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It's Raining Rockets: Heightening State Liability for Space Pollution

Sraavya Poonuganti*

Abstract

The uptick in outer space exploration activity by spacefaring nations has resulted in the increased proliferation of space debris orbiting Earth and reentering its atmosphere. The current liability regime, which was enacted as a result of the U.S.–Soviet Union space race in the 1960s and '70s, is ill-equipped to mitigate and deter such proliferation. Without proactive measures, the space debris buildup could escalate into the Kessler Syndrome, a proposed scenario in which space exploration, and its corresponding benefits, may be rendered infeasible due to the extreme risk of high-impact space object collisions. This Comment first analyzes existing proposals for amending the outer space treaty liability regime. Next, to argue that spacefaring states have an affirmative responsibility to remove space debris that originates from their satellites and space objects, this Comment applies three landmark principles of customary international law: the polluter pays principle, the precautionary principle, and the prohibition against transboundary harm. Finally, this Comment proposes a novel solution to establish a security deposit program that participating spacefaring nations must pay into in order to launch objects and satellites into outer space, modeled after existing international environmental law efforts to solve the issue of marine debris. Focusing on preventative measures to reduce the amount of space debris produced in outer space is the most effective solution to ensure the continued use of space as a shared resource for spacefaring nations.

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I. INTRODUCTION

The week of May 8, 2021, frightened the world as it awaited the potential uncontrolled reentry of a section of China's Long March 5B rocket, which had been launched from China's Wenchang Space Launch Center on April 29, 2021, for the purpose of delivering a module of the Tianhe Space Station.¹ Thankfully, the section did not land over any populated area; rather, it landed in the middle of the Indian Ocean.²

This is just one of many examples of unchecked space debris currently floating around Earth. This collection of orbital debris poses a potential liability problem to the future of deep space exploration, given the relatively relaxed approach as a result of the gap in regulation³ of both accidental and purposeful rocket reentry under international law.⁴ Space law experts strongly believe that the reentry of the Long March 5B section is a symptom of an impending catastrophe regarding space debris reentry as well as space debris buildup in Earth's atmosphere—which creates the Kessler Syndrome⁵—particularly with the rise in private commercial actors participating in outer space exploration.⁶ The commercialization of space travel places an increasing amount of pressure

¹ W. Robert Pearson & Benjamin L. Schmitt, *The Crisis in Space*, FOREIGN POLICY (May 15, 2021), <https://perma.cc/LMG3-YDDL>.

² *Id.*

³ One of the main causes of the continuing gap in outer space regulation is the disagreement between established spacefaring nations and nations with fewer or recently developed space capabilities as to what the correct approach is for the evolution of the international space law regime. See Joanne I. Gabrynowicz, *Space Law: Its Cold War Origins and Challenges in the Era of Globalization*, 37 SUFFOLK U.L. REV. 1041, 1054 (2004). Established spacefaring nations, such as the U.S. and India, support the existing treaty regime and take the view that “encouraging adherence to the existing treaties is the more practical way to achieve development.” *Id.* at 1053. Nations with fewer or recently developed space capabilities, such as China and Iran, support a new, comprehensive treaty as a holistic approach to address the changing needs of space behavior. *Id.*

⁴ See Pearson & Schmitt, *supra* note 1; see also Alex Ward, *The Falling Chinese Space Rocket is a Policy Failure*, VOX (May 7, 2021), <https://perma.cc/N9T7-J9XN> (“Despite regulations on space flight and conduct, the issue of rocket reentry is loosely and poorly regulated, so countries cut corners and take their chances that a falling rocket won’t hit anything major.”).

⁵ The Kessler Syndrome refers to the predicted cascading phenomena where “[a]s space debris accumulates in Earth’s orbit, it becomes increasingly likely that the debris will collide with each other and other objects, resulting in exponential growth in space debris” and, by extension, an increased likelihood of space debris collisions. Jordan Liew, *The Kessler Syndrome: A World Without Satellites*, GEO. INT’L ENV’T L. REV. ONLINE (2015). Space debris is dangerous not because of its minute size, but rather the speed in which the pieces of debris are orbiting the Earth. *Id.* Because space debris can travel at a speed of up to 17,500 miles per hour, a piece of orbital debris less than one centimeter long can damage other spacecrafts or satellites. See *id.* (“NASA has been forced to replace many space shuttle windows damaged by paint flecks.”).

⁶ See Ward, *supra* note 4.

on international legislative bodies to amend or rehaul the liability regime as it relates to space debris proliferation.

The current landscape surrounding outer space activity has evolved tremendously from the original purpose of the enactment of most of the current treaty regime governing outer space behavior.⁷ While the original purpose of U.N. Resolution 1884 and U.N. Resolution 1962, the bases of the Outer Space Treaty of 1967, was to “stipulate[] that all countries have the right to freely explore and use space,”⁸ an increasing number of companies, militaries, civil departments, and private individuals have launched spacecraft into orbit to gain commercial advantage, collect scientific data, and support meteorology and telecommunication disciplines, in this newly created marketplace.⁹

One of the ancillary consequences to the increasing number of satellites and spacecraft launches is the buildup of space debris currently orbiting Earth.¹⁰ The United States Space Surveillance Network estimates that there are “over 170 million pieces of space debris currently orbiting the Earth” with most of these pieces being less than 1 mm in size.¹¹ Furthermore, the Network estimated in 2018 that between 200 to 400 tracked pieces of space debris enter Earth’s atmosphere every year.¹² While rocket debris reentry rarely affects the human population, the risk has exponentially increased with the more recent private attempts to explore space by actors that do not directly fall under the jurisdiction of international regulation of space law.

There are several concerning harms that may result from the increasing collection of unchecked orbital debris. The rarest, although most deadly, potential harm is that large pieces of debris will not completely disintegrate upon reentering Earth’s atmosphere, creating a risk of harm to people, animals, and property on Earth. Another concern is the potential impact and limitation on space exploration capabilities, with states perhaps having to act more restrictively in their spacefaring endeavors. A separate concern arises from the treatment of debris as a form of pollution, which is discussed below. This treatment enforces the principle that ordinary air pollution is inherently harmful—that is, the particulate pieces of debris floating around Earth’s

⁷ See Daryl Kimball, *The Outer Space Treaty at a Glance*, ARMS CONTROL ASS’N (Oct. 2020), <https://perma.cc/5AKZ-EZPJ> (“Talks on preserving outer space for peaceful purposes began in the late 1950s at the United Nations.”).

