FROM MITIGATION TO REMEDIATION: INTERNATIONAL LEGAL RESPONSIBILITY FOR SPACE DEBRIS AND ORBITAL SUSTAINABILITY

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ABSTRACT

The orbital environment is a finite resource, and its degradation by space debris threatens states that depend on space services. This article assesses whether existing international space law can address debris across mitigation, liability, active removal and remediation. It distinguishes state responsibility under Articles VI and IX of the Outer Space Treaty from compensation liability under Article VII and the Liability Convention. The doctrinal analysis, informed by state practice and non-binding guidelines, finds that fault and attribution complicate in-orbit claims; Articles VI and IX support a plausible but not yet precise due diligence obligation; Article VIII makes consent the clearest legal basis for active removal; and no existing treaty allocates the costs of proactive remediation. The article proposes clearer mitigation standards, improved registration and breakup reporting, a consent protocol for removal, and a financing mechanism, and considers implications for Indian space legislation. It distinguishes current law from proposals where the law remains unsettled.

Keywords: Space debris; International responsibility; Liability Convention; Due diligence; Active debris removal; Orbital sustainability

1. Introduction

Since 1957 the number of objects placed in Earth orbit has risen steadily, and the rate has accelerated sharply with the deployment of large commercial constellations. Agency estimates now count tens of thousands of tracked objects, and more than a million fragments larger than one centimetre, most of them non-functional. Debris travels at orbital velocities, so even small fragments can disable an operational satellite. The scientific concern, first set out by Kessler and Cour-Palais in 1978, is that beyond a certain density collisions generate fragments faster than atmospheric drag removes them, producing a self-sustaining cascade that could render parts of low Earth orbit unusable.[1]

This is also a legal problem. Debris has no function, yet it remains subject to the legal regime that governs the object from which it originated. The legal questions are concrete. Who is responsible when a fragment damages an operational satellite? Who must dispose of a defunct satellite, and by what standard? May a state remove another state's dead satellite, and who pays?

The literature on space debris is extensive. Technical and policy writing concentrates on mitigation, tracking and removal technologies. Legal scholarship has examined the Liability Convention in depth, including its application to debris.[2] Less developed is the connection between three questions that are often treated separately: whether Article VI can ground a binding due diligence duty to mitigate debris; how Article VIII constrains removal; and how remediation costs, distinct from compensation for damage, could be allocated. This article addresses those questions as parts of a single accountability problem.[3]

The article argues that the fault and attribution requirements of the Liability Convention complicate claims for in-orbit debris damage; that Articles VI and IX support a plausible but not yet precise due diligence obligation; that Article VIII makes consent the clearest legal basis

1 Donald J Kessler and Burton G Cour-Palais, 'Collision Frequency of Artificial Satellites: The Creation of a Debris Belt' (1978) 83 *Journal of Geophysical Research* 2637; European Space Agency, *ESA's Annual Space Environment Report* (ESA Space Debris Office, latest edn).

[2] See generally Carl Q Christol, 'International Liability for Damage Caused by Space Objects' (1980) 74 *American Journal of International Law* 346; Francis Lyall and Paul B Larsen, *Space Law: A Treatise* (2nd edn, Routledge 2018) ch 10; Stephan Hobe, Bernhard Schmidt-Tedd and Kai-Uwe Schrogl (eds), *Cologne Commentary on Space Law* (vols I–III, Carl Heymanns 2009–2015).

3 C Q Christol, International Liability for Damage Caused by Space Objects, 74 AM. J. INT'L L. 346 (1980); FRANCIS LYALL & PAUL B. LARSEN, SPACE LAW: A TREATISE (2d ed. 2018); COLOGNE COMMENTARY ON SPACE LAW (Stephan Hobe, Bernhard Schmidt-Tedd & Kai-Uwe Schrogl eds., vols. I–III, 2009–2015).

for removing registered objects; and that existing law does not allocate the cost of proactive remediation. It develops these arguments through analysis of the treaty framework, state practice, non-binding guidelines, national legislation and relevant international decisions, before proposing incremental reforms and considering their implications for India.

