict, even though its application ultimately depends on a variety of factors.[96] The ILC 2011 draft states that the applicability of a treaty during an armed conflict depends on the provisions of the relevant articles of the treaty, as well as the nature of the normative content.[97] Given that most treaties do not explicitly negate the applicability in armed conflicts, their provisions may be applied among contracting parties as long as they are relevant to a particular armed conflict.[98] As for customary rules, their applicability depends on the existence of relevant state practice and whether they are

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1996, para. 30.

[95] ICRC, Guidelines on Protection of Natural Environment in Armed Conflict, paras. 44–45.

[96] *Ibid.*, para. 26.

[97] ILC, Draft Articles on the Effects of Armed Conflicts on Treaties, Art. 3–6.

[98] Dale Stephens, "The International Legal Implications of Military Space Operations: Examining the Interplay between International Humanitarian Law and the Outer Space Legal Regime", *International Law Studies*, Vol. 94, p. 75.

generally accepted as legal obligations.

In particular, obligations of international law in peacetime function in times of tension and crisis. Space now is increasingly congested, and as States' diverse interests in the use and exploration of space continue to expand, the likelihood of disputes arising correspondingly grows. In the situations of tension and crisis, a response must begin with an accurate legal characterization of the unfriendly act of another party, followed by an assessment of the appropriate and legally available measures.[99] How to define the severity of environmental damage is still conventional, since the traditional assessment is based on the environmental damage's impacts on human survival, health, or the ecosystem, and the form of damage. The excessive uncertainty about the legal risks of relevant military operations thereby detracts from the effectiveness of IHL. Obligations of international law in peacetime can make up this gap.

3.3.1 International Environmental Law

IEL can still contribute to the protection of the space environment in armed conflicts. IEL can provide materials for the proper interpretation of the rules of wartime environmental protection. Although the rules of environmental protection in armed conflict were separated from IEL and have been developed over the past few decades, they still rely heavily on the established rules of IEL, particularly the related concepts or norms. For example, AP I prescribes the prohibition of inflicting "widespread," "long-term," and "severe" damage[100] to the natural environment, without further

[99] Woomera Manual, pp.153–226.
[100] AP I, Art. 35.3.

clarifying the language used. IEL provides the "ordinary meaning" or constitutes the "context" for the interpretation of wartime environmental damage, as VCLT puts it. More specifically, its contents appear to naturally serve as a persuasive explanation, only to be considered for deviation when more persuasive reasoning arises. In such scenarios, IEL can supply or elaborate, in the process of legal interpretation, on the protection of the space environment under IHL.[101]

IEL can also be used as a guide for the development of rules on protecting the space environment in armed conflicts. IEL is developing into a comprehensive and increasingly meticulous branch of international law. It has established criteria and procedural rules for evaluating and determining the extent of environmental damage through various legal documents, the accumulation of state practice, and international adjudications. According to IEL, States are obligated to prevent, reduce, and control contamination, conduct regional or international cooperation, and take the precautionary approach. These rules have important implications for the further development of an environmental protection regime for outer space in IHL. Furthermore, from an interdisciplinary perspective, the provisions of environmental protection lie at the intersection of IHL and IEL, influenced by both. Regarding control of the environmental damage in outer space, the appropriate introduction of the "stringent" requirements and standards of IEL could balance the vulnerability caused by the secondary status of the environment in the IHL mechanism, which will be further discussed below.

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[101] ILC, "Second Report on Protection of the Environment in Relation to Armed Conflicts by Special Rapporteur Marja Lehto", 27 March 2019, A/CN.4/728, paras. 182–183.

3.3.2 Outer Space Law

If only seen from the sources of international law in Article 38 of the ICJ Statute, the global regulations for outer space are still the five treaties of the UN done in the 1970s, including the 1967 Outer Space Treaty, 1968 Rescue Agreement, the Convention on International Liability for Damage Caused by Space Objects (1972 Liability Convention), Convention on Registration of Objects Launched into Outer Space (1975 Registration Convention), and the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979 Moon Agreement).[102] In addition, regional legislation and soft-law documents have played an important role in outer space regulation. These documents may not be completely concluded for community interests, but for the convenience of regulation or satisfying the requirements of the most affected countries, like the United States-led Artemis Accords.[103] Our discussion is grounded in the five core UN space treaties, as they represent the most inclusive multilateral consensus to date, ensuring broad participation and negotiation among member states.

