
SUSTAINABILITY BEYOND EARTH: REVISITING THE OUTER SPACE TREATY AND GOVERNANCE OF ORBITAL DEBRIS

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ABSTRACT

The Increasing accumulation of orbital debris in Low Earth Orbit (LEO) and Geostationary Earth Orbit (GEO) constitutes a serious peril to the long-term sustainability of outer space as a global common. Over 36,500 trackable objects larger than 10 centimeters and an estimated 130 million untraceable fragments smaller than one centimeter in LEO are increasing the collision cascades. The paper evaluates whether the existing international instruments and voluntary guidelines provide adequate legal basis for debris governance. The paper draws upon Ehrlich's Living Law Theory to explore how the evolution of informal norms and shared responsibilities can complement the absence of binding legal regulations in international space governance. Through doctrinal analysis of relevant treaty provisions, a comparative assessment of domestic regulatory approaches and the application of Ehrlich's Living Law Theory, the paper identifies two critical gaps—First, the prevailing International instruments are deficient to adequately mitigate the debris owing to their non-binding nature; Secondly, reliance on voluntary guidelines has resulted in inconsistent compliance rates ranging from 30-90% across operators, thereby undermining regulatory uniformity and long-term sustainability objectives. The paper seeks to articulate a nexus between the jurisprudential framework of Living Law and emerging state practice in responding to contemporary challenges. To institutionalise these norms, the paper proposes recognising sustainable space development as a proposed 18th Sustainable Development Goal (SDG 18) to the 2030 Agenda with specific targets for debris mitigation and tracking infrastructure. This approach, grounded in cooperation and reciprocity offers a pathway from voluntary compliance to normative obligation enabling pragmatic and sustainable use of outer space.

Keywords: Orbital Debris Mitigation, Shared Responsibility, Space Governance, Sustainable Development Goals (SDG 18), Living Law Theory.

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Introduction

Geographers and scientists are exploring space through advanced technological capabilities, while nations regard such capabilities as indicators of national development and strategic power, the extent of space exploration has become an indicator of a country's technological advancement and global standing. Whilst space exploration is necessary for the development of countries and technological expansion it is also crucial to address the consequences it brings: Space debris has emerged as a significant threat to the environment of earth as a consequence of the growing space launches. These objects orbit at velocities exceeding 28,000 kilometers per hour in Low Earth Orbit (LEO), rendering even small fragments capable of damaging an operational spacecraft.³ The orbital waste poses navigational and environmental hazards upon each debris re-entry event. This position does not advocate an improbable cessation of space exploration, rather an ecologically sound approach to continue with modern necessities of 5G network, Artificial Intelligence and GPS systems enabled by such launches.

The term "space debris" lacks a universal definition under codified international law, making it essential to deduce a working definition for the purpose of mitigation. Substantially, the orbital space debris does not merely contain human-made remnants of space objects but also natural celestial materials such as the meteoroids, asteroids and cosmic dust. The artificial debris comprises components of satellites released post-launch that no longer serve their function and remain in Earth's unregulated orbital zones. The commencement of the space age exploration spans from late 1950s, with the Soviet Union's launch of satellite sputnik 1 in 1957⁴ marking the beginning of space debris accumulation in outer space. It is estimated that these debris remnants persist in the orbital space for decades, creating risks of collision with the operational space objects. Such collisions implode objects into additional particles, generating further debris – a paradigmatic justification for the Kessler Syndrome theory⁵.

These concerns are substantiated by recent collision incidents. The defunct Russian satellite Kosmos 2251 in 2009 colliding with the United States Iridium 33 operational satellite resulted

³ European Space Agency, mitigating space debris generation, https://www.esa.int/Space_Safety/Space_Debris/Mitigating_space_debris_generation (last visited Sep. 2, 2025).

⁴ Office of the Historian, Foreign Service Institute, U.S. Department of State, "Sputnik, 1957," Milestones in the History of U.S. Foreign Relations, accessed November 17, 2025, <https://history.state.gov/milestones/1953-1960/sputnik>.

⁵ Dylan Houle, Preventing the Next Global Crisis: Addressing the Urgent Need for Space Debris Removal, 111 Calif. L. Rev. 1955 (2023).

in over 2,300 trackable debris.⁶ The Chinese 2007 anti-satellite weapon test of its FengYun-1C weather satellite produced more than 3,500 fragmented pieces, which migrated to highly populated zone.⁷ These figures are indeed exponentially growing its previous population of launch debris in some orbital regimes.⁸ This phenomenon discusses how conglomerated satellite collisions create more junk in the earth's orbit, ultimately impeding the efficient functioning of scientific researchers, astronauts, and operational satellites.

Objective

This paper aims to assess the legal status of the regulatory instruments addressing space debris mitigation. Particular emphasis is placed on the traditional International Treaties dating from 1967,⁹ revised voluntary guidelines targeting debris mitigation and emerging State practice addressing challenges in the 21st century. The research attempts to determine the extent to which the international space law instruments that are currently extant allow sufficient legal support to limit orbital debris, and to explore the role of nascent informal rules as a kind of living law that will fill the gaps in official regulation. Using the Living Law Theory of Eugen Ehrlich distinguishing between law in books (official written law) and law in action (norms practiced in the market)¹⁰ this paper examines the dynamics of the space-debris regulation to reveal that the industry norms, insurance requirements, or professional customs tend to have a stronger influence on the behaviour within given spheres than stated in the statute. Furthermore, the paper demonstrates the necessity of a sustainable approach to space development by proposing the sustainable development goal 18 as a framework with universal application.¹¹ The research thus represents a new addition to the body of knowledge on space-law through systematic implementation of the legal-sociological theory to the management of orbital debris.