The study is doctrinal. It examines treaties, United Nations resolutions, COPUOS guidelines, judicial and arbitral authority on due diligence, documented state practice, national legislation and secondary literature. It focuses on debris in Earth orbit; planetary protection and space-resource ethics fall outside its scope.

2. Space Debris as a Legal Problem

The Inter-Agency Space Debris Coordination Committee (IADC) defines space debris as all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional. The COPUOS Space Debris Mitigation Guidelines use a similar definition.[4] These are technical definitions. No binding treaty defines debris, and the lack of a legal definition has consequences.[5]

The central consequence concerns status. The Liability Convention defines a "space object" to include its component parts as well as its launch vehicle and parts thereof (Article I(d)).[6] It is generally accepted that defunct satellites and rocket stages remain space objects. Whether a fragment too small to be identified is a "component part" of an identified object is arguable. If fragments are component parts, a state remains answerable for the debris its objects produce. If they are not, the Convention may not apply to them at all.[7]

The second consequence concerns time. Debris is created by events (breakup, collision, weapons tests) and by omissions (failure to dispose of a satellite at end of life). The legal

[4] Inter-Agency Space Debris Coordination Committee, *IADC Space Debris Mitigation Guidelines* (IADC-02-01, rev 3, 2021) s 3.1; UN Committee on the Peaceful Uses of Outer Space (COPUOS), *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space* (2007) UN Doc A/62/20, Annex, s 1.

5 Inter-Agency Space Debris Coordination Committee (IADC), Space Debris Mitigation Guidelines (Revision 2, 2021), §3; UNCOPUOS, Space Debris Mitigation Guidelines (endorsed by GA Res 62/217 (22 December 2007), annex). The COPUOS Guidelines do not supply a general legal definition of "space debris".

[6] Convention on International Liability for Damage Caused by Space Objects (adopted 29 March 1972, entered into force 1 September 1972) 961 UNTS 187 (Liability Convention) art I(d).

7 Convention on International Liability for Damage Caused by Space Objects (Liability Convention), 29 March 1972, 961 UNTS 187, art I(d); UNCOPUOS, Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering Space Objects, GA Res 62/101 (17 December 2007). Whether every unidentifiable fragment is a "component part" remains unresolved.

framework deals better with discrete events causing damage than with continuing accumulation. This feature of the problem is the starting point for the analysis below.

3. The Binding Framework: Responsibility and Liability

3.1 International responsibility: Article VI

Article VI of the Outer Space Treaty provides that states bear international responsibility for national activities in outer space, whether carried out by governmental agencies or non-governmental entities, and that the activities of non-governmental entities require authorisation and continuing supervision by the appropriate state.[8] Article VI is the legal basis for national licensing regimes and the primary link between private operators and international law.[9]

Article VI is a rule of responsibility, which concerns breach of an international obligation. The Liability Convention, in contrast, concerns liability for damage, which may arise even without a wrongful act. The two should be distinguished. A state may be liable to pay compensation for damage caused by a space object without having breached any obligation, and a state may breach Article VI (for example, by failing to supervise a licensed operator who abandons a satellite) without any damage yet occurring. Under the International Law Commission's Articles on State Responsibility (2001), a state's responsibility requires an act or omission attributable to it that breaches an international obligation.[10] The significance of Article VI for debris therefore depends on the content of the obligations with which it is associated, which is the subject of section 4.[11]

3.2 International liability: Article VII and the Liability Convention

Article VII makes the launching state liable for damage to another state party or its natural or juridical persons caused by a space object or its component parts.[12] The Liability Convention

[8] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (opened for signature 27 January 1967, entered into force 10 October 1967) 610 UNTS 205 (Outer Space Treaty) art VI.

9 Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space (Outer Space Treaty), 27 January 1967, 610 UNTS 205, art VI.

[10] International Law Commission, 'Articles on Responsibility of States for Internationally Wrongful Acts' (2001) UN Doc A/56/10, art 2; Bin Cheng, *Studies in International Space Law* (OUP 1997) 603–07.

11 International Law Commission, Articles on Responsibility of States for Internationally Wrongful Acts, GA Res 56/83 (12 December 2001), annex, arts 2, 4, 12 and 31. Article VI of the Outer Space Treaty concerns international responsibility for national activities; the Liability Convention separately establishes a compensation regime for damage.