Article 1 of the 1967 Outer Space Treaty mandates state parties to act "for the benefit and in the interests of all countries," and that outer space "shall be the province of all mankind."[104] Article 9 stipulates that contracting states to "pursue studies of outer space, including the

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[102] The traditional source of international law refers to which in Article 38 of the ICJ Statute. The year mentioned here is the year that the treaty opened for signature. More information about the five treaties and related principles, please refer to the United Nations Office for Outer Space Affairs, Space Law Treaties, and Principles, available at: https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html.

[103] Artemis Accords, available at: https://www.state.gov/bureau-of-oceans-and-international-environmental-and-scientific-affairs/artemis-accords/.

[104] 1967 Outer Space Treaty, Art. 1.

Moon and other celestial bodies, and conduct exploration of them to avoid their harmful contamination."[105] This article also established the principle of due regard to control the adverse changes to the near earth environment. Because the debris resulting from weapon tests and actual use in combat constitutes a similar danger, China brought up that they can be seen as a phenomenon "which could constitute a danger to the life or health of astronauts.[106] The 1967 Outer Space Treaty, as a product of the 1960s and the era of decolonization, places a clear value on equal access to space resources, without discrimination on any basis. It specifically includes the denial of the "first-come-first-served" principle, which could allow the developed states to enjoy the clear, pristine environment of the original space, and leave a much contaminated, damaged environment to the developing countries.

Although a limited number of States signed the 1979 Moon Agreement, it is a legal document with influence as the only treaty particularly for one extraterrestrial body.[107] In Article 3, the Moon shall be used by all States Parties exclusively for peaceful purposes. Any threat, use of force, hostile act, or threat on the moon is prohibited. Article 7 requests States to avoid harmful effects to the moon and inform the Secretary-General of the United Nations of potential harmful operations like placing radioactive material on the moon.[108] In particular, the 1979 Moon Agreement defines the meaning

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[105] 1967 Outer Space Treaty, Art. 9.

[106] A/AC.105/1262 – Note verbale dated 3 December 2021 from the Permanent Mission of China to the United Nations (Vienna) addressed to the Secretary-General, available at: https://www.unoosa.org/oosa/oosadoc/data/documents/2021/aac.105/aac.1051262_0.html.

[107] There are 11 signatories of 2025, available at: https://treaties.un.org/Pages/ViewDetails.aspx?src=IND&mtdsg_no=XXIV-2&chapter=24&clang=_en.

[108] 1979 Moon Agreement, available at: https://www.unoosa.org/pdf/gares/ARES_34_68E.pdf.

of harmful contamination on the moon. It reads as "prevent the disruption of the existing balance of its environment."[109] This definition can be applied to similar situations in other parts of Outer Space, including Earth orbits, before a unified definition is settled down.

The 1972 Liability Convention elaborates on rules and procedures concerning liability for damage and remedy.[110] The convention establishes a framework for addressing liability issues arising from space activities and the potential damage caused by space objects. Under the convention, launching States bear absolute liability for any damage caused by their space objects to other States or their space objects. This liability extends to both governmental and non-governmental entities. The convention provides a mechanism for resolving disputes through consultation and negotiation, emphasizing the peaceful resolution of conflicts related to space activities. With the continued growth of space exploration and utilization, the Convention on International Liability for Damage Caused by Space Objects remains a cornerstone in shaping the legal landscape governing international space activities and ensuring accountability for potential damages.

In summary, IHL is considered of essential importance to control potential environmental damage to outer space. States and international organizations should work together to adapt IHL to the characteristics of outer space and further develop the legal regime. In practice, belligerents may reject IHL for being too vague or unsuitable for armed conflicts in outer space. In this case, it is significant to see the interaction between IHL and legal norms in peacetime. The IEL

[109] 1979 Moon Agreement, Art. 7.
[110] 1972 Liability Convention, Preamble.

and the outer space law could provide a reference for interpreting and applying IHL rules.