Methodology

The paper analyses primary and secondary sources through a doctrinal approach. Primary

⁶ Timothy G. Nelson, *Regulating the Void: In-Orbit Collisions and Space Debris*, 37 *J. Air L. & Com.* (2012).

⁷ A. Dey & Jithin Jagadanandan, *Study on Space Debris Mitigation Under the National Space Laws*, 9 *U. Bologna L. Rev.* (1) 45-72 (2024).

⁸ Murtaza Hassanien & et al., *Orbital Debris Threat for Space Sustainability and Way Forward*, 83 *J. Air L. & Com.* (2018).

⁹ *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies*, Jan. 27, 1967, 610 *U.N.T.S.* 205 (The Outer Space Treaty).

¹⁰ Shcherbaniuk, O.V. & Manyk, A.Z. (2023). The concept of "living law" by E. Ehrlich from the point of view of the specificity of social relations in the globalized world. *Аналітично-порівняльне правознавство (Analytical Comparative Jurisprudence)*,

¹¹ Simonetta Di Pippo, "The contribution of space for a more sustainable earth: leveraging space to achieve the sustainable development goals", 2 *Global Sustainability* 1-11 (2019).

sources include International Treaties and guidelines, particularly the Outer space Treaty,¹² Rescue Convention,¹³ Liability Convention,¹⁴ Registration Convention,¹⁵ Moon Treaty, and the recent UN COPUOS voluntary guidelines¹⁶ and their evaluation. The State legislations and soft laws instruments from both developed and developing nations are examined. Secondary sources comprising existing theses, research articles, scholar opinions and peer-reviewed research papers. The paper has also employed quantitative data to analyse the current State of debris in outer space. The research moves forward with a conceptual analysis to simplify complex theories and apply them effectively to address the identified issues.

Limitations

This research is limited to the extent of analysing the existing international legal instruments and their development in addressing the current issue utilising the published statistics and secondary data. This research does not include any primary data collection or surveys. The paper is confined to the suggestive approach of incorporating the voluntary standards and does not propose any new legislation or delve into technical aspects of the debris mitigation.

Literature Review

The literature referred for this paper spans the past 10 years comprising thirty-five literatures including research papers, journals, scholarly articles. The prime instrument of the regulatory order (which to this day serves as its cornerstone) is the outdated Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (the Outer Space Treaty), containing general principles of state responsibility and non-harmful contamination. With these binding instruments, Inter-Agency Space Debris Coordination Committee (IADC)¹⁷ and the Committee on the Peaceful Uses of outer space (COPUOS)¹⁸ have gone to the extent of issuing voluntary Space Debris

¹² Outer Space Treaty, *supra* note 9.

¹³ Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, 672 UNTS 119 (opened for signature Apr. 22, 1968, entered into force Dec. 3, 1968).

¹⁴ Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 961 U.N.T.S. 187 (entered into force Sept. 1, 1972).

¹⁵ United Nations Office for Outer Space Affairs, Convention on Registration of Objects Launched into Outer Space, <https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties/registration-convention.html> (accessed Sep. 21, 2025).

¹⁶ United Nations Office for Outer Space Affairs, Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space, ST/SPACE/49, Vienna, 2010.

¹⁷ United Nations Office for Outer Space Affairs, IADC Space Debris Mitigation Guidelines, A/AC.105/C.1/2025/CRP.9.

¹⁸ COPUOS, *supra* note 16.

Mitigation Guidelines to redress the weaknesses of the treaty provisions. Among the scholarly literature, such gaps in enforcement and interjurisdictional differences in compliance have been defined in academia so far, with the analysis of Larsen (2018)¹⁹ of the changing of regulations of the IADC and the article by Dey and Jagadanandan (2024)²⁰ on national space laws. However, a theoretical framework which can explain why informal industry norms are successfully applied to control the behavioral patterns in the gaps created by formal legal tools remains in the current literature.

Theoretical Framework: Living law Theory

The paper revolves around the core concepts of “living law” (*Lebendes Recht*) perceived by Eugen Ehrlich in his main work *Grundlegung der Soziologie des Rechts*.²¹ Ehrlich distinguished between the two forms of law, “law in books” and the “law in action”.²² The former refers to the codified legislations, court judgments and civil codes which are applied by the judiciary in legal conflicts, in contrast, he introduces the concept of “living law” defined as the body of rules that actually regulates social life irrespective of their formal codification.²³ Such law is discernible through empirical observation of social practices, customs and commercial dealings. “Living Law” described by Ehrlich as:

“The law that dominates life itself, even though it has not been printed in legal propositions. The source of our knowledge of this law is, first, the modern legal document. Secondly, direct observation of life, of commerce, of customs and usages, and of all associations not only of those that the law has recognized but also of those that it has overlooked or passed by, indeed of those that it has disapproved.”

Accordingly, the theory represents the standard conduct of members of society in mundane interactions. Myriad social relationships are governed by moral norms implicitly acceptable as binding within a group. Therefore, it would be the duty of the sociologists to ascertain how

¹⁹ Paul B. Larsen, Solving the Space Debris Crisis, 83 J. Air L. & Com. 475 (2018).

