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ARTIFICIAL SPACE DEBRIS REGULATION: A LEGAL ANALYSIS AND THE ARGUMENT FOR A NEW INTERNATIONAL CONVENTION

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Abstract

Near-Earth orbit, a limited resource of pivotal importance to the world economy and contemporary society, is under growing threat from the proliferation of space debris. This paper offers a critical legal study contending that the current international legal regime, a product of the Cold War era, is essentially deficient in responding to this 21st-century problem. A doctrinal analysis of the Outer Space Treaty and its offspring reveals profound lacunae: vague principles such as "due regard," a unworkable fault-based liability regime for on-orbit collisions, and excessive reliance on non-binding "soft law" mitigation guidelines.

In addition, the article raises an alarm on the insurmountable legal obstacles in Active Debris Removal (ADR), a required environmental remediation method, mainly the perpetual state ownership and jurisdiction over space objects doctrine. It advocates for a shift in paradigm, recasting space debris as long-term pollution to be regulated by the tenets of international environmental law, such as the precautionary principle and the polluter pays principle.

Finally, the paper builds a strong argument for the immediate negotiation of a new, all-encompassing and binding international treaty. It argues that such a treaty requiring verifiable standards of mitigation, creating new liability and insurance regimes, and providing a clear legal framework for ADR is not an obstacle to space activities, but the necessary condition for their long-term sustainability and for the safekeeping of the orbital commons for future generations.

Keywords: Space Debris, Outer Space Treaty, International Space Law, Orbital Pollution, Liability Regime, Active Debris Removal (ADR), Precautionary Principle, Polluter Pays Principle

I. Introduction

A. The Orbital Commons in Peril: A Modern Tragedy

Outer space, once thought of as an infinite void a res extra commercium beyond human stewardship, has, over the sixty years that have passed since the launch of Sputnik 1, been irreversibly transformed into a field of essential infrastructure. It is the crucial basis on which an economy reliant upon satellites relies, for broadcasting, financial transactions, accurate navigation, and Earth observation. And the very success has had an insidious and increasing threat: that of cluttering the near-Earth space with man-made space debris. It is a classic "tragedy of the commons" where the reasonable, self-interested pursuit of economic and strategic advantage by numerous actors causes degradation of a common, finite resource.[24] With each satellite deployment, each mission, a growing orbital cemetery of dead satellites, abandoned rocket stages, and most menacingly, millions of fragments from on-orbit breakups and collisions has been created. These objects, travelling at hypervelocities at which the kinetic energy of a

[24] Garrett Hardin, *The Tragedy of the Commons*, 162 SCI. 1243, 1243–48 (1968).

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one-centimetre aluminium sphere is equal to that of a hand grenade (KE = 1/2mv²), are manifestly and immediately dangerous to operational satellites and manned spaceflight. The proliferation of this trash has the potential to induce a self-sustaining chain of crashes, a long-held speculation by NASA researcher Donald J. Kessler in 1978, that will leave vital orbital rings out of reach for centuries. This is not a distant hypothetical threat; it is an immediate environmental emergency unfolding in the global commons overhead, with extensive consequences for international law, security, and the future of human activity in space.

B. Landmark Events as Legal Catalysts and Doctrinal Stress Tests

Although the debris problem has built up incrementally, specific events have served as catalysts, moving the issue from the sphere of technical modelling to real-time policy consideration. These incidents were tests of the viability of the extant legal framework, laying bare its doctrinal weaknesses and functional shortcomings.

1. The 2007 Chinese Anti-Satellite (ASAT) Test: A Challenge to "Due Regard"

In January 2007, the People's Republic of China conducted a kinetic anti-satellite (ASAT) test that destroyed one of its own dead Fengyun-1C weather satellites. The test was a catastrophic success, leaving behind the largest single object of debris cloud in space operations history: over 3,000 pieces of trackable space trash and roughly 150,000 larger one-centimetre pieces[25]. From a law perspective, the test was highly disruptive. Although China did not technically violate any binding agreement, it destroyed its own listed object, and there is no ban on such weapons under the Outer Space Treaty. The move was widely decried as violating the spirit, if not the letter, of the Outer Space Treaty. It squarely challenged the application of Article IX, which requires states to conduct their activities with "due regard to the corresponding interests of all other States Parties."[26] The cloud of Fengyun-1C debris will contaminate a very busy orbital altitude for a century or more, indiscriminately endangering the space assets of all countries and demonstrating that unilateral action by a single state can have long-term, global consequences.