⁸ *See id.*

⁹ See Alexandra Witze, *The Quest to Conquer Earth’s Space Junk Problem*, NATURE (Sept. 5, 2018), <https://perma.cc/499B-JFNB>.

¹⁰ See *About Space Debris*, EUR. SPACE AGENCY, <https://perma.cc/4RQ3-5BCN>.

¹¹ *Does Space Junk Fall from the Sky*, DEP’T OF COM. (Jan. 19, 2018), <https://perma.cc/3499-26P6> (providing data on space debris in Earth’s atmosphere).

¹² *Id.*

atmosphere is what causes the damage itself. This is the basis on which the Kessler Syndrome was founded.¹³

The fundamental question this Comment seeks to address is how international regulation of space debris can be improved (1) to provide a stronger avenue of legal recourse for affected victim states to recover damages from spacefaring launchers as a result of space debris reentry and collision, as well as (2) to deter and align states' incentives to make such recourse less necessary. This Comment proposes a novel solution: bind spacefaring nations with affirmative duties to clean up space debris and create a security deposit mechanism to ensure those nations carefully monitor and reduce the risk of proliferating space debris from their satellites.

This Comment proceeds in seven Parts. Part II outlines the history of the current regime of international space law and the treaties. It reviews the pertinent provisions relevant to state and private actor liability for space debris reentry into Earth's atmosphere; it also breaks down the various bases of liability (absolute liability versus negligence) established by the various international legal frameworks.

Part III addresses the existing scholarly literature on the current shortcomings of the liability scheme established by the five treaties above, particularly by the 1972 Liability Convention, with the primary focus being the lack of recourse for or against private actors within the context of space exploration and space debris. Part III includes a case study on the discrete event that triggered the application of the 1972 Liability Convention, the Kosmos 954 Crash of 1978. In Part IV, the Comment digs deeper into the issue of "space debris," which is not properly defined by any of the treaties mentioned above.

Part V analyzes existing proposals for improvement on post-collision liability schemes for states to abide by when resolving disputes and recovering damages. In Part VI, the Comment applies several customary international law principles to argue that spacefaring nations have an affirmative duty to clean up space debris—both their own debris as well as debris caused by other nations. In Part VII, the Comment proposes the solution of establishing a security deposit mechanism that spacefaring nations must buy into if they wish to engage in space exploration activities. This solution is modeled after existing international law efforts to combat the buildup of marine debris in Earth's seas. The Comment concludes in Part VIII with a series of recommendations and an account of what questions remain unresolved.

¹³ See *supra* note 5 and accompanying text.

II. THE CURRENT OUTER SPACE TREATY LIABILITY REGIME

There are five U.N. Space Treaties that “constitute the nucleus of space law.”¹⁴ The enactments of these five treaties were not focused particularly on space commercialization, which is more pervasive in present day than it was when the U.N. first laid out the legal foundations.¹⁵ The Legal Subcommittee of the Committee on the Peaceful Uses of Outer Space (hereinafter COPUOS or “Committee”) promulgated all five of the treaties that govern the various international legal principles of outer space exploration.¹⁶

A. Outer Space Treaty of 1967

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 “Outer Space Treaty” or “Outer Space Treaty of 1967”), establishes that states “shall bear international responsibility for national activities in outer space” and declares that states must supervise and authorize all national space activities, whether public or private.¹⁷ Additionally, this treaty also connects absolute liability¹⁸ with launching status, meaning that a state will be liable for damages caused by rockets that it launches into space.¹⁹

The necessity to enact the Outer Space Treaty arose “by the commencement of space activities with the launch of the first artificial satellites of the Earth under an international scientific programme.”²⁰ When the Legal Subcommittee of COPUOS initially convened for its first session in the spring of 1962, the members proposed and negotiated an initial set of rules that

¹⁴ Yun Zhao, *Space Commercialization and the Development of Space Law*, in OXFORD RESEARCH ENCYCLOPEDIA OF PLANETARY SCIENCE (Peter Read ed., Oxford Univ. Press 2018), <https://perma.cc/9QYW-YQZ3> (noting that “legal issues related to space commercialization were not the main regulatory targets for these five treaties, which is understandable in view of the time when these treaties were drafted.”).

¹⁵ Pearson & Schmitt, *supra* note 1 (citing Yun Zhao, *An International Space Authority: A Governance Model for a Space Commercialization Regime*, 30 J. SPACE L. 277 (2004)).

¹⁶ See *Committee on the Peaceful Uses of Outer Space*, U.N. OFF. FOR OUTER SPACE AFFS., <https://perma.cc/SSU3-JT89>.

¹⁷ 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, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

¹⁸ Absolute liability in the outer space treaty regime is legally equivalent to the concept of strict liability in the U.S. domestic tort regime.

¹⁹ Susan Trepczynski, *The Effect of the Liability Convention on National Space Legislation*, 33 J. SPACE L. 221, 223–24 (2007).

²⁰ Vladimir Kopal, *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, U.N. AUDIOVISUAL LIBR. OF INT’L L. (1966), <https://perma.cc/ZLN2-YV7F>.

eventually was adopted by consensus on December 13, 1963 as the Declaration of Legal Principles Governing the Activities of States in the Exploration and Use of Outer Space.²¹ These rules, while nonbinding at the time, “outlined the scope of legality for activities of States in the space environment” while also describing initial protocols for handling certain problems that were already pervasive of the space activities being undertaken at that time.²²

With the race escalating between the U.S. and the Soviet Union to reach the Moon, and the desire of certain governments to explore the possibility of implementing weapons of mass destruction on satellites or celestial bodies, the Legal Subcommittee reconvened at its fifth session in Geneva in 1966.²³ While part of this convention was a review of the fundamental principles laid out in the 1963 Declaration, the Subcommittee took particular note of addressing international cooperation in the context of space activities, and how best to implement such cooperation.²⁴

The Outer Space Treaty was opened for signature in London, Moscow, and Washington on January 27, 1967.²⁵ The Treaty officially entered into force on October 10, 1967, with the Russian Federation, the U.K., and the U.S. serving as the depository governments.²⁶ To date, the Treaty has 89 signatory states and 111 states parties.²⁷

The Preamble to the Outer Space Treaty enumerates several high-level goals consistent with the context under which the Treaty was enacted. In particular, the Preamble desires “to contribute to broad international cooperation in the scientific as well as the *legal* aspects of the exploration and use of outer space for peaceful purposes.”²⁸ The Preamble further provides the overall framework within which the subsequent outer space treaties, addressed below, were discussed and eventually enacted.