²⁰ See Dey & Jagadanandan, supra note 7.

²¹ Eugen Ehrlich, *Fundamental Principles of the Sociology of Law* 121 (Walter L. Moll trans., Harvard University Press, Cambridge, 1936).

²² Marta Bucholc & Maciej Komornik, "Eugen Ehrlich's failed emancipation and the emergence of empirical sociology of law", 49 *Historyka Studia Metodologiczne* 243-261 (2019).

²³ David Tan, ‘Revisiting Pound’s Law in Action and Ehrlich’s Living Law to Find the “Gap”: A Compilation of Lecture Notes’ (2022) 24(2) *JJR – Journal of Jurisprudence and Research* 225–238 7220-37-12148-1-10-20221207-2

these laws are to be regarded as operative and binding by members of the society.²⁴

RELATION WITH INTERNATIONAL LAW

International law is fundamentally different to domestic law. The lack of centralized enforcement approaches towards international law through binding commitments, coupled with states agreeing to abide by a treaty which weds on reciprocal owing, and reputational reasons, underscores the relevance of the living-law theory of Ehrlich.²⁵ Under the situations where formal treaties have no enforcement clauses the compliance is only achieved by internalization of the norms within states and other actors as norms of responsible behaviour.

The Space debris governance is representative of this dynamic. Under the Outer Space Treaty, states have international responsibility regarding national space operations, and through the Liability Convention, the countries are liable to damage caused by space objects.²⁶ No monitoring, protocols, or sanctions against non-compliance are provided. IADC Space Debris Mitigation Guidelines, an initiative of thirteen key space agencies, are technical guidelines on mitigating debris, which have been adopted by major space agencies not due to the legally enforceable nature of guidelines, but as a professional code of conduct by communities of space operators.

This trend depicts the work of living-law. Formal treaties (law in books) formulate general principles and such rules are supplemented by voluntary rules and law in action (operational substance). There is a wide range of compliance with IADC guidelines by operators, with some having compliance rates of more than 90% and others reaching below 30%.²⁷ This level of variation not only proves the potency of the living law in regulation but also shows its weakness in meeting the collective action problems, which require mass participation.

The International Legal Framework Governing Orbital Debris

A. Foundational Space Law Treaties

1. Outer Space Treaty (1967)

²⁴ibid.

²⁵ Shcherbaniuk O V & Manyk A Z, The concept of “living law” by E. Ehrlich from the point of view of the specificity of social relations in the globalized world (2023) 4 Analytical-Comparative Jurisprudence 102–113, DOI: 10.24144/2788-6018.2023.04.102.

²⁶ Liability Convention, supra note 14.

²⁷ IADC Guidelines, supra note 17.

The United Nations Office for Outer Space Affairs established the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (hereinafter “OST”) in 1967.²⁸

The treaty establishes key provisions that mandate heightened State vigilance outlining collision risk management. Article I establishes State responsibility, accentuating that space exploration must be carried out for the benefit of all mankind (*erga omnes*) in consistency with international law. While Article II of the explicitly prohibits State appropriation claims of sovereignty, establishing space as freely accessible to all states.²⁹ The treaty further vetoes placing nuclear weapons and weapons of mass destruction in orbit, and forbids the establishment of any military bases, fortifications or testing of weapons on the celestial bodies. It mandates State to bear the international responsibility and liability for all governmental or non-governmental activities carried out in outer space, including damages resulting from such acts.³⁰

Though the treaty analyses the potential exploration-related harm and promotes international consultation among spacefaring states, the technical standards of implementation vary state-wise and makes the operation difficult. The gap between formal principles and operational requirements demonstrates incomplete legal regulation which can be supplemented by living law mechanisms.

2. Rescue Agreement (1968)

The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space was adopted by virtue of Resolution 2345 (XXII) in 1968³¹. This agreement requires the high contracting parties to notify the launching authority and the UN Secretary General upon discovering space objects or parts within their territory, high seas or in unregulated areas.

While the agreement facilitates the return of space objects, it does not address the long-term environmental consequences of undiscovered debris remaining in orbit. The agreement represents the formal law within limited operational impact on debris mitigation as the

²⁸Outer Space Treaty, *supra* note 9.

²⁹ *Id.*, Arts. I, II.

³⁰ *Id.*, Art. VII.

³¹ Rescue Agreement, *supra* note 13.

fragmented debris cannot be tracked before atmospheric reentry.

3. Liability Convention (1972)

The Convention on International Liability for Damage Caused by Space Objects (hereinafter, “Liability Convention”) came into force in 1972,³² sets out the absolute liability principle for damage caused on the surface of the Earth or to aircraft, and fault-based liability for damage occurring elsewhere in space. Elaborating on the Article VII of OST, the convention specifies liable parties, grounds of liability, and procedures for claims and settlement. In circumstances where a person or property of a State suffers damage, the launching State shall be held liable where such damage is attributable to its fault.³³

The critical gap in the Convention concerns the attribution of fault in highly congested orbital environments. When collision involves untracked debris, establishing the fault-based liability requiring proof of negligence is often practically impossible. To date, no successful debris-related claims have been processed under the Liability Convention rendering it to be ineffective as a deterrent or remedial mechanism.³⁴

4. Registration Convention (1975)

Examining compliance gaps and tracking systems deficiencies in existing legislations specifically for debris, the General Assembly adopted another Resolution 3235 (XXIX), establishing the Convention on Registration of Objects Launched into Outer Space (hereinafter “Registration Convention”)³⁵, opened for signatories in 1975. The Convention mandates the launching States to register their space objects and report details to the UN registry, facilitating hazardous objects tracking and holding accountability on launching States for any damage caused in outer space.