[12] Outer Space Treaty (n 8) art VII.

gives effect to this principle in two regimes.[13]

For damage caused by a space object on the surface of the Earth or to aircraft in flight, the launching state is liable (Article II). For damage caused elsewhere, including damage in orbit, a launching state is liable only if the damage is due to its fault or the fault of persons for whom it is responsible (Article III). The Convention does not define fault. Joint and several liability applies where two or more launching states cause damage to a third state (Article IV). Claims are presented by the state suffering damage through diplomatic channels (Articles VIII and IX), within one year of the damage or of identification of the liable state (Article X), and do not require exhaustion of local remedies (Article XI). Where diplomatic negotiation fails, a Claims Commission may be established at the request of either party (Article XIV onwards), but its award is binding only if the parties have so agreed; otherwise, it is recommendatory (Article XIX).[14]

Three features of this regime make it a poor fit for debris.

First, the fault standard. Orbital collisions are the most probable form of debris damage, and they fall under Article III. A claimant must show that the other state, or a person for whom it is responsible, was at fault. There is no agreed standard of care in orbit, and the content of fault is uncertain. Is it a failure to follow IADC or COPUOS guidelines, which are non-binding? Is it a failure to maneuver? If a defunct satellite is struck, its owner can do nothing, and fault may be impossible to show.[15]

Second, attribution. A claim requires identification of the launching state of the object that caused the damage. Most fragments are too small to be catalogued or linked to a parent object. The tracking catalogue relied on in practice is maintained by a single state and has limits of its own. The Registration Convention does not solve this, because it requires registration of objects and not of fragments, and it does not require notification of a breakup.[16]

13 Outer Space Treaty, (n 8) art VII; Liability Convention, (n 6), arts I(c)–(d), II–III.
14 Liability Convention, (n 6) arts III–IV, VIII–XI and XIV–XIX. Article IX concerns diplomatic claims procedure; article X sets the limitation period. Under art XIX(2), a Claims Commission decision is binding only if the parties have agreed that it shall be.
15 Liability Convention, art III. The Convention does not define "fault," and the content of any orbital standard of care remains unsettled.
16 Convention on Registration of Objects Launched into Outer Space (Registration Convention), 14 January 1975, 1023 UNTS 15, arts II and IV–VI. Article VI expressly provides for feasible assistance in identifying an object; the Convention does not establish a comprehensive fragment-registration or breakup-notification system.

Third, the definition of damage. Damage under Article I(a) means loss of life, personal injury or other impairment of health, or loss of or damage to property. The Convention does not address purely environmental harm, such as the increased collision risk to an orbital regime caused by a breakup, where no satellite has yet been harmed. Canada's claim for the clean-up costs of Cosmos 954 relied on the Convention and on general principles of international law, which shows that the question was not settled even in the one case in which it arose.[17]

3.3 Jurisdiction, control and registration: Article VIII

Under Article VIII, the state on whose registry an object is carried retains jurisdiction and control over it and over any personnel on it while in outer space, and ownership of objects launched into space is not affected by their presence in space or by their return to Earth. These rules are central to responsibility, because they identify the state that must supervise the object, and they are central to removal, as section 5 explains. The Registration Convention requires the launching state to register an object in a national registry and to inform the UN Secretary-General of specified information (Articles II and IV). It does not require deregistration, a statement of whether an object has become non-functional, or registration of fragments.[18]

3.4 Due regard and harmful contamination: Article IX

Article IX requires states to conduct activities with due regard to the corresponding interests of other states, and to avoid harmful contamination of space and adverse changes in the Earth's environment. It also requires consultations where a state has reason to believe that its activity would cause potentially harmful interference with the activities of others. Although its drafting dates from a period when environmental concerns in space were minimal, Article IX is the provision in the treaty closest to a mitigation duty. Whether "harmful contamination" includes debris is a matter of interpretation, and under Article 31 of the Vienna Convention on the Law of Treaties 1969 it is open to an evolutive reading consistent with the treaty's object and purpose.[19]

17 Liability Convention, (n 6) art I(a); Canada, "Claim against the Union of Soviet Socialist Republics for Damage Caused by Soviet Cosmos 954" (1979) 18 ILM 899; Protocol between Canada and the USSR (2 April 1981), reproduced by UNOOSA. The Convention text does not expressly list abstract environmental degradation as damage; Canada's claim and settlement do not establish a general environmental-damage rule.