Article VII of the Outer Space Treaty enumerates the first international form of liability between state parties in the event of damages caused by space

²¹ *Id.*

²² *Id.*

²³ *Id.*

²⁴ *Id.*; see also Zhao, *supra* note 14 (“Several fundamental principles, including non-appropriation of outer space, peaceful uses of outer space, and international space cooperation, are now part of customary international law.”) (citations omitted).

²⁵ *Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies*, U.N. OFF. FOR DISARMAMENT AFFS., <https://perma.cc/P7KA-VUHP>.

²⁶ *Id.*

²⁷ *Id.*

²⁸ Outer Space Treaty pmb. (emphasis added).

objects.²⁹ The provision explains that “[e]ach State Party to the Treaty that launches or procures the launching of an object into outer space . . . and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or its natural or juridical persons by such objects or its component parts on the Earth” but fails to explain how this liability is determined, where this dispute would be adjudicated, or what factors the damages calculation would consider.³⁰

Furthermore, the Outer Space Treaty details the first articulation of the concept of a state’s “jurisdiction” over space objects orbiting in outer space. In Article VIII, a State “shall retain the jurisdiction and control over such object and over any personnel thereof, while in Outer Space or on a celestial body.”³¹ The Registration Convention expands on this concept of jurisdiction and control over space objects, as discussed below.

B. Rescue and Return Agreement of 1968

The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Space (hereinafter “Rescue and Return Agreement”) entered into force on April 22, 1968, with the same depository governments as the Outer Space Treaty.³² The primary purpose of the Rescue and Return Agreement’s enactment was to outline the duties that run to “personnel of a spacecraft” and provide a mechanism for ensuring the rescue and return of astronauts to the state that registered the launch vehicle.³³

Under Article V of the Rescue and Return Agreement, “objects launched into outer space . . . found beyond the territorial limits of the launching authority” must be returned promptly to the “launching authority,”³⁴ regardless of the circumstances that led to the object arriving in the state’s jurisdiction.³⁵ The Rescue and Return Agreement does not make a clear distinction between public and commercial spaceflight enterprises, and scholars have broadly

²⁹ *Id.* art. VII.

³⁰ *Id.*

³¹ Rochus Moenter, *The International Space Station: Legal Framework and Current Status*, 64 J. AIR L. & COM. 1033, 1044 (1999).

³² The Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue and Return Agreement].

³³ See Steven A. Mirmina, *Astronauts Redefined: The Commercial Carriage of Humans to Space and the Changing Concepts of Astronauts Under International and U.S. Law*, 10 FIU L. REV. 669, 671 (2015).

³⁴ Rescue and Return Agreement art. V.

³⁵ Mark J. Sundahl, *Business Legal, and Policy Issues in Relation to Increased Private Space Activity*, in OXFORD RESEARCH ENCYCLOPEDIA OF PLANETARY SCIENCE (Peter Read ed., Oxford Univ. Press 2019), <https://perma.cc/7Y3J-T2RX>.

interpreted the Agreement to “require states to rescue nongovernmental personnel *and* return private spacecraft.”³⁶

C. 1972 Liability Convention

1. Liability Convention Background and Framework

Recognizing the shortcomings of the existing liability framework and the lack of detail regarding compensation and dispute resolution, the 1972 Convention on International Liability for Damage Caused by Space Objects (hereinafter “1972 Liability Convention”) elaborated on the space activity liability regime established in Article VIII of the Outer Space Treaty.³⁷ The 1972 Liability Convention is the most up-to-date governing treaty for states to reference when establishing liability and apportioning appropriate damages.³⁸

While the 1972 Liability Convention does acknowledge the capacity for individual private actors to pursue remedies outside the Convention’s parameters, the Convention does not provide an enumerated pathway for a private party to present a claim of compensation.³⁹ Rather, the party must have its government present the claim for compensation to the government of the launching party (which may be the government itself) in order for the Convention’s provisions to govern the dispute.⁴⁰

Article I defines several relevant terms that were not previously defined by the Outer Space Treaty. “Launching State” is defined as “(i) A State which launches or procures the launching of a space object; (ii) A State from whose territory or facility a space object is launched.”⁴¹ “Space Object” includes “component parts of a space object as well as its launch vehicle and parts thereof.”⁴² For purposes of establishing liability, the Convention defines “damage” to mean “loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons, natural or juridical, or property of international intergovernmental organizations.”⁴³

The Liability Convention provides a bimodal framework for assessing a state’s liability in the event of space object collisions. Article II establishes an

³⁶ *Id.* (emphasis added).

³⁷ Convention on International Liability for Damage Caused by Space Objects pmbl., Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter *Liability Convention*].

³⁸ Note that the *Liability Convention* “grants neither rights nor responsibilities to the private sector.” Moenter, *supra* note 31, at 1042.

³⁹ *Id.* at 1043.

⁴⁰ *Id.*

⁴¹ *Liability Convention* art. I(c).

⁴² *Id.* art. I(d).

⁴³ *Id.* art. I(a).

absolute liability framework for launching states in cases where “damage [is] caused by its space object on the surface of the earth or to aircraft flight.”⁴⁴ It is not clear whether this absolute liability extends to “space debris,” non-functional remote pieces of space junk, or whether it is purely confined to a narrowed definition of “space object,” as Part III will explore. Article III establishes a fault-based liability framework for launching states or for “persons for whom [the launching state] is responsible,” “[i]n the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State.”⁴⁵

Article VI provides the sole exception for launching States to be exonerated from Article II’s absolute liability framework through a comparative negligence approach, but it does not define the level of negligence required on behalf of the plaintiff state for this exception to be triggered.⁴⁶ States will be exonerated from absolute liability “to the extent that a launching State establishes that the damage has resulted either wholly or partially from gross negligence or from an act or omission done with intent to cause damage on the part of a claimant State or of natural or juridical persons it represents.”⁴⁷

Article VIII gives signatory states the ability to present a “claim for compensation” to the responsible launching State for any damages suffered by the state or the state’s natural or juridical persons.⁴⁸ Lastly, Article IX vaguely defines the mechanism for victim states to bring a claim of compensation, by announcing that the claim “shall be presented to a launching State through diplomatic channels.”⁴⁹

2. Applying the Liability Convention’s Provisions: The Case Study of the Kosmos 954 Crash

The 1972 Liability Convention governs the legal regime for disputes regarding damages from space objects launched by “launching States.” There are several sources of ambiguity in the Convention’s language with lack of resolution namely because the Convention itself has gone largely untested in how effectively it can govern and resolve disputes. In fact, the 1972 Liability Convention has been exercised exactly once—in the aftermath of the crash of Kosmos 954. The U.S.S.R.’s reconnaissance satellite, Kosmos 954, malfunctioned and crashed in the Northwestern Territories of Canada on

⁴⁴ *Id.* art. II.