States often fail to provide timely registration data and objects remain unregistered. Due to the absence of verification mechanisms registration obligations are incomplete.³⁶ In practice, the

³² Liability Convention, *supra* note 14.

³³ *Id.*, Arts. II, III.

³⁴ Chelsea Muñoz-Patchen, *Regulating the Space Commons: Treating Space Debris as Abandoned Property in Violation of the Outer Space Treaty*, 19 *Chi. J. Int'l L.* 233 (2018).

³⁵ Registration Convention, *supra* note 15.

³⁶ United Nations Committee on the Peaceful Uses of Outer Space, *Status of International Agreements relating to activities in outer space as at 1 January 2025*, UN Doc. A/AC.105/C.2/2025/CRP.9 (May 5, 2025).

United States Space Surveillance Network provides a more comprehensive tracking mechanism than the Registration Convention through legal mandate could achieve.

5. Moon Treaty (1979)

Finally, the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (hereinafter "Moon Treaty"), was entered into force in 1984.³⁷ The Moon Treaty establishes the common heritage of mankind principles, equitable sharing of resources, and environmental protection of celestial bodies. Article XI of the Treaty forbids national appropriation of the Moon and other celestial bodies while promoting international cooperation.³⁸

As of 2025, The Moon Treaty has achieved only 17 ratifications, excluding all major spacefaring States³⁹. Its normative guidance regarding environmental stewardship provides guidance yet lacks legal ramifications over non-parties.

B. Soft Law Instruments

1. IADC Space Debris Mitigation Guidelines

The soft law elements of the international space governance regime are produced through institutional mechanisms in addition to treaty law. The Committee on the Peaceful Uses of Outer Space (COPUOS), established in 1959,⁴⁰ is the most prominent among these voluntary mechanisms. COPUOS has two auxiliary bodies: The Scientific & Technical Subcommittee and the Legal Subcommittee in order to draft guidelines and recommendations. These guidelines though not legally binding, shape State practice and domestic policy in the global arena.

Concurrently, the Inter-Agency Space Debris Coordination Committee (IADC) established in 1993,⁴¹ and comprising thirteen of the major space authorities such as NASA, ESA, JAXA,

³⁷ Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, opened for signature December 18, 1979, entered into force July 11, 1984.

³⁸ *Id.*, Art. XI.

³⁹ United Nations, Status of International Agreements relating to activities in outer space as at 1 January 2025, A/AC.105/C.2/2025/CRP.9 (5 May 2025), Office for Outer Space Affairs, Committee on the Peaceful Uses of Outer Space, Legal Subcommittee, Sixty-fourth Session (Vienna, 5–16 May 2025).

⁴⁰ COPUOS guidelines, *supra* note 16.

⁴¹ IADC Guidelines, *supra* note 17.

Roscosmos and ISRO developed comprehensive Space Debris Mitigation Guidelines In 2002, later revised in 2007 and 2025.⁴² These guidelines provide technical recommendations – First, limit debris released during regular operations. Second, minimize potential for on-orbit break-ups through spacecraft passivation. Third, limit the probability of accidental collision through collision avoidance maneuvers. Fourth, avoid intentional destruction and other anti-beneficial activities. Fifth, the post-mission disposal of LEO objects within twenty-five years.⁴³

2. COPUOS Space Debris Mitigation Guidelines

The Space Debris Mitigation Guidelines were implemented in 2007 by the United Nations Committee on the Peaceful Used of Outer Space which are substantially similar to the IADC framework. The guidelines were endorsed by the United Nations General Assembly, extending them political legitimacy.⁴⁴ These guidelines suggest that space systems should be designed to restrict the number of debris discharged during the routine operations, mission planners minimize the possibility of a break-up at the operational stages, post-mission disposal procedures be implemented, and collision avoidance should be exercised throughout operational life. COPUOS also developed the Guidelines on the Long-term Sustainability of Outer Space Activities⁴⁵, the twenty-one voluntary guidelines on the policy and regulatory frameworks, safety of space operations, international cooperation, and scientific and technical research in 2019.⁴⁶

Nevertheless, the voluntary nature of these instruments gives us a basic gap on enforcing it. Conversely to binding environmental regimes that have been set up on topics like the Montreal Protocol⁴⁷ on Substances that Deplete the Ozone Layer or the United Nations Convention on the Law of the Sea (UNCLOS)⁴⁸, that include a system of compliance measures, monitoring protocols and systems of dispute resolution, the space debris mitigation guidelines do not impose binding liabilities. States can choose to comply, adapt, or ignore such suggestions to

⁴² Id.

⁴³ Id.

⁴⁴ COPUOS guidelines, supra note 16.

⁴⁵Kumar, Vijay; Raju, K.D.; Subramanian, S.R., “Long-Term Sustainability of Outer Space: Role of Sustainable Development Goals and Its Legal Consequences,” Indonesian Journal of Environmental Law & Sustainable Development, Vol. 2, No. 1 (2023).