18 Outer Space Treaty, (n 8) art VIII; Registration Convention, arts II and IV. See also GA Res 62/101 (2007), which recommends additional information in registration submissions, including orbital parameters, general function and date of decay/re-entry where applicable.

19 Outer Space Treaty, (n 8) art IX; Vienna Convention on the Law of Treaties, 23 May 1969, 1155 UNTS 331,

3.5 State practice and limits of the liability regime

Reported practice is sparse, which limits the conclusions that can be drawn from the absence of claims.

In 1978 the Soviet nuclear-powered satellite Cosmos 954 re-entered over northern Canada, scattering radioactive debris. Canada presented a claim in 1979 invoking the Liability Convention and general principles of international law, and in 1981 the two states settled for a sum of about half of the amount claimed.[20] It remains the only formal claim under the Convention. It concerned absolute liability on the surface, so it does not show how the in-orbit regime would work.[21]

In July 1996 the French military satellite Cerise was struck by a fragment of an Ariane rocket stage launched ten years earlier. No claim was made. In February 2009 the operational Iridium 33 satellite collided with the defunct Cosmos 2251, producing thousands of trackable fragments. No state presented a claim under the Convention, though both launching states were identifiable. The destructive anti-satellite tests of 2007 (China) and 2021 (Russia) created some of the largest debris clouds in history, and the second forced the crew of the International Space Station to shelter. Neither gave rise to a Liability Convention claim, although in 2022 the General Assembly adopted Resolution 77/41 calling on states not to conduct destructive direct-ascent anti-satellite missile tests.[22]

The Iridium–Cosmos collision illustrates the practical difficulty of applying Article III even where the launching states are identifiable. The absence of a claim does not establish why the Convention was not invoked; political, commercial and legal considerations may all have mattered. The episode therefore supports a doctrinal concern about fault and

arts 31–32. “Harmful contamination” as applied to anthropogenic orbital debris is an interpretative argument; the text expressly discusses harmful contamination and adverse Earth-environment changes in relation to exploration and extraterrestrial matter.

[20] *Protocol on Settlement of Canada's Claim for Damage Caused by "Cosmos 954"* (signed 2 April 1981) 20 ILM 689.

21 Canada’s 1979 claim is reproduced at (1979) 18 ILM 899; the 2 April 1981 Protocol settled all matters connected with Cosmos 954 for C$3 million. See UNOOSA, “Protocol between the Government of Canada and the Government of the USSR” (2 April 1981), arts I–II. It is commonly identified as the only claim formally presented under the Liability Convention.

22 For the 2009 Iridium 33/Cosmos 2251 collision, see NASA Orbital Debris Program Office, “Iridium 33-Cosmos 2251 Collision” (Orbital Debris Quarterly News, 2009). For the General Assembly’s non-binding call, see UNGA Res 77/41 (7 December 2022) UN Doc A/RES/77/41, Destructive Direct-Ascent Anti-Satellite Missile Testing (7 December 2022), paras 1–3. The resolution calls on states to commit not to conduct such tests; it does not itself establish a treaty prohibition.

attribution, but does not prove that the Convention is ineffective in every debris-damage case.

4. Soft Law, Sustainability Instruments and Due Diligence

4.1 Technical and political guidelines

The principal mitigation standards are the IADC Space Debris Mitigation Guidelines (first issued in 2002 and since revised), which were adapted into the COPUOS Space Debris Mitigation Guidelines and endorsed by the General Assembly in Resolution 62/217 (2007). They contain seven guidelines, including limiting debris released in normal operations, minimising the potential for breakups, and disposal at end of life, with a widely applied 25-year limit for post-mission presence in low Earth orbit. In 2019 COPUOS adopted the Guidelines for the Long-term Sustainability of Outer Space Activities, a set of 21 guidelines covering policy and regulatory frameworks, safety of operations, international cooperation, and scientific and technical research. COPUOS work continues under a further working group.[23] These instruments are voluntary and implementable "to the extent feasible".[24]