⁴⁵ *Id.* art. III.

⁴⁶ *Id.* art. VI.

⁴⁷ *Id.*

⁴⁸ *Id.* art. VIII.

⁴⁹ *Id.* art. IX.

January 24, 1978, scattering radioactive debris.⁵⁰ Canada invoked the treaty and billed the U.S.S.R. over 6 million Canadian dollars, although it rejected the Soviet Union's offer to assist in the cleanup efforts.⁵¹ Notably, Canada accepted U.S. assistance in the cleanup and chose not to repay them for their aid.⁵²

On April 2, 1981, the U.S.S.R. agreed to pay Canada 3 million Canadian dollars.⁵³ Alexander F. Cohen argued that the incident demonstrated diverging expectations between "the duty to forewarn, the duty to provide information, the duty to clean up, and the duty to compensate for injury," as the U.S.S.R. only warned the U.S. of the possible crash because projections indicated the satellite was more likely to fall over American territory.⁵⁴ The U.N. did not appear to play a significant role in the negotiations or managing the aftermath of the crash.

However, if the U.S.S.R. and Canada had not diplomatically resolved the issue within a year, the Liability Convention's Claims Commission provisions very likely would have been tested for the first time.⁵⁵ Article XIV of the Liability Convention provides: "[i]f no settlement of a claim is arrived at through diplomatic negotiations as provided for in Article IX, within one year from the date on which the claimant State notifies the launching State that it has submitted the documentation of its claim, the parties concerned shall establish a Claims Commission at the request of either party."⁵⁶

Subsequent Convention provisions outline how the three members of the Commission would be selected and that the Commission's purpose is to establish the merits of the petitioning state's claim and damages, if any.⁵⁷ Two crucial problems may still remain if rocket reentry disputes resort to using the Liability Commission provisions. For one, Article XIX(2) notes that the decision is only binding if the parties agree that it will be prior to a judgment being delivered.⁵⁸ Second, the Convention is fairly unhelpful in establishing the grounds upon which a judgment would be made: Article XIX(2) merely acknowledges that the Commission "shall state the reasons for its decision or

⁵⁰ Andrew Brearley, *Reflections upon the Notion of Liability: The Instances of Kosmos 954 and Space Debris*, 34 J. SPACE L. 291, 292–94 (2008).

⁵¹ Alexander F. Cohen, *Cosmos 954 and the International Law of Satellite Accidents*, 10 YALE J. INT'L L. 78, 80 (1984).

⁵² *Id.* at 85.

⁵³ Brearley, *supra* note 50, at 310.

⁵⁴ Cohen, *supra* note 51, at 81.

⁵⁵ Brearley, *supra* note 50, at 310.

⁵⁶ Liability Convention art. XIV.

⁵⁷ *Id.*

⁵⁸ *Id.*

award” without providing guidelines on how these decisions should be reached.⁵⁹

While this incident would have served as a useful blueprint in applying the current outer space liability framework, the case of the Kosmos 954 crash nevertheless demonstrates some of the key issues and gaps in implementing the treaty regime outlined above. First, the U.N. did not have any leverage in negotiating, facilitating, or expediting the litigation between the U.S.S.R and Canada. This resulted in a costly back and forth between the states that reduced the likelihood of reaching a mutually beneficial agreement. Furthermore, the states involved seemed to be unclear as to what exactly their obligations were under the Liability Convention and to each other as fellow spacefaring nations. Finally, the U.S.S.R did not display any sense of obligation to implement measures to reduce the risk of such crashes in the future, and the U.N. played virtually no role in ensuring such measures were taken for future space exploration by both the U.S.S.R and other nations.

D. 1975 Registration Convention

The 1975 Registration Convention on Registration of Objects Launched into Outer Space (hereinafter “Registration Convention”) is another example of international space law development conducted through the elaboration of key principles from the Outer Space Treaty. As of 2010, fifty-four states have ratified the Registration Convention.⁶⁰ The purpose of the Registration Convention was to clarify and expand on responsibility and liability for particular pieces of space objects and debris.⁶¹

Article II lays out the requirement for launching states to register any space object they launch into space “by means of an entry in an appropriate registry which it shall maintain,” and each such registration must be followed up with informing the Secretary-General of the U.N. “of the establishment of such a registry.”⁶²

While the Registration Convention does affirmatively require nations to register space objects launched into space, it does not clearly require states to keep track of and report the creation of space debris generated by launches,

⁵⁹ *Id.*

⁶⁰ Convention on Registration of Objects Launched into Outer Space, Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration Convention].

⁶¹ Joseph S. Imburgia, *Space Debris and Its Threat to National Security: A Proposal for a Binding International to Clean Up the Junk*, 44 VAND. J. TRANSNAT'L L. 589, 618 (2011) (proposing a binding international space debris agreement as a response to the impending space debris crisis caused by a two-satellite collision in space).

⁶² Registration Convention art. II.

upkeep, or inactive satellites.⁶³ Another significant drawback of the Registration Convention is the failure to establish a set length of time for nations to notify the U.N. Secretary-General.⁶⁴ Without a set length of time, states may lose track of their inactive satellites to the point where it becomes more difficult to establish causation between the states' original space launch and what ends up ultimately being the piece of space debris that crashes into another nation's space object or reenters Earth's atmosphere.