⁴⁶Peter, Hugo, “The Importance of the Committee on the Peaceful Uses of Outer Space (COPUOS) in the Space Debris Mitigation: What Evolution for COPUOS?,” in Proceedings of the 8th European Conference on Space Debris (SDC8) (Virtual Conference, 20-23 Apr. 2021).

⁴⁷Montreal Protocol on Substances that Deplete the Ozone Layer, Sept. 16, 1987, 1522 U.N.T.S. 3.

⁴⁸United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397.

no effect. The lack of verification policy, reporting, or penalties forms a governance model in which voluntary compliance and goodwill will suffice on its own, a strategy that is less and less effective due to the active rise of space activities, as well as the irreversible character of the debris accumulation.

Such disparity between normative aspirations and the state practice is clearly visible when one considers state practice. Although leading spacefaring countries have integrated the nature of debris mitigation concepts to the national regulations, it has not been completely implemented. The discrepancy between recommended measures and feasible implementation provides the rationale towards the necessity of more potent governing frameworks which could mitigate the collective action issue, which orbital debris management can involve.

Fragmented State Practice and Regulatory Asymmetry

When international soft law guidelines are translated into national regulations that are enforceable, there is a high discrepancy in approach, stringency as well as effectiveness. The dominant spacefaring countries have created different forms of regulation models based on their own space industry formats, policy emphases, and attitudes to governing.

A. United States: Market-Based Licensing Regime

The United States employs a distributed regulatory approach for licensing with primary authority divided between the Federal Communications Commission (FCC) managing spectrum distribution and the Federal Aviation Authority (FAA) licensing launches.⁴⁹ Orbital debris mitigation was mandated by the space policy directive-3 on National Space Traffic Management in 2018 as a license obligation.⁵⁰ In September 2022, the FCC adopted rules requiring LEO satellites to deorbit within five years of completion of their missions, drastically decreasing the previous twenty-five-year guideline.⁵¹

The regulatory mechanism in the United States commits operators to prove financial

⁴⁹ Federal Communications Commission, "FCC Adopts New '5-Year Rule' for Deorbiting Satellites," (September 29, 2022), available at: <https://www.fcc.gov/document/fcc-adopts-new-5-year-rule-deorbiting-satellites> (last visited on December 17, 2025).

⁵⁰ The White House, Space Policy Directive-3, National Space Traffic Management Policy, (June 18, 2018), <https://trumpwhitehouse.archives.gov/presidential-actions/space-policy-directive-3-national-space-traffic-management-policy/> (last visited Dec. 1, 2025).

⁵¹ FCC, *supra* note 49.

responsibility by insured policies or verifiable economic capability thus making sure that third-party claims of liability can be met.⁵² Operators must also prove to the Federal Communications Commission that they have used the spectrum, that they have received a launch license from the Federal Aviation Authority, and that they have satisfied the federal standards of orbital debris mitigation.⁵³

Enforcement mechanisms in this regulatory form are more likely to be reactive. Even though FCC can at its own discretion suspend or revoke the license in case of non-observance, the fact is that, in the area of protecting the debris, no such punishments have ever been imposed on the violation of the debris creation or disposal rules.⁵⁴ It has been previously mentioned that the regulatory schemes are restraints over fragmented entrants and small operators with responsibility under definite licensing conditions, whilst operators with monumental grandfathered licenses have comparatively lenient restraints.

Actual compliance is largely dependent on the self-interest of the operators. The SpaceX, which runs the Starlink system containing about 5,000 satellites as of 2025, has made the commitment of deorbiting their assets within a five-year period publicly,⁵⁵ regardless of the economics involved in more frequent replacement, both in a regulatory environment and in a reputational sense. In addition, the insurance market also has incentives in the form of entitlements because underwriters attach the risk penalty on provable collision avoidance and disposal skills. These living-law mechanisms would include market forces, reputational pressures, insurance requirements, etc., that supplement the formal regulatory structure.

B. European Union: Precautionary Regulatory Approach

European space law reflects precautionary principles relying on environmental protection and sustainability. The 2008 Space Operations Act (*Loi sur les opérations spatiales*) of France defined the full requirements of authorization of operators such as obligatory insurance, technical competence examinations, and compliance with the mitigation of debris⁵⁶. The United Kingdom Outer Space Act of 1986, as amended in 2018 presents similar licensing

⁵² Id.

⁵³ Space Policy Directive-3, supra note 50.

⁵⁴ See generally, FCC enforcement actions database (limited debris-related enforcement).

⁵⁵ SpaceX, Starlink Progress Report 2024 (last visited Dec. 7, 2025).

⁵⁶ France, Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (Space Operations Act).

conditions for UK-flagged operators, that is, they must demonstrate the capability to avoid collisions and post-mission disposal strategies.⁵⁷

The current European Union proposals of Space Traffic Management regulations are in the process of development with the aim of achieving harmonised standards among member states. The Clean Space project of the European Space Agency depicts the design-to-demise principles, according to which the spacecraft is designed to break down completely on re-entry into the atmosphere and decrease the risk of terrestrial casualties as well as eliminate space debris touching the ground.⁵⁸

There exist high standards of environmental protection that are realized in the real satellite design in European regulation. ESA member states and commercial operators based in Europe often use design-for-demise engineering without a legal requirement, which implies that the professional norms are internalized,⁵⁹ which is evidenced by criminal sanctions in France and license suspension in the United Kingdom in case of regulatory violations, making that a stronger deterrent than civil penalties used in the United States.