2. The 2009 Iridium-Cosmos Collision: The Failure of the Liability Regime

There was the very first unplanned hypervelocity collision of two intact satellites in February 2009. An operational U.S. commercial communications satellite, Iridium 33, collided with a defunct Russian military satellite, Cosmos 2251. The collision, at a relative velocity of around 11.7 km/s, destroyed both spacecraft and produced nearly 2,000 new pieces of trackable debris[27]. It vividly brought home the inadequacy of existing space situational awareness and, more importantly, the effective impossibility of applying the fault-based regime of liability under the Liability Convention to a chaotic orbital environment.[28] No claim for damages was ever filed, presumably due to the impossible legal and evidentiary hurdles of proving "fault" for an accident in a space environment with no rules of the road. The crash converted the issue of debris into a reality from a theoretical probabilistic to that of a proven fact, with the implicit requirement for a practical legal framework of space traffic management and a better liability system.

C. The Inadequacy of Cold War-Narrative Law and the Argument of the Paper

International law of space was born in the Cold War period, a product of geopolitics with two superpowers. Its simple function was to prevent nationalisation of celestial bodies and deployment of weapons of mass destruction into orbit, thereby preserving a degree of

[25] Nicholas L. Johnson, *The Fengyun-1C ASAT Test: A Look Back*, THE SPACE REV. (Jan. 14, 2013), https://www.thespacereview.com/article/2219/1.

[26] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, art. IX, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205.tr

[27] NASA Orbital Debris Program Off., *First-Ever Satellite Collision*, ORBITAL DEBRIS Q. NEWS, Apr. 2009, at 1.

[28] Convention on International Liability for Damage Caused by Space Objects, art. III, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187.

strategic stability. It is a law architecture of a bygone era, not a multipolar, multi-sigma world with dozens of spacefaring nations and an emerging private industry eager to launch mega-constellations of tens of thousands of satellites. This essay argues that this anachronistic legal regime is inherently ill-equipped to address the complex and transnational risk of space debris.

Its central argument is that the interaction between imprecise language in treaties, a dysfunctional liability system, and application of non-binding "soft law" has created a permissive regime of orbital pollution that fails to deter bad conduct or enable necessary environmental remediation. This article will provide a critical and doctrinal examination of the legal instruments at hand, demonstrate their insufficiency, and set out to elaborate on a new, binding, and all-encompassing international convention for space debris management. The article will be divided into seven sections. Following this introduction, Section 2 provides a comprehensive description of the physical character and classification of space debris, a prerequisite for the legal investigation. Section 3 critically analyses the existing international law regime, and specifically the Outer Space Treaty and its progeny. Section 4 is a comparative analysis of national legislative initiatives and their merits and demerits. Section 5 discusses the critical legal challenges confronting Active Debris Removal, which is the only solution to the problem of existing space debris. Section 6 recasts the issue in international environmental law and ethical terms, demanding a paradigm shift in how the orbital commons are governed. Section 7 offers a summary of the main provisions of a proposed international convention. Finally, Section 8 concludes by reaffirming the compelling imperative for legal reform to secure the sustainable and equitable use of outer space on behalf of all mankind.

II. The Physical and Technical Dimensions of Space Debris

Any space debris legal regime will have to be grounded in a sound understanding of the physical problem it is intended to control. The technical dimensions of debris, namely, size, speed, source, and distribution in orbits, have a direct bearing on the legal problems of traceability, liability attribution, and restoration.

A. Characterisation and Taxonomy of Orbital Debris

Orbital junk is not a monolithic category. It spans a wide category of man-made items, each of which poses a distinct hazard. For legal purposes, a specific taxonomy is required:

1. **Non-functional Spacecraft ("Dead Satellites"):** Satellites whose functional lifespan has run out due to system malfunction, fuel exhaustion, or deliberate obsolescence. They are typically large, heavy pieces with a high collision risk.
2. **Upper Stages and Mission Hardware Expended:** The rocket bodies and hardware attached to them (e.g., payload adapters) left in orbit after their payloads have been released. These are among the largest and most dangerous objects and a high-priority target for eventual destructive removal missions.
3. **Mission-Related Debris:** Objects discharged either deliberately or accidentally in the regular performance of mission procedures. These could include lens caps, fairing components, explosive bolts, insulation blankets, and even frozen coolant droplets. Each small object, in isolation, poses a small hazard; their collective impact contributes to the overall danger.
4. **Fragmentation Debris:** The largest, most hazardous population group is the vast quantity of fragments resulting from energetic events. The principal sources are (1) accidental explosions, often due to time-delayed ignition of residual propellant or thermal runaway of batteries on dead spacecraft, and (2) hypervelocity collisions between active objects.