Article VI of the Registration Convention creates a "data-sharing duty to assist in the tracking of space objects"⁶⁵ by creating a request system and shared obligations between signatory states that are keeping track of and monitoring the proliferation of their space objects.⁶⁶ This tracking system serves as an important basis for resolving liability disputes later on by using the data-sharing platforms as a way to establish causation and assign ownership over the space objects to the appropriate spacefaring nations.

E. 1979 Moon Agreement

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (hereinafter "Moon Agreement") is the most recently written and ratified space treaty, having entered into force on July 11, 1984.⁶⁷ The Moon Agreement was elaborated and adopted by the Legal Subcommittee because of a need to expand upon the provisions of the Outer Space Treaty, and to clarify the application of such provisions as applied to the Moon and other celestial bodies.⁶⁸ In particular, the Moon Agreement provides that the Moon and other celestial bodies "should be used exclusively for peaceful purposes."⁶⁹

The Moon Agreement is the only iteration of international space treaty law that "acknowledges the possibility of commercialization" of outer space as a natural resource.⁷⁰ For example, Article VII of the Moon Agreement states that "[i]n exploring and *using* the moon, States Parties shall take measures to prevent the disruption of the existing balance of its environment."⁷¹ Notably, this Article VII language is also one of the strongest signals in outer space treaty law to

⁶³ Imburgia, *supra* note 61, at 619.

⁶⁴ Registration Convention art. VI.

⁶⁵ Imburgia, *supra* note 61, at 619.

⁶⁶ Registration Convention art. VI.

⁶⁷ Rachel Rogers, *The Sea of the Universe: How Maritime Law's Limitation on Liability Gets It Right, and Why Space Law Should Follow by Example*, 26 IND. J. GLOB. LEGAL STUD. 741, 747 (2019).

⁶⁸ Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1363 U.N.T.S. 3, 18 I.L.M. 1434 [hereinafter Moon Treaty].

⁶⁹ *Id.*

⁷⁰ Zhao, *supra* note 14.

⁷¹ Moon Treaty art. VII.

describe outer space as a form of “environment” rather than simply a space or area of property.⁷²

F. Shortcomings of the Current Liability Regime

The existing international outer space liability regime contains three main categories of shortcomings that reflect the outdated nature of the treaties.⁷³ First and foremost, the current treaty regime does not provide a definition of “space debris,” nor does it account for the greater likelihood of space debris proliferation resulting from reduced barriers to entry in space exploration. This drawback is addressed in depth in Part IV, which highlights the fact that U.N. soft law instruments are currently the only sources of definitions of “space debris.” This lack of definition plays a role in several of the treaties, most notably raising the question of whether the Registration Convention’s requirements extend to non-functional pieces of orbital debris, given that the treaty’s text only specifies space objects.

Next, the liability regime only addresses issues arising from apportioning liability to states in the event of a space object-related collision. It fails to provide states with affirmative obligations to take proactive measures reducing the risk of collisions in the first place.⁷⁴ States currently have little to no guidance on what these proactive measures would look like, how much they should expect to budget for these measures, and what is within their jurisdiction to clean up.

Lastly, the current scheme does not provide any dispute resolution mechanisms for states to explore in the event a collision has already occurred. While the Liability Convention does define the level of liability attached to states in the event of a collision, it does not give states a clear mechanism for recouping the damages that result. The current scheme also fails to address environmental concerns about the proliferation of space debris—concerns related to apportioning costs arising from the deterioration of outer space as a global commons and as a future mining resource for spacefaring nations.

III. DEFINING “SPACE DEBRIS”

A direct result of more “outer space exploration and utilization” is an exponential increase in the amount of space debris created by satellite fragmentation events or pieces of satellites that are no longer functional, such as

⁷² *Id.*

⁷³ Most of these shortcomings stem from COPUOS’s lack of foresight regarding (1) the sheer increase in volume of space launches and (2) the advancement of space and satellite technology and how such advancement leads to more complex satellites.

⁷⁴ Note that reducing the likelihood of collisions between space objects also reduces the proliferation of space debris arising from such crashes.

mission-related objects and defunct satellites.⁷⁵ “The proliferation of space debris represents a hazard for human activities in outer space”—not to mention the hazard to people and infrastructure on Earth due to damage caused by reentering debris.⁷⁶

None of the five treaties governing the current regime of international space law provide a definition of “space debris.” Despite the operative language of the treaties being “space object[s],” legal scholars have often conflated the two terms when interpreting the 1972 Liability Convention.⁷⁷ The only sources of definitions of “space debris” come from soft law instruments, described below, rather than any legally binding treaties or resolutions for states. This ambiguity and lack of consensus contributes to the need for binding international law instruments to regulate the rising issue of proliferation of space debris because the current framework does not give states clear guidance as to what is considered “debris” for the purpose of allotting cleanup efforts and reducing debris proliferation in the first place.

The first international attempt to define the term “space debris” was attempted by the International Law Association’s Draft International Instrument on the Protection of the Environment from Damage Caused by Space Debris (hereinafter “ILA Conference Buenos Aires 1994”).⁷⁸ In this iteration, the Conference defined space debris as “manmade objects in outer space, other than active or otherwise useful satellites, when no change can reasonably be expected in these conditions in the foreseeable future.”⁷⁹

COPUOS’s Scientific and Technical Subcommittee took several years to produce a report on this issue.⁸⁰ The Technical Report on Space Debris served as the groundwork for discussion about and creation of future international legal instruments addressing space debris.⁸¹ In the Technical Report, the Subcommittee defined “space debris” as:

all man-made objects, including their fragments and parts, whether their owners can be identified or not, in Earth orbit or re-entering the dense

⁷⁵ Christos Kypraios & Elena Carpanelli, *Space Debris*, in MAX PLANCK ENCYCLOPEDIAS OF INTERNATIONAL LAW (2018).

⁷⁶ *Id.*

⁷⁷ See, e.g., Alexander P. Reinert, *Updating the Liability Regime in Outer Space: Why Spacefaring Companies Should Be Internationally Liable for Their Space Objects*, 62 WM. & MARY L. REV. 325, 335 (2020) (“For example, this strict liability would be invoked if debris from a space object were to fall to the earth and damage property in a foreign country.”).

⁷⁸ Maureen Williams, *The ILA Finalizes its International Instrument on Space Debris in Buenos Aires, August 1994*, 23 J. SPACE L. 47, 48 (1995).