Difficulties still persist based on the fragmented European Union jurisdiction. The regulation over space takes place at the level of the member-states, where France, Germany, Italy, and the United Kingdom have varying regulatory regimes, which results in inconsistent standards among the member states.⁶⁰ EU Space Traffic Management proposals have been put forward to make these standards consistent, though they are still underdeveloped in 2025.⁶¹

C. India: Emerging Space Regulatory Framework

India's space regulatory framework evolved significantly with the 2020 regulation establishment of Indian National Space Promotion and Authorization Center (IN-SPACe)⁶² which assumed the licensing functions previously held by the Indian Space Research Organisation (ISRO).⁶³ The new regulatory framework being established in India is focused on

⁵⁷ United Kingdom, Outer Space Act 1986 (as amended 2018).

⁵⁸ European Space Agency Clean Space Initiative (last visited Nov. 10, 2025).

⁵⁹ See European Space Agency, *supra* note 3.

⁶⁰ See Dey & Jagadanandan, *supra* note 7.

⁶¹ European Union, Proposed Space Traffic Management Regulations (under development 2025).

⁶² Indian National Space Promotion and Authorization Center (IN-SPACe), Government of India, About IN-SPACe (established 2020), available at: <https://www.inspace.gov.in> (last visited Nov. 20, 2026).

⁶³ Indian Space Research Organisation (ISRO), Department of Space, Government of India, About ISRO, available at: <https://www.isro.gov.in> (last visited Nov. 20, 2026).

domestic commercial space sector capacity building with respect to the international best practice of mitigating debris.⁶⁴ The draft Space Activities Bill, which is still pending as of 2025, includes detailed requirements on licensing that will include a debris mitigation plan, compulsory insurance, with environmental impact evaluation.

The evolution of the regulatory landscape in India, moving away and to a commercial sector authorization regime, is an example of a quick institutional growth process. Rapid regulatory development has created challenges in implementation, where implementation infrastructure has not kept pace with intent of the regulation, creating discrepancies between official provisions and operational enforcing.

Commercial launches and satellite activities have been authorised by IN-SPACe, however, in the absence of any demonstrable enforcement steps to date, the practical stringency and operational robustness of the debris-mitigation requirements remain undetermined.⁶⁵ This reflects a nascent phase in which the “living-law” operates in practice prior the crystallisation of mature enforcement mechanisms. The NETRA (Network for Space Objects Tracking and Analysis), available since 2020, is the initiative of the Indian space program that provides capabilities of space situational awareness using only indigenous equipment,⁶⁶ namely ground-radar and optical telescopes, and reduces the dependency on the system of the United States tracking data. NETRA enables India to monitor its space assets and predict collision risks using ground-based radars and optical telescopes, reducing dependence on United States tracking data.⁶⁷ Technical capabilities development precedes complete regulatory framework implementation, illustrating how operational needs drive institutional evolution.

Living Law and Normative Ordering Beyond Formal Treaties

A. Understanding Living Law Theory

The ongoing inability to use formal legal tools to successfully regulate space debris brings us

⁶⁴ Draft Space Activities Bill (pending 2025), Government of India (Draft space legislation to regulate and promote space activities and grant statutory powers to IN-SPACe; pending introduction/consideration in Parliament as of 2025), available at: https://en.wikipedia.org/wiki/Space_Activities_Bill (last visited Nov. 20, 2026).

⁶⁵ IN-SPACe Authorisations List (published online by IN-SPACe), available at: https://www.inspace.gov.in/inspace?id=inspace_authorizations (last visited Febr. 2, 2026).

⁶⁶ Press Information Bureau (PIB), “Parliament Question: Space Debris Management” (Ministry of Personnel, Public Grievances & Pensions / Department of Space, Government of India, 04 Dec. 2024), available at: <https://www.pib.gov.in/PressReleasePage.aspx?PRID=2080634> (last visited Febr. 2, 2026).

⁶⁷ *Id.*

to the need to rethink our regulatory model. The philosophy of an emerging law (*lebendes Recht*), formulated by one of the founders of modern legal sociology, Eugen Ehrlich, is the thesis that law is not just produced by laws enacted by States and judgments by judges but rather as a result of the social practices, customs, and normative expectations that actually control human behavior⁶⁸. Ehrlich applied the distinction between law in books and law in action⁶⁹ and believed that the latter, the norms that are followed in practice, is the true fount of ordering of law.

In the case of space governance, the living law theory acknowledges that formal treaties and conventions, though symbolically important, have only a weak practical impact on the behavior of actors without the support of social practices and a sense of normative commitments. The voluntary adherence of large space agencies to IADC guidelines, though of non-binding nature, is an example of living law at work norms followed not because States enforce the rules on them but because they are a part of general groups of practitioners and are seen by them as reality and are needed.⁷⁰

This theoretical prism sheds light on why even years of international discussions led to the creation of lengthy formal frameworks, but did not help put a stop to the piling of debris. The Outer Space Treaty, the Liability Convention and the Registration Convention are law in books, i.e. formal written obligations, and have poorly defined applicability mechanisms of contemporary challenges. In the meantime, real space activities are carried out based on industry practice, technical standards created by the various engineering communities, and risk management calculus routed by operators and insurers, the living law of space activities.