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This debris ranges from sub-millimetre-sized chunks of solid rocket motor slag to items the size of a school bus. The United States Space Surveillance Network and its international partners can identify objects as small as about 10 centimetres in LEO. There are estimated to be over a million objects of 1 to 10 centimetres, each having the ability to severely disable an on-orbit satellite. Most of this lethal waste is untracked, and it presents a statistical rather than a deterministic risk that complicates collision avoidance and fault.[29]

B. Critical Orbital Environments and Their Legal Importance

The distribution of debris is not even. It is concentrated in the most favourable orbital regions, each with unique legal and operational concerns.

1. **Low Earth Orbit (LEO):** The Zone of Highest Congestion: Between approximately 200 and 2,000 km altitude, LEO is both the most utilised and most congested orbital regime. It is necessary for people to have spaceflight (the International Space Station), observation of the Earth (e.g., the Hubble Space Telescope, Copernicus constellation), and the new mega-constellations for global internet access (e.g., Starlink, OneWeb). The high population density of objects and high orbital velocities in LEO make it the collision hazard hub and the focal region where Kessler Syndrome is initiated.
2. **Geostationary Orbit (GEO):** A Limited Natural Resource with Specific Rules: GEO, at 35,786 km, is unique in that satellites here have the same rotation period as Earth and therefore do not move in the field of view of the ground. This makes it extremely useful for telecommunications, broadcasting, and missile warning. GEO is a limited natural resource, with restricted longitudinal "slots" allocated by the ITU[30]. The general practice, as documented in IADC guidelines, has been for GEO satellites at end-of-life to be raised to a higher "graveyard orbit" (typically 300 km above GEO). But errors in this manoeuvre allow great, irrelevant items to float on this vital artery, posing a severe long-term threat and raising questions on the legal status of this customary norm.
3. **Medium Earth Orbit (MEO):** The Realm of Navigation and Permanent Pollution: Between LEO and GEO lies MEO, where key Global Navigation Satellite Systems (GNSS) like the U.S. GPS, Europe's Galileo, Russia's GLONASS, and China's BeiDou are situated. Atmospheric drag at such altitudes is minimal, and debris in MEO has orbital lifetimes very long, typically expressed in millennia. This pollution is effectively permanent on human scales, and mitigation is absolutely required.

III. The Current International Legal Framework: A Critical Examination

The corpus juris spatialis, or the international space law, is composed primarily of five UN treaties negotiated between 1967 and 1979. Doctrinal analysis reveals that while they established a philosophic foundation for space activities, they do not provide pragmatic, enforceable rules governing the complex, modern problem of debris management.

A. The Outer Space Treaty (1967): The Principled but Unrealistic Constitution

The OST is the "Magna Carta" of space law, establishing general principles which are now widely understood to constitute customary international law and binding on all states irrespective of whether they have signed.

1. Article I and the "Province of All Mankind": Common Use or Common Heritage?

Article I provides that the use and exploration of outer space "shall be the province of all

[29] *Space Debris by the Numbers*, EUR. SPACE AGENCY, https://www.esa.int/Space_Safety/Space_Debris/Space_debris_by_the_numbers (last visited Oct. 12, 2025).

[30] INT'L TELECOMMC'N UNION, RADIO REGULATIONS art. 1 (2020).

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mankind.[31]" The language has been the subject of richly textured jurisprudential debate. One reads it as setting up a "common use" regime, akin to the high seas, that guarantees freedom of access but with minimal responsibility for stewardship. Another, more enlightened reading, subscribed to by most commentators, connects it with the "common heritage of mankind" principle of the UN Convention on the Law of the Sea. This would not merely be a right of use, but an active obligation on all states to preserve the space environment for future generations. The lack of clear interpretation has allowed a minimalist approach to environmental responsibility to prevail.