4.2 The Artemis Accords and the Code of Conduct

The Artemis Accords (2020) are a set of non-binding political commitments among participating states, which include a commitment on orbital debris and disposal at the end of a mission (Section 12).[25] They bind no one in law, though they may contribute to the evidence of state practice. The European Union's draft International Code of Conduct for Outer Space Activities, first circulated in 2008 and revised in 2010, 2012 and 2014,[26] aimed to establish voluntary rules on safety, sustainability and avoidance of harmful interference. It failed to achieve consensus after consultations in 2015, partly because of objections to its process and its treatment of military activities. A Russian and Chinese draft treaty on the prevention of the placement of weapons in outer space, introduced at the Conference on Disarmament in 2008

[23] UNGA Res 62/217 (22 December 2007) UN Doc A/RES/62/217; COPUOS, 'Guidelines for the Long-term Sustainability of Outer Space Activities' (2019) UN Doc A/74/20, Annex II.

24 UNCOPUOS, Space Debris Mitigation Guidelines (2007), annex; GA Res 62/217 (2007); UNCOPUOS, Guidelines for the Long-term Sustainability of Outer Space Activities, UN Doc A/74/20 (2019), annex II; GA Res 74/82 (13 December 2019), para 12. The 25-year post-mission disposal timeframe is found in IADC/technical standards and national rules; it is not expressly specified as a numeric period in the seven COPUOS Guidelines.

[25] *The Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes* (signed 13 October 2020) s 12.

[26] Council of the European Union, *Draft International Code of Conduct for Outer Space Activities* (31 March 2014).

and revised in 2014, also stalled. The common lesson is that comprehensive instruments have failed because of disagreement on security, and sustainability measures that are separated from security questions, such as debris, may stand a better chance.[27]

4.3 Due diligence

A binding obligation could arise from general international law even where soft law is not binding. The International Court of Justice has held that the customary duty to prevent significant transboundary harm is a duty of due diligence (Corfu Channel; Pulp Mills on the River Uruguay (2010)), and the ITLOS Seabed Disputes Chamber's 2011 Advisory Opinion characterised due diligence as an obligation of conduct whose required standard rises with the risk of the activity. The International Court's Advisory Opinion on the Obligations of States in respect of Climate Change (23 July 2025) again treated due diligence as a stringent standard in a context of serious environmental risk. The ILC's 2001 Articles on Prevention of Transboundary Harm from Hazardous Activities reflect the same principle.[28]

Two textual hooks connect these principles with space. Article VI requires "continuing supervision" of non-governmental activities, which implies a duty to supervise how an operator manages risk throughout the life of its object, including disposal. Article IX requires due regard and the avoidance of harmful contamination. Read together, and informed by the guidelines as evidence of what a reasonably diligent state would do, they support an argument that states must take reasonable steps, calibrated to the available technology, to prevent their objects from becoming long-lived debris. Guidelines on this reading are not law, but they supply a benchmark against which due diligence is measured, just as technical standards are used in other fields.[29]

Two limits should be acknowledged. First, due diligence is an obligation of conduct, and a state

27 The Artemis Accords (13 October 2020), §12; Council of the European Union, Draft International Code of Conduct for Outer Space Activities, Council Doc 14455/10 (27 September 2010), and subsequent EU consultation materials. The draft did not proceed to adoption; the 2015 process should not be characterized as a formal treaty negotiation failure.

28 *Corfu Channel (United Kingdom v Albania)* (Merits) [1949] ICJ Rep 4, 22; *Pulp Mills on the River Uruguay (Argentina v Uruguay)* (Judgment) [2010] ICJ Rep 14, para 101; *Responsibilities and Obligations of States Sponsoring Persons and Entities with Respect to Activities in the Area* (Advisory Opinion, 1 February 2011) ITLOS Reports 2011, 10, para 117; *Obligations of States in respect of Climate Change* (Advisory Opinion, 23 July 2025) ICJ; ILC, 'Articles on Prevention of Transboundary Harm from Hazardous Activities' (2001) UN Doc A/56/10, art 3.