B. The Current Governance Gap

After extensive international deliberations spanning six decades, the absence of binding, enforceable international specifically addressing the mitigation of debris remains the greatest governance gap.⁷¹ This absence reflects no ignorance or insensitivity rather structural obstacles

⁶⁸Eric Wm. Mogren, "Eugen Ehrlich," EBSCO Research Starters (2023)

⁶⁹David Nelken, "Law in Books and Law in Action: The Problem of Legal Change," 52 Maine Law Review 317 (2000).

⁷⁰ Peter, Hugo, *supra* note 46.

⁷¹ United Nations Office for Outer Space Affairs, Space Debris Mitigation and Remediation: Policy and Legal Challenges, A/AC.105/C.2/2025/CRP.24 (2025).

in the inherent international lawmaking.⁷²

The international law is made to work mostly on the basis of consent by states. Treaties are only binding after framing and its enforcement requires the willingness of the State to enact domestically and yielding to the dispute resolution tools. Such a by-consensus basis puts a core asymmetry: States which have developed space dominant capabilities (those placing the majority of debris into space) have disproportionate influence over the creation of the law, and can push either against a legal regime that they feel controls their technological superiority or a legal set of requirements that they feel limit their economic prospects.

COPUOS guidelines and IADC recommendations are not binding, which is indicative of this fact.⁷³ The countries that have engaged in spacefaring will easily support the best practices in principle but oppose the translation of the principle into legal commitments. Advanced countries that have invested a lot in space infrastructure might consider the tightening of the regulations on debris to the detriment of their well-developed industries or constrain their capabilities to operate in the future. The newcomers to the space arena, in turn, might be opposed to regulations they view as keeping the developed world on top of the mountain by restricting the freedom of operations of the new ones, a situation sometimes referred to as kicking away the ladder as new players become restrictive once they have made their own footprint. This generates a diffusion of blame issues. Accountability is lost when there is a theoretical division of responsibility but no deductive and enforceable duties on any given actor.

C. Living Law as Precursor to Formal Regulation

According to Ehrlich's theory there is an alternative pathway to go forward, instead of trying to get immediate binding treaties⁷⁴, which constantly fail on State opposition, the development of living law by informal norms, transparency measures and professional norms can establish bases of future formal codification. This evolutionary theory acknowledges that any law that is to be efficient must have more than mere coercion enforcement but must have social validity. As long as professional communities internalize norms, self-reinforcement of compliance

⁷² Marco A. Janssen & Xiao-Shan Yap, "Governing Outer Space as a Commons is Critical for Addressing Commons on Earth," *International Journal of the Commons*, vol. 18, no. 1 (2024) 32-38, DOI: 10.5334/ijc.1378.

⁷³ *Id.*

⁷⁴ Hertogh, *supra* note

transpires.

This evolutionary approach is evidenced by space agencies disseminating the data on the debris, operators who organize and coordinate collision avoidance maneuvers, and satellite manufacturers that have designed-for-demise principles. Such practices are not created due to a treaty requirement but because of shared awareness of vulnerability for each other and a shared concern of protecting orbital commons.

On the same note, industry requirements in organizations such as the International Organization for Standardization (ISO), consultant committee on space data systems (CCSDS) and commercial consortia are also steadily being encompassed in expressions of technical requirements with regard to mitigating the impact of debris.⁷⁵ Underwriters responding to actuarial risk assessment, not legal requirements, demand that operators who wish to obtain insurance coverage prove they can mitigate their risks as a term of coverage. Market mechanisms, therefore, impose norms which are voluntary in formal law.

D. Institutionalizing Shared Responsibility

The living law theory has been drawing towards a more governance model that is oriented towards the shared responsibility institutionalized through mechanisms of transparency and reputation and not State coercion. This method conforms to the regime evolution theory that argues that international cooperation evolves over time through processes of creating precedents and building trust⁷⁶. These cultural commons worldview indicates that orbital management must extend beyond technical regulation or economic incentives developing the sense of collective identity as custodians of the space commons.⁷⁷ As space sustainability becomes part of professional communities, policymakers and public as a collective responsibility instead of a technical issue, self-sustaining behavior change can be established.

Using this framework to govern space debris suggests emphasizing the process of installing practices that reflect shared responsibility. The obligatory data sharing requirements when all operators share tracking data and can access shared situational awareness may create mutual

⁷⁵ International Organization for Standardization (ISO), ISO 24113:2023 – Space systems — Space debris mitigation requirements (4th edn, ISO, published May 2023) (defines primary space debris mitigation requirements for unmanned systems including spacecraft and launch elements).

⁷⁶ *Supra*.13

⁷⁷ Tabas, Brad. “The Outer Space Inside Us: Ordinary Language and the Care for the Extraterrestrial Commons.” *International Journal of the Commons*, vol. 17, no. 1, 2023, pp. 363-374.

obligations regardless of treaties. Peer monitoring and reputational enforcement would be made possible by disclosure requirements on post-mission disposal plans, collision avoidance capabilities and propulsion reserves. Responsibility can be encouraged without new treaties by industry certification schemes, where the operators who have shown compliance with the requirements of mitigating the effects of their actions are given a preferential treatment in the allocation of spectrums or placement in orbital slots.

These mechanisms leverage the strengths of living law of flexibility, adaptability to technological change and reliance on professional norms, and provide an infrastructure that will eventually be codified. Customary practice is codified instead of requiring behavioral change, a much easier political accomplishment.