2. Article VI: The Pillar of State Responsibility and the "Due Diligence" Standard

Article VI stipulates that states bear international responsibility for their space activities, "whether such activities are carried on by governmental agencies or by non-governmental entities.[32]" This is the central legal link that makes states accountable for actions of their private ventures, and requires them to "authorise and continually supervise" them. This is the foundation of national licensing regimes. However, no specific criteria for what constitutes adequate supervision or "due diligence" are provided by the Treaty. Under the case of debris, can a state be held responsible if it licenses a satellite that subsequently fails to perform its post-mission de-orbit burn? The issue is uncertain, and there is legal uncertainty for states and operators.

3. Article VIII: Jurisdiction, Control, and the Legal Bar to Salvage

Article VIII requires the registry state of an object in outer space "shall retain jurisdiction and control over such object." Notably, it further provides that ownership "is not affected by their presence in outer space.[33]" That provision, which seeks to protect a state's sovereign property from interference, has the unfortunate and unforeseen consequence of declaring inoperable satellites and space junk as the launching state's permanent property. Unlike maritime law, there is no salvage or abandonment. Thus, a state cannot legally touch, remove, or "salvage" another state's wreckage without specific permission, posing an apparently insurmountable barrier to environmental remediation activity.

4. Article IX: The Ambiguous Obligation of "Due Regard" and "Harmful Contamination"

Article IX requires states to continue their operations with "due regard to the corresponding interests of all other States Parties" and avoid "harmful contamination" of outer space. While the deliberate creation of a massive cloud of debris, as in the 2007 ASAT test, appears to be a clear violation of the "due regard" norm, the term remains undefined and imperfectly articulated to be effectively enforced. Similarly, while there is a strong argument to be made that physical trash constitutes a form of "harmful contamination," the preparatory documents to the treaty reveal that the authors were more concerned with biological and nuclear contamination. The potential for the concept to evolve in practice in the future exists, but currently too nebulous to act as an effective legal deterrent.

B. The Liability Convention (1972): A Solution in Theory Only

The Liability Convention was intended to give practical effect to the liability rules of the OST, but, because of its bifurcated structure and excessive evidentiary burden, it is ill-suited to the reality of on-orbit collision of space debris.

1. The Bifurcated Regime of Liability and the Unacceptable Burden of Proof of "Fault"

[31] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, *supra* note 4, art. I.
[32] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, *supra* note 4, art. VI.
[33] Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, *supra* note 4, art. VIII.

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The Convention adopts two standards of liability. Article II mandates absolute liability for harm caused by the launching of a space object on the Earth's surface or to aircraft in flight.[34] However, where the harm is caused by the launching of a space object in outer space, Article III mandates a fault-based regime of liability. The aggrieved party is required to prove that the harm was caused due to the "fault" of the launching state. This is essentially an impossible legal and technical challenge. It would involve:

I. **Identification and Causation:** Identifying with certainty the specific, typically microscopic, piece that harmed from among a cloud of tens of thousands of identical articles and proving its causal link to the harm.
II. **Establishing the Standard of Care:** Developing a clear legal standard of "fault" for space operations. Is not deliberately de-orbiting a satellite within the 25-year guideline timeframe negligence per se? Given that the guidelines are voluntary, this is highly suspect. The claimant would likely have to prove gross negligence, a very high standard.
III. **Evidentiary Difficulties:** Finding admissible evidence of a hypervelocity impact which likely caused both objects thousands of kilometres apart in space to be destroyed.

The procedural hurdles, such as a requirement to exhaust remedies first by diplomatic means, contribute to the difficulty. To date, no claim has yet succeeded under the fault-based provisions of the Convention. It is a theoretical legal remedy only.

C. Non-Binding Instruments: The dissemination of "Soft Law"

In recognition of political gridlock in treaty-making, the international community has shifted towards the production of non-binding "soft law" tools. The 2007 UN Space Debris Mitigation Guidelines, supported by the UN General Assembly, demonstrate global endorsement of best practices[35]. They are supported by the more detailed guidelines of the Inter-Agency Space Debris Coordination Committee (IADC) and the broader UN COPUOS Long-Term Sustainability (LTS) Guidelines. While these instruments are most effective and adopted into domestic law on a grand scale, their voluntary nature is ultimately their downfall. There are no enforcement mechanisms or methods to coerce non-members or newly emerging space actors, creating a gaping void that generally impairs the regime's functionality.