IV. State Compliance with Environmental Obligations

Having analysed provisions on environmental protection and examined how the unique characteristics of the outer space environment may affect their application, we proceed to consider methods to encourage States to accept and comply with these obligations. State engagement and coordination are crucial for ensuring the sustainability of outer space. Meanwhile, scholarship in IEL is undergoing a shift toward critiquing anthropocentrism, a perspective that stands in contrast to nature-centrism (eco-centrism).[111] The existing framework of outer space protection is largely human-oriented, primarily aimed at ensuring exploration and use of outer space rather than its protection. This part explores the possible approach to balance nature-centrism with national interests.[112]

Within the United Nations system, the International Telecommunication Union (ITU) coordinates global radio frequencies, satellite orbits, and communication standards. In accordance with the 1975 Registration Convention, launching States report their launch plans and activities to the United Nations Office for Outer Space

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[111] Vito de Lucia, "Beyond Anthropocentrism and Ecocentrism: A Biopolitical Reading of Environmental Law", *Journal of Human Rights and the Environment*, Vol. 8, No. 2, September 2017, pp.181–202.

[112] Yannick Radi, "ESIL Reflection – Clearing up the Space Junk – On the Flaws and Potential of International Space Law to Tackle the Space Debris Problem", *European Society of International Law*, Vol. 12, Issue 2, available at: https://esil-sedi.eu/esil-reflection-clearing-up-the-space-junk-on-the-flaws-and-potential-of-international-space-law-to-tackle-the-space-debris-problem/.

Affairs (UNOOSA). Although not all UN member States have acceded to the unified regulatory framework for outer space, they often engage in mutual cooperation driven by pressing security considerations.

4.1 Difficulties of Compliance

Parties in specific armed conflicts tend to prioritize immediate military advantage over environmental considerations. Attempts to damage the environment and natural resources as a strategy of war against a formal enemy or as a means of instilling terror have been quite common throughout history. For example, the deliberate burning of Kuwaiti oil wells as a tactic caused catastrophic marine damage during the 1991 Gulf War.[113] The allocation of resources to military capabilities in outer space still constitutes a significant portion of the budgets of major powers.[114] Although these actions are taken to increase defensive ability, they have increased the risk of militarization of the outer space environment. Despite the existence of normative frameworks, the outer space environment is still vulnerable.

Moreover, the international community lacks scientific conclusions and a basic consensus to interpret environmental obligations in outer space. This is primarily because States differ in their space capabilities and potential impact on their near-Earth

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[113] Olof Linden, Arne Jernelov and Johanna Egerup, "The Environmental Impacts of the Gulf War 1991", *International Institute for Applied Systems Analysis*, pp. 8–9, available at https://pure.iiasa.ac.at/id/eprint/7427/1/IR-04-019.pdf.

[114] Take an example, in the published 2025 defence budget of the Department of Defence of the United States, their budget for Space Force reaches up to 29.6 billion US dollars to integrate multiple subjects and capabilities to form a joint force. To realize this target, 3.1 billion dollars was added to develop space domain awareness, space data network, missile warning and tracking, and space control. *See* more Under Secretary of Defense, available at: https://comptroller.defense.gov/Budget-Materials/.

environment from outer space activities. Most of the essential communications meteorological satellites are in geostationary orbits directly above the equator.[115] The orbital mechanics render the equatorial region disproportionately vulnerable to space-based environmental hazards. The equatorial orbital resonance phenomenon, driven by complex interactions between terrestrial rotation and gravitational forces, creates persistent debris accumulation zones—most prominently the geosynchronous orbital debris belt.[116] Compounding these physical vulnerabilities, the equatorial ionosphere exhibits particular susceptibility to electromagnetic interference due to the unique atmospheric and magnetospheric conditions.[117] This creates additional difficulties for space situational awareness and collision avoidance. However, the equatorial States, which are the most exposed to space environmental hazards, typically possess limited space capabilities.[118] The number of military satellites of the US exceeds that of the tenth-ranked space power by an order of magnitude.[119] This technological asymmetry comes with profound implications for obligation attribution. This capacity gap severely impedes timely debris detection and mitigation, creating unacceptable risks to near-Earth environmental security.

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[115] E.g., Strategic assets like Starlink constellations and the international space stations, which occupy low inclination and low Earth orbit (LEO).