29 Outer Space Treaty, arts VI and IX; UNCOPUOS, Space Debris Mitigation Guidelines (2007), annex; Pulp Mills, paras 197–204. The proposed application of environmental due diligence to debris mitigation is the paper's legal argument, not a rule directly decided by these authorities.

that applied the guidelines would not breach it even if debris resulted. Second, state practice on disposal compliance is uneven, with significant numbers of objects not complying with the 25-year rule, so the claim of a customary rule at the level of specific disposal requirements is not yet made out.[30]

The instruments discussed above are non-binding as such. Read with Articles VI and IX, however, they can inform an argument for a general due diligence obligation to mitigate debris. Its precise content remains unsettled and depends on the applicable treaty interpretation, available technology and relevant state practice; current law does not establish a uniform, enforceable disposal period.

5. Active Debris Removal

Technologies for capturing and removing objects have moved from concept to demonstration. The European Space Agency's Clean Space programme and the planned ClearSpace-1 mission, and Astroscale's ELSA-d demonstration (2021) and ADRAS-J inspection of a Japanese upper stage (2024), show that removal is technically feasible, although no routine commercial service yet exists.[31] The legal obstacles are different from the technical ones.[32]

Jurisdiction, control and ownership. Under Article VIII, the state of registry retains jurisdiction and control over a registered object, and ownership is unaffected by its presence in space. A defunct satellite is not presumed abandoned. Unauthorized capture or deorbiting would likely interfere with the registering state's rights absent consent or another applicable justification; the treaty does not expressly prescribe a removal procedure.[33]

Consent. Consent of the state of registry is the clearest legal basis, and operators of removal missions have accordingly concentrated on objects of their own state or customers. Consent is likely to be refused where the object is military or contains sensitive technology. Debris whose

30 UNCOPUOS, Space Debris Mitigation Guidelines (2007), annex, guideline 6; IADC, Space Debris Mitigation Guidelines (Revision 2, 2021), §5.3.2. The guidelines are voluntary at the international level; domestic licensing rules can separately make similar standards mandatory for licensees.

31 European Space Agency, 'ClearSpace-1' (ESA Clean Space); Astroscale, 'ELSA-d End-of-Life Services Demonstration' (2021) and 'ADRAS-J Active Debris Removal by Astroscale-Japan' (2024).

32 European Space Agency, "ClearSpace-1" mission materials; Astroscale, ADRAS-J mission updates (2024) and ELSA-d mission materials. These demonstrate inspection and removal technology, not routine operational debris-removal services.

33 Outer Space Treaty, (n 8) art VIII. The article expressly preserves jurisdiction, control and ownership; the conclusion that unauthorized capture/removal would breach international law is a strong and widely argued interpretation, but the treaty does not expressly set out an active-removal consent procedure.

owner cannot be identified is also a problem, because consent cannot be obtained.

Dual use. A capability to approach, capture and move an object is also a capability to disable one, and removal technologies are therefore politically sensitive. A state may reasonably regard an uninvited approach as hostile, which engages the obligation under Article IX to consult and the general law on the threat and use of force.[34]

Liability for removal. An operator or state that damages another state's object in an attempted removal is liable under the Convention, and it is unclear whether a removal service is a "launch" with its own launching state. Insurance and allocation of risk between the client and the service provider are undeveloped.[35]

Third-party benefit and free riding. Removal benefits all orbital users, but only those who pay bear its cost. A state with no incentive to pay will wait for others, and the party that created the debris has no legal duty to remove it, as noted in sections 3 and 4.

Consent is therefore the clearest legal basis for removing a registered object. The application of Article VIII to unidentified debris and objects whose registry state no longer exists remains unsettled, making these cases important candidates for agreed international rules.