⁷⁹ *Id.*

⁸⁰ Comm. on the Peaceful Uses of Outer Space, Technical Report on Space Debris, U.N. Doc. A/AC.105/720 (1999) [hereinafter Space Debris Technical Report].

⁸¹ Kypraios & Carpanelli, *supra* note 75.

layers of the atmosphere that are non-functional with no reasonable expectation of their being able to assume or resume their intended functions or any other functions for which they are or can be authorized.⁸²

In 2002, the Inter-Agency Space Debris Coordination Committee (IADC) prepared the IADC Space Debris Mitigation Guidelines to further develop some of the concepts contained in the Technical Report on Space Debris.⁸³ These guidelines included a definition of space debris that was an abbreviated version of the Technical Report's definition.⁸⁴ They defined "space debris" as "all man made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere."⁸⁵

After COPUOS made space debris an agenda item under the direction of the U.N. General Assembly and deliberated the issue over several years, COPUOS finally provided "nonbinding guidelines for mitigati[on] of man-made space debris" in 2007 to the U.N. General Assembly for eventual consideration as binding language to be adopted by states.⁸⁶ In the Report's annex, COPUOS noted that since the Technical Report on Space Debris was published, "it has been a common understanding that the current space debris environment poses a risk to spacecraft in Earth orbit."⁸⁷ Note that the definition of "space debris" in the 2007 Nonbinding Guidelines for Space Debris Mitigation is identical to the definition provided in the IADC Space Debris Mitigation Guidelines.⁸⁸

In late 2007, COPUOS provided the U.N. General Assembly with seven nonbinding guidelines to assist in the international effort in ensuring the mitigation of space debris.⁸⁹ In February 2008, the U.N. General Assembly

⁸² Space Debris Technical Report, *supra* note 80, ¶ 6.

⁸³ INTER-AGENCY SPACE DEBRIS COORDINATION COMM., SPACE DEBRIS MITIGATION GUIDELINES (2007), <https://perma.cc/3TES-MCRA>.

⁸⁴ *See id.*

⁸⁵ *Id.*

⁸⁶ Imburgia, *supra* note 61, at 623.

⁸⁷ Comm. on the Peaceful Uses of Outer Space, Rep. of the Scientific and Technical Subcommittee on Its Forty-Fourth Session, U.N. Doc. A/AC.105/890, at 42–46 (Mar. 6, 2007) (Annex IV).

⁸⁸ *Id.* (defining space debris as "all man-made objects, including fragments and elements thereof, in Earth orbit or reentering the atmosphere, that are non-functional.")

⁸⁹ The seven nonbinding guidelines include: (1) limit debris released during normal operations; (2) minimize the potential for break-ups during operational phases; (3) limit the probability of accidental collision in orbit; (4) avoid intentional destruction and other harmful activities; (5) minimize potential for post-mission break-ups resulting from stored energy; (6) limit the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission; and (7) limit the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission. Comm. on the Peaceful Uses of Outer Space, Rep. of the Comm. on Its Sixty-Second Session, U.N. Doc. A/62/20 (2007).

endorsed by resolution these seven measures.⁹⁰ Unfortunately, while this was a step in the right direction, the guidelines are nonbinding and thus do not ensure a mechanism for states to follow through with space debris mitigation commitments.⁹¹ While nonbinding guidelines could become binding customary international law “through repeated practice over time,”⁹² these guidelines fail to address the existing issue of the proliferation of space debris by focusing on mitigation rather than removal.

The current liability regime for damage caused by space debris is unclear. As mentioned in Part II, Article II of the 1972 Liability Convention, echoing Article VII of the Outer Space Treaty, provides that a launching state is absolutely liable to pay compensation for damage caused by its space *object* on the surface of the Earth or to aircraft in flight.⁹³ Article III’s fault-based liability framework reiterates that the provision applies to damage caused by “space objects.”⁹⁴ As discussed in Part IV.A, scholars have proposed expanding the definition of “space object” to include nonfunctional pieces of junk, that is, the space debris that breaks off from such objects. This scholarship further complicates attempts to define space debris because, while it may be feasible to track larger pieces of space debris, smaller pieces may be harder to link to their original space objects, so including those smaller pieces in the definition might create an unrealistic standard.

While the Liability Convention—and eventually the Registration Convention—define space object as the “component parts of a space object as well as its launch vehicle and parts thereof,”⁹⁵ it is unclear whether all space debris falls squarely within that definition because some debris may no longer be considered “part” of the space object if it serves no functional purpose. Furthermore, there are several possibilities for assessing fault that may lead to contradicting conclusions. On one hand, fault could be determined through a lack of compliance with the COPUOS space debris mitigation guidelines. On the other hand, the level of fault may be reduced if the issue was a lack of control in space debris proliferation during an active removal procedure.

⁹⁰ See G.A. Res. 62/217, U.N. Doc. A/RES/62/217 (Feb. 1, 2008).

⁹¹ Imburgia, *supra* note 61, at 623.

⁹² *Id.* at 625 (citing North Sea Continental Shelf (Ger. v. Den. & Neth.), Judgment, 1969 I.C.J. 3, 44 (Feb. 20) (noting that it did not become customary law through repeated practice over time in this case but was given as a possibility)).

⁹³ Liability Convention art. II.

⁹⁴ *Id.* art. III.

⁹⁵ *Id.* art. I.

IV. EXISTING SCHOLARLY PROPOSALS FOR IDENTIFIED SHORTCOMINGS

As the earlier Parts allude to, the current legal regime derived from the 1972 Liability Convention is ill-equipped to handle the complexities arising from the newly renewed space race among private individuals, the U.S., and China, as well as companies looking to exploit new sources of natural resources in celestial bodies.⁹⁶ These complexities are a result of the evolution of space technology as well as the sheer increase in volume of space satellite launches.