[116] Tabaré Gallardo, "Resonances in the Asteroid and Trans–Neptunian Belts: A Brief Review", *Planetary and Space Science*, 2018.

[117] M. A. Abdu, "Equatorial Ionosphere Thermosphere System: Electrodynamics and Irregularities", *Advances in Space Research*, Vol. 35, Issue 5, 2005, pp. 771–787.

[118] Most Farjana Sharmin and Yug Desai, "Barriers to Space Cooperation in South Asia: Africa as an Inspiration", *The Defence Horizon Journal*, 13 December 2023, available at: https://tdhj.org/blog/post/barriers-space-cooperation-south-asia/.

[119] "Military Satellites by Countries 2025-World Population Review", *World Population Review*, available at: https://worldpopulationreview.com/country-rankings/military-satellite-by-country.

Besides, the interpretation of articles shall guide subsequent agreements, relevant rules of international law and practice between the parties regarding the obligations under various treaties and instruments.[120] However, the proper approach toward balancing the direct military advantage that may be derived from attacking targets in outer space vis-à-vis the harm that may be occasioned to the outer space environment has not been clarified by international adjudications or other persuasive sources. Similar questions will also be raised again in the context of the prohibition on indiscriminate attacks, the proportionality principle, the precaution principle, and due regard, etc. It would be difficult, and even myopic, to entirely rely on experience and knowledge established from situations within the atmosphere to answer these questions.

4.2 Proposal for Improvement

The efforts of the international community to form a common understanding of State obligations encounter numerous difficulties. The lack of uniformity in practice may result from the tension between nature-centrism and anthropocentrism. These two approaches are the classic dichotomy in environmental protection: "the value of ecosystems independent of human needs" versus "nature's worth is determined by its utility to humanity." Historically, anthropocentrism has long been the dominant framework in international legal study, while today this tradition is increasingly incorporating nature-centric perspectives. As the international community evolves, the framework undergoes systemic reconstruction from merely focusing on anthropocentric demands to include global environmental concerns, such as space debris and planetary contamination. The concept of

[120] VCLT, Art. 31.

"sustainable development" is also being developed, reflecting shifting societal priorities toward more holistic ecological considerations.[121] This trend suggests that future international law will also move beyond a purely anthropocentric regime and integrate more environmental obligations to ensure the long-term preservation of outer space. Based on this balanced approach, we put forward the following proposals to strengthen the norms of protecting the outer space environment.

Common But Differentiated Responsibility

The principle of common but differentiated responsibilities established in IEL[122] can also be applied to the protection of the outer space environment, particularly the removal and mitigation of space debris after armed conflicts. There is a view that the atmosphere and orbit are similar, and the regulation of greenhouse gas and space debris can be an analogy.[123] Based on this, States share a common responsibility for the sustainability of outer space as well as specific responsibilities commensurate with their financial and technological capacities. This principle operates independently from the attribution of international wrongful acts of States in armed conflicts. Its primary purpose is to mobilize international resources to increase efficiency and quality, thereby better mobilizing diverse stakeholders to actively contribute to mitigating the damage caused by armed conflicts to the

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[121] Karl Johan Bonnedahl, Pasi Heikkurinen and Jouni Paavola, "Strongly Sustainable Development Goals: Overcoming Distances Constraining Responsible Action", *Environmental Science & Policy*, Vol. 129, 2022, pp. 150–158.

[122] 1992 UN Framework Convention on Climate Change, The Preamble and Art. 3, available at: https://unfccc.int/resource/docs/convkp/conveng.pdf.

[123] Yongliang Yan, "Application of the Principle of Common but Differentiated Responsibility and Respective Capabilities to the Passive Mitigation and Active Removal of Space Debris", *Acta Astronautica*, Vol. 209, August 2023, pp. 117.

outer space environment.[124]

Under this principle, scientific definitions may help to clarify the protective responsibilities. For example, they may contribute to clarifying the boundary between outer space and the Earth's atmosphere. Although the Woomera Manual pointed out that the lack of international agreement on the delimitation between aerospace and outer space has not impeded international cooperation,[125] the vague boundary of outer space may impact the distribution of environmental responsibility. This is particularly pertinent given the need to prioritize the protection of the low Earth orbit (LEO) region. According to the International Telecommunication Union, the LEO is between 200 and 2,000 km above Earth's surface.[126] The location where the attack occurs directly affects the severity of the damage. Over 80 percent of satellites are deployed in low Earth orbits, and the impact of disrupting orbits at different altitudes is different. Establishing a consensus on the scope and classified discussion is required. That is why the ICRC and the International Law Commission (ILC) have notably recommended that such an agreement designate "areas of major environmental importance" as "demilitarized zones or non-defended localities."[127]

Special Regulation for Non-State Armed Group（NSAG）

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[124] *Ibid.*, pp.117–131.