IV. National Legislation and the Limits of a Patchwork Approach

In response to inadequacies in the international regime, leading space-faring nations have enacted domestic law and regulation to impose debris mitigation obligations on their own licensees. This is the exercise of the "authorisation and continuing supervision" obligation under Article VI of the OST.

A. The United States: A Multi-Agency Regulatory Approach

The U.S. has one of the most sophisticated national systems. All U.S. government missions utilise the Orbital Debris Mitigation Standard Practices (ODMSP). In the commercial sector, the Federal Communications Commission (FCC), in its role as a satellite licensing authority, requires overall debris mitigation plans. In a landmark 2022 ruling, the FCC created a "five-year rule," whereby most new LEO satellites should be de-orbited within five years of mission completion, a massive reduction from the international benchmark of 25 years.[36] This indicates a good national policy, but simultaneously indicates the danger of regulatory divergence and its consequences for its application to non-U.S. actors in accessing the U.S. market.

[34] Convention on International Liability for Damage Caused by Space Objects, *supra* note 6, art. II.

[35] G.A. Res. 62/217, annex, Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (Jan. 22, 2008).

[36] Mitigation of Orbital Debris in the New Space Age, Report and Order, 37 FCC Rcd. 13423 (2022).

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B. Europe: ESA's "Clean Space" Policy and National Implementation

The European Space Agency (ESA) has been at the forefront in promoting sustainable values through its Clean Space policy, which focuses on the development of debris mitigation and remediation technologies. It has a powerful effect on its member states. France, by virtue of its 2008 Space Operations Act, has set up a complete legal framework that provides the government with the right to deny licenses to those operators who cannot demonstrate an assured and safe end-of-life disposal plan, with severe penalties for non-compliance[37]. Similarly, the UK Space Industry Act 2018 gives the regulator extensive powers to introduce insurance and liability obligations for its licensees.

C. The Inbuilt Drawbacks of a State-by-State Strategy

Despite being well-intentioned, this national strategy has inherent structural deficiencies:

1. **Jurisdictional Limits:** National rules apply only to those who are state-licensed. They cannot regulate the gigantic amount of past rubbish generated by other nations in the past 60 years, nor can they bind the states whose controls are weaker.
2. **Regulatory Arbitrage ("Flags of Convenience"):** The lack of a universal, binding international requirement raises the possibility of satellite operators "forum shopping" for less stringent, and therefore less costly, regulations by nations. This could lead to a race to the bottom, detrimental to global safety, reminding us of an age-old problem in maritime commerce[38].
3. **The Patchwork Problem:** The outcome is a patchwork of fragmented rules, not a unified global plan. An operator with a license in the U.S. has a different set of rules than one licensed in Luxembourg or China, even though all are working within the same shared, indivisible orbital space.

V. Active Debris Removal (ADR): A Legal Minefield

There is a developing scientific consensus that mitigation alone will not suffice. The density of big pieces in LEO is so high that the rate of creation of new debris by collisions is beginning to outpace the rate at which objects are being cleared away by natural atmospheric drag. Remediation via Active Debris Removal (ADR) is therefore a matter of environmental necessity. ADR missions, however, are faced with a myriad of intimidating legal barriers that currently make them almost impossible to execute.

A. Doctrine of Perpetual Ownership and Requirement of Consent

As mandated by Article VIII of the OST, an inoperative satellite is not necessarily "abandoned." It remains property belonging to the launching state, which has exclusive control and jurisdiction. An ADR operator, whether state agency or private enterprise, is not legally entitled to seize, de-orbit, or otherwise interfere with an object of debris except with the prior express consent of the state of origin. This "consent requirement" is the biggest single legal barrier to ADR. Collecting such compliance ad hoc for thousands of items, some of which belong to multiple no-longer-existent states (like the Soviet Union), would be a diplomatic and logistical nightmare. Lawyers have proposed circumventions, including a procedure to declare an item "derelict" after a period of non-contact, but no such procedure is currently offered by law.[39]

B. The Liability Vacuum for High-Risk Removal Operations

ADR is a technologically advanced and dangerous endeavour. If an ADR operation goes

[37] Loi 2008-518 du 3 juin 2008 relative aux opérations spatiales [Law 2008-518 of June 3, 2008 on Space Operations], JOURNAL OFFICIEL DE LA RÉPUBLIQUE FRANÇAISE [J.O.] [OFFICIAL GAZETTE OF FRANCE], June 4, 2008.