Consequently, the existing legal regime does not currently provide a cause of action or remedy for damage arising from space debris if the launching state or the governing body were to adopt a narrowly construed definition of “space object” within the meaning of the governing body of space treaty law. Furthermore, the 1972 Liability Convention has been repeatedly criticized for not providing a comprehensive forum for states to bring legal actions or resolve disputes regarding the adjudication of damages from space objects or orbital debris outside the confines of political influences.⁹⁷

A. Expanding the Definition of “Space Object”

Many legal scholars have argued that the current fault-based liability regime for damages resulting from orbital debris is inadequate to address, mitigate, and deter the existing threat of space debris.⁹⁸ For example, Michael Taylor proposes that the term “space object” should be clearly defined within the Liability Convention such that it applies to the issue of orbital debris.⁹⁹ He recommends that the U.N. use the current definition of “orbital debris”—in other words, all man-made and unidentifiable fragments in Earth’s orbit or atmosphere—in the soft law documents procured by the IADC and COPUOS as a starting point.¹⁰⁰

This proposal is a simple but effective first step to both reduce the proliferation of space debris and serve as an effective safeguard for parties resolving disputes arising from damages to space debris. Furthermore, the proposal is consistent with the development of space law and technology over time. While a narrowly construed definition of “space object” may have fit the parameters of the Legal Subcommittee’s priorities when enacting the Liability Convention, the Legal Subcommittee likely did not predict the massive issue of

⁹⁶ See Caley Albert, *Liability in International Law and the Ramifications on Commercial Space Launches and Space Tourism*, 36 LOY. L.A. INT’L & COMP. L. REV. 233, 233–34 (2014).

⁹⁷ For example, the U.N. played virtually no role in the management of the aftermath of the Kosmos crash, nor did it facilitate the negotiations that followed thereafter.

⁹⁸ Michael W. Taylor, *Trashing the Solar System One Planet at a Time: Earth’s Orbital Debris Problem*, 20 GEO. INT’L ENV’T L. REV. 1, 56–57 (2007).

⁹⁹ *Id.*

¹⁰⁰ *Id.*

space debris proliferation that arose as a result of the development of space technology.

This proposal's main drawback is its inability to reconcile with the current fault-based liability regime as applied to orbital debris collisions in space. While active space objects are currently tracked and monitored under the Registration Convention, tracking all pieces of space debris would be an enormous burden for states to take on in their data-sharing and monitoring platforms. An extension of this drawback is the U.N.'s practical inability to adequately assign fault arising from a broken or inactive piece of space debris that was once on a tagged and registered space object.

This drawback is likely irreconcilable with the problem this Comment seeks to resolve given the exceedingly unrealistic requirement that countries track millions of small fragments orbiting the Earth at high speeds, and, as such, this proposal insufficiently addresses and deters the existing threat of space debris. At the very least, this proposal cannot solve existing concerns about the current fault-based liability regime because it applies the same framework with the same drawbacks, albeit with a more tailored definition of "space object."

B. Market-Share Liability

Certain scholarship argues for a market-share liability system, where, in the issue of unidentified orbital debris, each party is held liable in proportion to its contribution to the overall debris problem.¹⁰¹ Market-share liability would, in practice, apportion a significant amount of responsibility to the states most likely to create space debris: the U.S., Russia, and China.¹⁰² Scholars argue that market-share liability will benefit the space industry, particularly by creating incentives for states to participate in both space debris mitigation and space debris remediation, as well as by "ultimately lowering the economic barrier to entering the space industry," because newer, more inexperienced spacefaring states will not face as high a financial burden associated with potential space debris collision risks.¹⁰³

While market-share liability solves the crucial problem of determining where liability falls between nations, the proposal comes with significant drawbacks that may make a market-share liability regime difficult to implement. First, while market-share liability payments can serve as a crucial response to the existing debris in the space commons, they cannot serve as a measure for reducing the creation of debris or sufficiently incentivizing the proactive removal

¹⁰¹ See, e.g., Mark J. Sundahl, *Unidentified Orbital Debris: The Case for a Market-Share Liability Regime*, 24 HASTINGS INT'L & COMP. L. REV. 125, 147 (2000).

¹⁰² See Sremeena Sethu & Mandavi Singh, *Stuck in Space: The Growing Problem of Space Debris Pollution*, 2 U.K. L. STUDENT REV. 96, 106 (2014).

¹⁰³ Sundahl, *supra* note 101, at 147.

of debris, because they only address concerns arising from costs of cleanup efforts in the event a debris-related collision has already occurred. In other words, market-share liability does not give states direct incentives or responsibilities to act with the intent not to create space debris. Rather, it arguably gives smaller states more leeway to create space debris, under the ill-founded reliance on the thought that larger states will pay for the damages.

Second, it may be difficult to properly determine the apportionment of market share amongst the spacefaring nations.¹⁰⁴ Should the apportionment of market share encompass states' private commercial spacefaring activities? Should the market-share liability framework provide mechanisms for states to recoup these costs from the private commercial actors? How often should the market-share liability apportionment be recalculated? Despite these difficult questions, market-share liability may serve as a useful tool for reshaping the existing liability regime so that cleanup costs and victim compensation can be properly accounted for and streamlined under an international framework.¹⁰⁵

C. Doctrine of Abandonment

The last main category of proposals addresses the regulation gap in what the U.N. considers "ownership" of space debris for the purposes of assessing liability and states' cleanup obligations. These proposals call for the application of the doctrine of abandonment from U.S. property law to post-mission satellites and their corresponding nonfunctional parts as a method of establishing ownership for the purposes of space debris cleanup measures.¹⁰⁶ While the abandonment doctrine has not been heavily litigated in or articulated by U.S. courts, judges have generally applied the following test: "For property to be considered abandoned, there must be 'a manifest act' of the owner showing intent 'to forsake his or her property.'"¹⁰⁷

Scholars have held the popular notion that chattel can be unilaterally abandoned and, in doing so, the chattel no longer has an owner and can be freely cleaned up by any party.¹⁰⁸ Applying the abandonment doctrine to orbital debris such that non-functional pieces of space debris are considered "abandoned" would encourage states to engaging in cleanup efforts because it

¹⁰⁴ See Sethu & Singh, *supra* note 102, at 107–08.

¹⁰⁵ See Chelsea Munoz-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, 255–57 (2018).

¹⁰⁶ See *id.*; see also Emily M. Nevala, *Waste in Space: Remediating Space Debris Through the Doctrine of Abandonment and the Law of Capture*, 66 AM. U.L. REV. 1495, 1520 (2017).

¹⁰⁷ *Friedman v. Farmer*, 788 F.3d 862, 868 (8th Cir. 2015) (citing *Schmidt v. Stearman*, 253 S.W.3d 35, 42 (Ark. Ct. App. 2007)).