[125] Woomera Manual, p. 29.

[126] "WRS-22: Regulation of Satellites in Earth's Orbit", *International Telecommunication Union*, available at: https://www.itu.int/hub/2023/01/satellite-regulation-leo-geo-wrs/.

[127] ICRC, Guidelines on the Protection of the Natural Environment in Armed Conflict, Geneva, 2020, pp. 82–83; ILC, Draft Principles on the Protection of the Environment in Relation to Armed Conflicts, UN Doc. A/CN.4/L.937, 6 June 2019, Principle 4.

The definition of NSAG in IHL is associated with that of NIAC. NIACs are armed confrontations occurring between governmental armed forces and the forces of one or more armed groups, or between such groups, arising on the territory of a State (party to the Geneva Conventions). Armed confrontation must reach a minimum level of intensity, and the parties involved in the conflict must show a minimum of organization.[128] The NSAG is a form of belligerence that may contribute to the degradation or destruction of the environment.[129]

In the debate over whether the AP I and the ENMOD Convention are customary international law, States and the ICRC have conflicting views: States, guided by considerations of their national interests, worry that the relevant provisions could lead to an abuse of international adjudication while ICRC, by contrast, is to apply the relevant provisions to NIAC for more comprehensive obligations under IHL. Even if the rules have a universal effect under customary law, it is more applicable to States than to NSAGs. The unsettled question is whether the obligations in customary international law, like those from IEL discussed in this paper, which are binding upon NSAGs, remain unexplored. In NIACs, there is only one minimum and ambiguous provision, which is Article 14, to prohibit damage to objects indispensable to the survival of the civilian population in AP II.[130] Besides, there is the general regulation of Common Article 3, the

[128] ICRC, How Is the Term 'Armed Conflict' Defined in International Humanitarian Law, 2024, pp.13–14, available at: https://www.icrc.org/sites/default/files/document_new/file_list/armed_conflict_defined_in_ihl.pdf.

[129] Thibaud de La Bourdonnaye, above note 22, pp. 580–581.

[130] Particularly, not all NIAC can apply the Protocol Additional to the Geneva Conventions of 12 August 1949 and relating to the Protection of Victims of Non-International Armed Conflicts (AP II).

Geneva Convention. Beyond the applicability of customary international law, regulations for NIACs and NSAG are insufficient.

The current academic debate and discussions within international organizations lean toward the view that customary international law obligations apply to NSAGs. Instruments such as the World Charter for Nature are frequently invoked in this regard.[131] The legal theories conclude that the NSAGs with a state-like behaviour pattern ought to acquire the required international legal personality.[132] The IEL obligations could be bound by customary IEL. Considering this situation, the ICRC has encouraged parties to NIACs to apply the full IHL regulation for environmental protection, even those under international armed conflicts.[133] Nonetheless, as these instruments lack legally binding force, such application in practice constitutes an expansive interpretation rather than a settled legal obligation. Some commentators also suggest that "while NSAGs do not have obligations under IEL as a matter of law, the need to enhance environmental protection in NIACs means that NSAGs should have certain responsibilities under IEL as a matter of policy."[134] Encouraging the NSAGs to comply with all the environmental obligations is only a temporary solution. The NSAG is distinct from a state in international

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[131] UN General Assembly, World Charter for Nature, UN Doc. A/RES/37/7, 28 October 1982, para. 21(c).

[132] Jann K. Kleffner, "The Applicability of International Humanitarian Law to Organized Armed Groups", *International Review of the Red Cross*, Vol. 93, No. 882, 2011, pp. 445–454.