[38] Frans G. von der Dunk, *Flags of Convenience in Outer Space*, *in* PROCS. OF THE 39TH COLLOQUIUM ON THE L. OF OUTER SPACE 281, 281–90 (1996).

[39] Ram S. Jakhu, *Legal Issues of Active Debris Removal*, *in* ACTIVE DEBRIS REMOVAL IN SPACE 145, 145–62 (B. Marchi et al. eds., 2016).

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wrong and, for instance, a grappling tool accidentally shatters the target debris, it would create thousands of new pieces. Under the Liability Convention, the initiating state of the ADR operation would almost inevitably be deemed "at fault" and would be liable for any resulting damage caused by this new shower of debris. This creates a significant fiscal and legal disincentive for any country or private company to undertake such missions without explicit international legal cover or some liability-sharing mechanism.

C. The Dual-Use Technology Problem and International Security

The technologies used in ADR (rendezvous and proximity operations, robotic grappling, nets, and harpoons) are inherently dual-use. A sophisticated ADR satellite could be indistinguishable from a co-orbital anti-satellite weapon[40]. The development and use of such technologies, even for non-military environmental purposes, could be perceived as threatening to other countries, could create mistrust, lead to a new space arms race, and violate the intent of peaceful use of outer space. This is the security dimension that makes the legal and diplomatic effort needed to enable cooperative ADR extremely challenging.

VI. Redefining the Debate: Environmental Law and Intergenerational Equity

In order to break the current political and legal stalemate, it is helpful to rethink the problem of space debris not only as an operational hazard but as a form of long-term environmental pollution of the international commons. This shift in conception allows for the transposition of robust normative principles from international environmental law.

A. Transposing Principles of International Environmental Law to the Orbital Commons

Two core principles of environmental law form a robust normative basis for the regulation of space:

1. **The Precautionary Principle:** The principle, which has been adopted within the Rio Declaration, is that where there is a risk of serious or irreversible harm, the absence of scientific certainty shall not be employed as the basis of deferring effective and affordable measures to avoid causing environmental harm[41]. The possibility of the Kessler Syndrome, which is scientifically real, though the exact tipping point cannot be determined, is a paradigmatic example of the application of this maxim. It is a case that demands anticipatory mitigation and remediation efforts now, before a catastrophe, not later.
2. **The Polluter Pays Principle:** This is the foundation of environmental law and environmental economics, and it holds that the person causing the pollution has to pay for the upkeep of it in order not to damage human health or the environment[42]. Applied to space, this would mean that satellite operators need to be responsible for the whole life-cycle cost of their missions, including end-of-life disposal. It makes a compelling economic and legal case for mandatory insurance, performance bonds, or "orbital use fees" to fund ADR.

B. The Ethical Necessity of Intergenerational Equity

Outer space is the shared heritage of all humanity. Current activities are dirtying the orbital environment in ways that will persist for centuries or millennia. This is a glaring violation of the intergenerational equity principle moral duty increasingly accepted in international law, to act as responsible custodians of the world and its atmospheric surroundings for the benefit of those who will come after us. We are actually cutting future generations short in their complete use of the scientific, economic, and cultural benefits of space. This normative

[40] Brian Weeden, *The Dual-Use Dilemma of Active Debris Removal*, THE SPACE REV. (Aug. 29, 2011), https://www.thespacereview.com/article/1922/1.

[41] Rio Declaration on Environment and Development, princ. 15, U.N. Doc. A/CONF.151/26 (Vol. I) (Aug. 12, 1992).

[42] Rio Declaration on Environment and Development, *supra* note 22, princ. 16.

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argument serves as the final basis for swift and firm action under the law.

VII. The Way Forward: Elements of a Binding International Convention

The failures of the existing regime and the rising nature of the threat necessitate a bold step: the negotiation of a fresh, binding international convention on space debris management, either as a separate convention or a new protocol to the Outer Space Treaty. The convention should be comprehensive and based on the following pillars:

A. Mandatory and Verifiable Mitigation Standards

The UN Guidelines must be codified in enforceable legal obligations applying to all signatories. These would be:

1. **A Universal De-orbit Timeframe:** An enforceable and enforceable deadline for post-mission disposal in LEO (e.g., 5-10 years), with penalties for violations.
2. **Mandatory Passivation:** Legal requirement that all spacecraft and rocket bodies be "passivated" on mission's end by blowing out residual propellants and draining batteries to prevent explosions.
3. **Operating and Design Standards:** Requirements to minimise the release of mission-related debris and to incorporate design features which maximise "design for demise" on atmospheric re-entry where possible.