6. National Implementation and the Indian Position

Because Article VI places responsibility on states for their national activities, domestic law is the main route by which debris obligations are made operational. The French Space Operations Act 2008 requires technical regulations, including provisions on end-of-life disposal and operator financial guarantees. The United Kingdom's Outer Space Act 1986 requires licensing, continuing supervision and an indemnity from the licensee, and the Space Industry Act 2018 adds regimes for launch and orbital operations. In the United States, the Federal Communications Commission adopted in 2022 a rule reducing the post-mission disposal period for satellites in low Earth orbit that it licenses from 25 years to five. The European Space Agency has adopted a Zero Debris approach and charter, though these are programme-level

34 Outer Space Treaty, art IX; Charter of the United Nations, arts 2(4) and 51. Whether a particular approach or servicing operation amounts to a threat or use of force is fact-specific; proximity alone does not resolve that question.

35 Liability Convention, arts I(c), II–IV. Article I(b) defines “launching” to include attempted launching; whether a later on-orbit servicing/removal operation creates an additional launching State or liability pathway is not expressly settled by the Convention.

commitments.[36]

India is a party to the Outer Space Treaty, the Rescue Agreement, the Liability Convention and the Registration Convention, and in 2023 signed the Artemis Accords. Its domestic framework is still developing. The Indian Space Policy 2023 established the Indian National Space Promotion and Authorization Centre (IN-SPACe) as the authorisation body for non-governmental entities, which gives practical form to Article VI. A comprehensive space activities statute, which has been under consideration since a draft Bill in 2017, has not yet been enacted.[37] ISRO has announced a goal of debris-free space operations by 2030 and publishes annual space situational assessments. India's 2019 anti-satellite test, conducted at a low altitude, attracted international attention to its debris implications.[38]

The Indian position illustrates a general point. A state that is a party to the treaties and has authorisation machinery in place may still lack a statutory basis for binding disposal standards, financial guarantees, and recourse against operators for the cost of liability. This is the point at which the international framework depends on national law, and the gap shows why reform has to operate at both levels.

7. Proposals for Reform

The analysis suggests that a single comprehensive treaty is unlikely in the near term. The 2015 failure of the Code of Conduct and the stalemate on arms control show that proposals with a security dimension do not command consensus. Reform is therefore more realistic as a package of incremental measures.

1. **An interpretative standard of due diligence.** The General Assembly, on COPUOS's recommendation, could adopt a resolution or declaration interpreting Articles VI and IX to require that states ensure, through authorisation and continuing supervision, that their space objects are designed, operated and disposed of in accordance with specified

36 Loi n° 2008-518 du 3 juin 2008 relative aux opérations spatiales (France); Outer Space Act 1986 (UK); Space Industry Act 2018 (UK); Federal Communications Commission, *Space Innovation; Mitigation of Orbital Debris in the New Space Age* (Second Report and Order, FCC 22-74, 29 September 2022) (US); European Space Agency, *Zero Debris Charter* (2023).

37 Department of Space, Government of India, *Indian Space Policy 2023* (20 April 2023); *Draft Space Activities Bill 2017* (India).

38 Indian Space Policy 2023, §§3.1–3.2, 4.1; Government of India, IN-SPACe, Norms, Guidelines and Procedures for Implementation of Indian Space Policy 2023 (2024); UNOOSA, Status of International Agreements relating to Activities in Outer Space (India entry).

mitigation standards. A resolution would not be binding as such, but it could be treated as a subsequent agreement or practice for treaty interpretation under Article 31(3) of the Vienna Convention, and it would give content to the standard of care that the Liability Convention lacks.[39]

2. **Improved registration and attribution.** The Registration Convention could be supplemented, through a COPUOS recommendation or a protocol, to require notification of end-of-mission status, deregistration or disposal, and breakup events, and to encourage identification of fragments from tracked breakups to their parent objects. A shared, multinational catalogue would lessen reliance on a single state's data.[40]

3. **A burden-shifting rule for in-orbit damage from identified breakup events.** Where debris damage can be traced to a breakup event involving an identifiable object, a presumption of fault where mitigation guidelines were not followed would make Article III workable. This could be achieved by agreed interpretation or by bilateral and regional practice.[41]

4. **A consent protocol for removal.** A multilateral instrument could provide a standard procedure for requesting consent, for notification of removal missions, for deemed consent to the removal of identified objects after a defined period of non-response, and for pre-consent for objects that are designated at launch as available for removal. Provisions on transparency of mission design would respond to dual-use concerns.[42]

5. **A financing mechanism.** There are precedents for allocating the cost of environmental harm: the polluter-pays principle in the Rio Declaration, operator liability and compulsory insurance under nuclear liability conventions, and the supplementary fund under the oil pollution regime.[43] A model suited to debris would require operators to

39 Vienna Convention on the Law of Treaties, (n 19) art 31(3)(a)–(b). A General Assembly resolution does not automatically qualify as a subsequent agreement or subsequent practice; that depends on evidence of the parties' agreement or practice in applying the treaty.