[133] *See* ICRC, Guidelines on the Protection of the Natural Environment in Armed Conflicts (Rules and recommendations relating to the protection of the natural environment under IHL with commentary), p. 84, available at: https://www.icrc.org/sites/default/files/document_new/file_list/guidelines_on_the_protection_of_the_natural_environment_in_armed_conflict_advance-copy.pdf.

[134] Thibaud de La Bourdonnaye, above note 22, pp. 596–697.

law. To respond to those problems, specialized norms will still be needed in the future. The concept of NSAG should be carefully reviewed, and its responsibility system, which is now under the Rome Statute and International Criminal Law, should include more content about environmental protection.

4.3 Guideline for Belligerents

When outer space faces environmental risks, we find that the applicability of the established IHL regime may not be much in doubt, but its effective implementation in such a novel context raises controversy. Looking back on the history of development of wartime environmental damage provisions, it is difficult to properly implement peacetime international law in the context of armed conflict. [135] Therefore, adaptations to the established rules are necessary for avoiding and reducing damage to the outer space environment from armed conflicts. The last part of this article reviews all the obligations discussed above and proposes a Guideline with specific measures in different phases of armed conflicts for belligerents to strengthen the protection of the outer space environment in armed conflicts.

Firstly, conducting proper assessments before military operations is a common requirement under a range of environmental protection norms in IHL. Although the ICRC appears to consider that environmental impact assessments (EIAs) prior to armed conflicts are

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[135] To coordinate the application of IHL and international law in peacetime, the ILC was approved to work on a special program to settle this problem. ILC, Effects of Armed Conflicts on Treaties, UN Doc. A/CN.4/L.727/Rev.1, 6 June 2008; M. Bothe, C. Bruch, J. Diamond and D. Jensen, "International Law Protecting the Environment during Armed Conflict: Gaps and Opportunities", *International Review of the Red Cross*, Vol. 92, No. 879, September 2020, pp. 579–580.

not mandatory as a general rule,[136] the particularities of the space environment should be further taken into account on this issue. The EIA is indispensable to comply with the relevant obligations, including the prohibition of significant environmental harm, the principle of distinction, the principle of proportionality, and the principle of precaution.[137] Skipping EIAs in favour of military activities in outer space would lead to States being unable to perform their environmental obligations.[138]

The EIA emphasizes prevention, compared with many other mechanisms for environmental protection.[139] Regarding military operations in outer space, the focus of the EIA should be on determining the potential impacts on current and future exploration and use of outer space. It is important to take into account both the direct damage that may result from the operations and the chain reaction it may trigger. In terms of procedural requirements, States should be required to establish due processes for EIAs, and well-

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[136] ICRC, Guidelines on Protection of Natural Environment in Armed Conflict, para. 14.

[137] The potential environmental effects of various types of weapons, even traditional kinetic weapons, are not yet clear in outer space. Therefore, it would be irresponsible to rush into military activities without a case-by-case assessment in a preventive manner. Karl Hebert, "Regulation of Space Weapons: Ensuring Stability and Continued Use of Outer Space", *Astropolitics*, Vol. 12, No. 1, 2014, pp. 1–26; Erin Pobjie, "Space Weapons and the Use of Force in Outer Space: Russia Tests Kinetic DA-ASAT Weapon", *Blog of the Essex Law Research*, 2 December 2021, available at: https://essexlawresearch.blog/2021/12/02/space-weapons-and-the-use-of-force-in-outer-space-russia-tests-kinetic-da-asat-weapon/.

[138] Considering the history of the development of IHL, the norms of IEL on the EIA and the transboundary EIA should be applied according to specific situations in armed conflicts. Michael Bothe, "The Protection of the Environment in Times of Armed Conflict", *German Yearbook of International Law*, Vol. 34, 1991, pp. 57–58.

[139] John Glasson and Riki Therivel, *An Introduction to Environmental Impact Assessment*, Routledge, New York, 2012, p. 5.

established procedures in IEL and the law of the sea can be used as a reference.[140] In addition, they should be encouraged to ensure the transparency of these EIA procedures and to provide information on the results of the assessment.[141]

Secondly, after fully assessing the possible environmental impacts and evaluating the legal risks of military operations, belligerents are obligated to conduct these operations in strict compliance with international law. The actual damage of the military operation might be very different from the findings of the EIA, and the environmental consequences in outer space can be long-lasting and ever-changing. Belligerents have a continuing obligation to prevent and reduce environmental damage, even after the conduct of the military operation. It is important to closely monitor the impact of a particular military operation.