B. A New Regime for Liability, Insurance, and Compensation

The unrealistic fault-based regime needs to be supplemented by a new, efficient system. A new regime can encompass a multi-strata model:

1. **Compulsory First-Party Insurance:** Requiring all satellite operators to be insured against the cost of their own satellite's post-mission disposal, including potential active removal if its onboard systems fail.
2. **Compulsory Third-Party Liability Insurance:** Requiring operators to carry a minimum amount of liability insurance to cover potential damage to other operational satellites.
3. **International Compensation Fund:** Following the same model as oil-spill funds (e.g., IOPC Funds), the fund would be subsidised by a small tax per space launch or an orbital-use fee annually[43]. It would compensate traceless-debris victims and, critically, subsidise internationally approved ADR missions against high-risk legacy debris.

C. A Clear Legal Framework for Active Debris Removal

The convention must ensure a clear, transparent, and safe legal process for ADR. This would involve:

1. A process of certifying debris: Establishing an international technical organisation to locate and certify certain high-risk debris objects as "derelict" based on well-specified criteria (e.g., no response for a specified period of years, unable to control its direction, on a collision course).
2. Limited Waiver of Jurisdiction: After an object has been declared to be derelict and the registry state has been given the last opportunity to act, the convention would allow a limited waiver of the exclusive jurisdiction of the original state under Article VIII so that an authorised actor can conduct removal.
3. A Liability Shield for Authorised ADR: An ADR mission authorised by an international body and run to strict operational standards would be granted a degree of immunity from liability for incidental harm, and any residual claims would be addressed by the international compensation fund.

[43] International Convention on the Establishment of an International Fund for Compensation for Oil Pollution Damage, Dec. 18, 1971, 1110 U.N.T.S. 57.

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D. An International Space Authority for Governance and Coordination

To perform and oversee these complex tasks, the convention would have to establish a lean, technically focused International Space Authority.[44] Its mandate would include:

1. **Registry and Data Sharing:** Maintaining a full, up-to-date public register of all space objects and their operational status.
2. **Standard Setting:** Creating and updating technical standards for mitigation, tracking, and ADR.
3. **Fund Administration**: Administering the international compensation fund.
4. **ADR Authorisation:** Facilitating the process for authenticating debris and authorising ADR missions to ensure safety, transparency, and prevent abuse of dual-use technology.
5. **Dispute Resolution:** Providing a forum for mandatory, binding dispute resolution for disputes under the convention.

VIII. Conclusion

The persistent pollution of the near-Earth environment with artificial space debris is an unsustainable course, an environmental crisis in slow motion. It is an international tragedy of collective action in which the rational actions of independent agents, taken under a permissive legal order, result in a collective and perhaps irreversible tragedy of the commons. This essay has argued that the current regime of international law, a relic of a bygone era, institutionally cannot bring this crisis to a close. Its principles underlying it are too vague to be practically enforced, its liability scheme is unworkable in practice, and its reliance upon voluntary "soft law" methods has not been sufficient to prevent the spilling of orbital pollution.

Something new is called for with a sense of urgency, something that moves beyond the Cold War stance of state sovereignty of space objects and rather views orbital space as a finite resource requiring positive, international management. By invoking the robust principles of international environmental law, precaution, polluter pays, and intergenerational equity, the world can and must build a new legal framework for space. The path forward is through a dedicated, binding international convention that harmonises mitigation standards, creates viable liability and insurance systems, and eventually enables the proper remediation of our orbital commons. The negotiations for such a treaty will undoubtedly be challenging, but it will require massive political will to go against vested interests. Inactivity, however, is a much greater risk. The inability to establish effective legal governance will not only put the multi-trillion-dollar space economy at risk but will also undermine our responsibility as protectors of this final frontier, subjecting it to danger.[45]

[44] Stephan Hobe, *The Establishment of an International Space Authority*, *in* 1 COLOGNE COMMENTARY ON SPACE LAW 34, 34–38 (Stephan Hobe et al. eds., 2009).

[45] THE SPACE FOUND, THE SPACE REPORT 2024: THE AUTHORITATIVE GUIDE TO GLOBAL SPACE ACTIVITY (2024).