40 Registration Convention, arts II, IV and VI; GA Res 62/101 (2007). The proposal to add end-of-mission and breakup reporting is a reform recommendation, not a requirement of current treaty law.

41 Liability Convention, art III. A rebuttable presumption of fault would be a proposed interpretative or treaty-development measure; it should not be presented as the current Convention rule.

42 Outer Space Treaty, art VIII; Registration Convention, art II. Deemed consent after silence would require an agreed legal instrument or other valid consent; silence alone is not established as consent under current space treaties.

43 Rio Declaration on Environment and Development (14 June 1992) UN Doc A/CONF.151/26 (Vol I), Principle

hold insurance or financial guarantees as a condition of authorisation, supplemented by an international remediation fund financed by contributions from launching states or operators, weighted by the orbital risk their objects create. Economists have proposed orbital-use fees on a similar logic, and the legal task is to design a mechanism that states will accept.[44]

6. **Domestic legislation in India.** A Space Activities Act should codify authorisation conditions, including mandatory disposal plans, financial guarantees or insurance, and a right of recourse against operators whose non-compliance causes the state to incur liability under the Liability Convention.[45]

The existing framework provides compensation for damage but no standing mechanism to finance proactive removal. A hybrid of operator-level incentives and collective funding is a policy proposal intended to address both preventable debris generation and the accumulated legacy problem.

8. Conclusion

This article has shown that international space law addresses discrete damage more directly than the continuing accumulation of orbital debris. In-orbit claims face fault and attribution difficulties under the Liability Convention. Articles VI and IX provide a basis for arguing that states must exercise due diligence in supervising national activities, while the content of any debris-specific standard remains unsettled. Article VIII preserves jurisdiction, control and ownership, so consent is the clearest basis for active removal of registered objects. No existing treaty creates a fund or duty to pay for proactive remediation. These limits support incremental reforms in mitigation standards, registration and attribution, removal consent, and financing,

16; ILC, 'Draft Principles on the Allocation of Loss in the Case of Transboundary Harm Arising out of Hazardous Activities' (2006) UN Doc A/61/10.

44 Rio Declaration on Environment and Development (1992), principles 15–16; Convention on Third Party Liability in the Field of Nuclear Energy (Paris Convention) (1960), as amended; International Convention on Civil Liability for Oil Pollution Damage (1992), arts V and 12; Protocol of 1992 to the International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, arts 3–4. Nodir Adilov, Peter J Alexander and Brendan M Cunningham, 'Earth Orbit Debris: An Economic Model' (2015) 60 *Environmental and Resource Economics* 81; Akhil Rao, Matthew G Burgess and Daniel Kaffine, 'Orbital-use Fees Could More Than Quadruple the Value of the Space Economy' (2020) 117 *Proceedings of the National Academy of Sciences* 12756.

45 Indian Space Policy 2023; Constitution of India, art 253 (Parliament's power to implement treaties); compare Liability Convention, art V, which permits launching States to make agreements on apportioning financial obligations among themselves.

alongside domestic implementation in India.

The central contribution of the paper is to treat mitigation, liability and removal as connected links in a chain of accountability. Weakness at any link, such as the lack of a standard of care, undermines the others. The reforms proposed here are incremental by design. They rely on interpretation, registration practice, domestic law and financial mechanisms rather than on a new comprehensive treaty, because the history of the Code of Conduct and of arms control negotiations suggests that a package that avoids the security question has the best prospects. Further research is needed on the content of a due diligence standard for specific orbital regimes, on the legal status of fragments, and on the design of a funding mechanism acceptable to both established and emerging space powers.