Thirdly, there is a need to improve accountability mechanisms. The parties involved in military operations that breach environmental obligations ought to make full reparation, in the form of restitution, compensation, and satisfaction for the environmental damage.[142] The restoration or recovery of the space environment should be prioritized, given the legal status of outer space as an area beyond the jurisdiction of States. In principle, the party should take all necessary measures, including performing restorative operations in outer space and providing sufficient funding, to return the environment to its previous status. Any remnants of war, such as debris and unexploded

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[140] UNCLOS, Part XII (Especially the rules on preliminary assessment); ICJ, *Pulp Mills on the River Uruguay* (*Argentina v. Uruguay*), Judgment of 20 April 2010, para. 204.

[141] ICRC, Guidelines on Protection of Natural Environment in Armed Conflict, para.14.

[142] ARSIWA, Art. 34.

ordnance, must be completely removed by the responsible party to prevent harm to future space activities for all States. However, it may not always be possible to restore the environment to its previous status with current technology. In such cases, alternative methods may be allowed to ensure full reparation, including the establishment of compensation funds to serve the exploration and use of outer space by all of humanity in the future. Parties to an armed conflict should incorporate the restoration of environmental damage into post-war procedures and reach an enforceable agreement for this purpose.[143]

Finally, international cooperation is essential for the prevention and recovery of the outer space environment. Regional and global collaborations should be encouraged to strictly monitor and control attempts to militarize outer space, including the deployment of weapons prohibited by international law, as well as the assembly of weapons that could be used for combat in outer space. In addition to bilateral and multilateral agreements among States, UN specialized mechanisms, such as the Committee on the Peaceful Uses of Outer Space and the UN Institute for Disarmament Research, can contribute to global cooperation. Within the framework of the UN, processes have been initiated to restrict the testing of outer space weapons and to promote cooperative efforts in space debris removal.[144] At present, States gradually recognize the seriousness of space environmental risks and take cooperative measures under the UN framework to establish a mechanism with the necessary adaptability and flexibility.

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[143] ILC, Draft Principles on Protection of the Environment in Relation to Armed Conflicts, Principles 14 and 16.

[144] E.g., The Prevention of an Arms Race in Outer Space (PAROS) and Transparency and Confidence-Building Measures (TCBMs) of the General Assembly.

V. Conclusion

Examining the rules of international law, environmental damage to outer space in armed conflict is not left uncontrolled under our legal regime. Rather, a series of specific and general norms can be applied to bind the actions of belligerents to prevent or mitigate potential direct or collateral damage, even though not all rules on environmental protection under IHL may be applicable. Nevertheless, given the paucity of scientific findings and State practice at the current stage, it is to be expected that States, international organizations, and international lawyers may encounter some thorny problems in the future when they set out to actually apply and interpret these rules to address relevant situations. Outer space, because of its special characteristics compared to the environment within the atmosphere, may pose far greater challenges to the application of the rules of environmental protection.

Discussing the applicability of IHL in outer space does not equate to allowing outer space to become a new battlefield. On the contrary, the aim is to do our utmost to limit space activities to peaceful use and prevent irreversible damage to the fragile space environment from geopolitical risks. All contemporary military applications of space technology, whether occurring during an armed conflict or merely in the research phase, must rigorously comply with the proposed obligations. On the one hand, substantive rules should be adapted to the space environment through legal interpretation. On the other hand, a series of procedural requirements and rules concerning enforcement under international law should not only be emphasized but also completed through the interpretation and development of rules.

As mentioned above, environmental damage caused by armed conflicts in outer space is unpredictable, and the cost may be unaffordable for humankind. Shifting the protection to the outer space environment from *ex post facto liability* to *ex ante obligation* requires a more robust normative framework for responsible space conduct. Establishing a general criterion applicable to all States is a complex endeavor. A strict system is difficult to acquire wide recognition and compliance. When interpreting obligations, a careful balance between regulatory objectives and fully respecting state sovereignty may represent a pragmatic means of strengthening its application.