SDG 18: Sustainable Space Development

The seventeen United Nations Sustainable Development Goals (SDGs), adopted in 2015, with target completion of development across the globe by the year 2030.⁷⁸ The omission includes the fact that there is no direct mention of space sustainability even though orbital infrastructure is highly significant in the provision of many of the currently existing SDGs. Earth observation with the use of satellites contributes to climate monitoring (SDG 13), disaster response, agricultural management (SDG 2), and telecommunications access (SDG 9). Transportation infrastructure and logistics are supported by navigation systems.⁷⁹ The space-based solutions to the terrestrial challenges would be preempted by satellite failures caused by the debris, which would directly weaken several SDGs.

Based on these premises, the paper will suggest the inclusion of individual goals on sustainable space development to be included in the SDG framework or as an adjunctive commitment. Four fundamental goals cover essential gaps in governance where the living-law norms have emerged.

Target 1: Reduction of Debris Generation

By 2030, half the amount of trackable orbital debris (those larger than ten centimeters) will be

⁷⁸ Kumar, Vijay; Raju, K.D.; Subramanian, S.R., "Long-Term Sustainability of Outer Space: Role of Sustainable Development Goals and Its Legal Consequences," *Indonesian Journal of Environmental Law & Sustainable Development*, Vol. 2, No. 1 (2023)

⁷⁹ Zimon, Dominik; Lysenko-Ryba, Kateryna; Szocik, Konrad, "SDG 18 for sustainable space exploration", 12 *Eur. J. Futures Res. Art.* 22 (2024).

produced annually compared to as of 2025. This objective tackles the problem on the cause by reducing the production of new debris. Measurements of these indicators are the rate of debris generation per year (objects per year), number of fragmentations per year and change in collision probability in major orbital regimes. The target achieves the principle of IADC guideline of ensuring minimisation of debris release during normal operations but establishes a specific amount of reduction.

Target 2: Post-Mission Disposal Compliance

Ensure that ninety-five percent of post-mission disposition requirements of LEO satellites are met within five years of mission completion by 2030. Such a target takes into consideration the developments of the living law like the 5 years rule of the United States FCC and a 25-year guideline of IADC, which sets a high compliance target. Reporting requirements create transparency enabling reputational mechanisms, while tracking the achievements of universal compliance.

Target 3: Infrastructure and Data Tracking.

By 2030, shared and accessible space-situational-awareness infrastructure that offers tracking coverage of objects larger than one centimeter. This target addresses attribution and monitoring loopholes that are limiting enforcement at the moment. The indicators include the tracked ability by the size threshold, the number of the countries that possess their native tracking infrastructure, Conjunction Data Message coverage indicators, and the number of data-sharing accords. This will need capacity-building initiatives to enable developing countries to engage in tracking systems (as was the case with NETRA model in India).

Target number 4: Active Debris Removal.

This is an aim of eliminating no less than fifty high-risk derelict objects in critical orbital regimes by 2035. This target is a response to the legacy debris that was built up in the past and there was no mitigation guideline set. The measures used are: total mass removed (kilograms) and the number of active missions to remove debris made, residual volume of high-risk objects in priority regimes. The implementation process requires legal issues on jurisdiction over defunct satellites, sources of finance on the removal procedures, and legal structures on the liability of debris caused during the removal process.

Conclusion

This analysis of orbital debris governance reveals a foundational paradox. Universal awareness exists regarding the debris threat. The legal system institutionalized in the five space treaties of the United Nations provides overall principles of state responsibility, liability of damages, and avoidance of contamination. The Liability Convention incorporates a fault-based test of damage in space and the Registration Convention provides that the registration of any space object should be done. However, these binding instruments do not have concrete debris-reducing provisions and effective enforcement measures. By contrast, the IADC and COPUOS have developed soft-law instruments that are non-binding and have detailed technical standards.

The Living Law theory by Ehrlich is applied to explain this paradox. The theory posits that the real law order can be achieved when norms attain social validity in the regulated communities by differentiating the law written in books and law as practiced. An example of this dynamic is orbital-debris governance where there are principles set in treaties that do not specify the operational content and voluntary guidelines provide specifications but cannot set a compulsion. Legal control is realized in the form of living-law arrangements in the form of such bodies as professional standard-setting institutions (ISO, CCSDS), insurance markets in which mitigation is incentivized, coordination of collision-avoidance based on mutual vulnerability, and transparency rules based on reputational considerations. They create high levels of behavioural regularity, especially in those instances where professional communities internalise norms, market incentives are consistent with mitigation objectives, and reputational pressures hold the level of compliance.

However, a system of living-law mechanisms is not enough to address the collective-action issues which require the participation of everyone. Adherence to the standards of post-mission disposal is quite uneven with the operators facing both high cost and low individual risk, possibly delaying such action. The structural shortcomings reveal the constraints of internalising the norms of voluntary adherence in the lack of commitments and enforcing systems.

The sustainable space-development objectives that were proposed are geared towards institutionalising the new norms that have already been established. Reduction of the creation of debris, high rates of disposal, expansion of tracking and data-sharing systems, elimination

of high-risk items, and creation of legally binding frameworks are measurable goals, which still demonstrates the continuity of the current practice, but introduce monitoring, reporting, and accountability systems. Integrating the concept of debris mitigation into a developmental system boosts orbital sustainability to a world agenda and puts it into the perspective of a collective operation. The crystallisation and codification of norms are the way of transition of voluntarism to the obligation. Living-law norms occur due to practice; when they become widespread, it becomes open to formalisation.