¹⁰⁸ Munoz-Patchen, *supra* note 105, at 249.

would remove fears about engaging in potential geopolitical disputes over the property.¹⁰⁹

The main issue with applying the elements of the doctrine of abandonment to space debris specifically is the intent factor couched within the abandonment test.¹¹⁰ In most cases, when small pieces of space debris separate from satellites and other space objects, the owner is likely unaware of all the pieces their satellite has produced.¹¹¹ Therefore, the abandonment doctrine would apply less to situations involving microparticulate orbital debris, where it is difficult to establish ownership in the first place, and would apply more to situations involving larger pieces of debris.¹¹² The abandonment analysis may nonetheless serve as a useful tool for larger pieces of debris that are still tracked under the U.N. Space Objects Index.

The bigger concern with this approach, despite its ability to assign concrete ownership of unidentifiable orbital debris, is that it allows launching states to freely part with pieces of orbital debris if they merely show intention of abandonment. This arguably creates an incentive to launch satellites with measures suggesting intent to abandon, which could exacerbate the orbital debris problem. One way to mitigate this concern is to apply current limitations on the right to abandon. For example, in current U.S. jurisprudence, persons generally cannot abandon real property, and they also cannot abandon personal property on someone else's property without permission.¹¹³ Utilizing these constraints of the abandonment framework could help serve the doctrine's goal of better defining ownership of space debris without increasing the likelihood of incentivizing proliferation of debris.

V. APPLYING CUSTOMARY INTERNATIONAL LAW TO CREATE AFFIRMATIVE LEGAL OBLIGATIONS

Customary international law “refers to international obligations arising from established international practices.”¹¹⁴ Article 38(1)(b) of the Statute of the International Court of Justice list all of the relevant sources of international law that may be applied by the Court, and one such source is “international custom,

¹⁰⁹ *Id.*

¹¹⁰ Nevala, *supra* note 106, at 1529 (“Essential to the law of abandonment is an owner’s knowledge of the existence of the property.”).

¹¹¹ *Id.*

¹¹² *Id.* at 1527–28.

¹¹³ See generally Eduardo M. Penalver, *The Illusory Right to Abandon*, 109 MICH. L. REV. 191 (2010). The right to abandon, for both land and chattel, is largely perfunctory to the extent that the legal prohibition of abandoning land greatly qualifies the actual scope of a person’s right to abandon personal property.

¹¹⁴ *Customary International Law*, LEGAL INFO. INST., <https://perma.cc/LQK9-SKX9>.

as evidence of a general practice accepted as law.”¹¹⁵ The mainstream understanding of customary international law is informed by American Law Institute’s Restatement (Third) of Foreign Relations Law, and it is that customary rules must fulfill two elements: (1) state practice and (2) *opinio juris*, a sense of legal obligation.¹¹⁶

State practice requires both “evidence of frequent repetition of the specific international practice among the general community of states,” and that “those states that are particularly affected by the proposed norm.”¹¹⁷ There are several instruments of law that would fulfill the requirement of a custom serving as a “state practice,” such as bilateral treaties, unilateral treaties, national laws, and governmental statements of policy.¹¹⁸ It is not clear whether there is a required duration or a required level of expansion of the custom before it becomes considered a “state practice.”¹¹⁹ However, once a state practice has been established, it must “rigorously and consistently conform to the rule at issue,” and an inconsistent state practice will be considered a breach of the customary international law established, assuming there is *opinio juris* present.¹²⁰

Opinio juris requires that a state practice be derived from a legal—as opposed to political, moral, or economic—obligation.¹²¹ There are several forms of evidence that can be relevant to the factual inquiry of whether *opinio juris* exists:

diplomatic correspondence, government policy statements and press releases, opinions of official legal advisers, official manuals on legal questions, comments by governments on drafts produced by the International Law Commission, State legislation, international and national judicial decisions, legal briefs endorsed by the States, a pattern of treaties in the same form, resolutions and declarations by the United Nations.¹²²

¹¹⁵ Statute of the International Court of Justice art. 38(1)(b), June 26, 1945, 59 Stat. 1031, 33 U.N.T.S. 993.

¹¹⁶ Daniel M. Bodansky, *The Concept of Customary International Law*, 16 MICH. J. INT’L L. 667, 670 (1995); see also George Norman & Joel P. Trachtman, *The Customary International Law Game*, 99 AM. J. INT’L L. 541, 544 (2005).

¹¹⁷ Ajmel Quereshi, *The Search for an Environmental Filartiga: Trans-Boundary Harm and the Future of International Environmental Litigation*, 56 HOW. L.J. 131, 145 (2012) (quoting DAVID HUNTER ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 311–12 (2d ed. 1998)).

¹¹⁸ Andrew T. Guzman, *A Compliance-Based Theory of International Law*, 90 CALIF. L. REV. 1823, 1874 (2002) (citing ANTHONY D’AMATO, THE CONCEPT OF CUSTOM IN INTERNATIONAL LAW 6–10 (1971)).

¹¹⁹ *Id.*

¹²⁰ Quereshi, *supra* note 117, at 145.

¹²¹ DAVID HUNTER ET AL., INTERNATIONAL ENVIRONMENTAL LAW AND POLICY 312 (2d ed. 1998).

¹²² *Id.* (note that this list is non-exhaustive).

Other scholars argue that customary law is formed by “a continuous process of raising mutual claims and the adoption of an attitude to such claims by competent state organs.”¹²³

Yet other scholars, as well as outer space environmental preservationists, have suggested referring to customary international legal norms to strengthen the argument that spacefaring states have affirmative obligations to both reduce the amount of space debris they contribute and clean up the staggering amount of orbital debris accumulating in the space commons.¹²⁴ This concept is derived from the customary international law identified in international court cases that conclude that “states can be held responsible for pollution damage caused to other states.”¹²⁵ In the *Trail Smelter Case*, a seminal decision on global commons air pollution liability, a court of arbitration held that Canada was liable to the U.S. for pollution damages.¹²⁶ This holding defined the customary rule governing any pollution of the global commons.¹²⁷

Space debris likely falls within the purview of customary international law originally developed in the context of environmental law because space debris is treated by space preservationists as a form of outer space pollution.¹²⁸ As such, the removal and cleanup process of space debris, and by extension the liability for creating such pollution damage, may be dictated by customary international law norms addressing marine pollution, air pollution, and other types of pollution on Earth. In particular, three customary international law principles have become widely accepted in international legal jurisprudence regarding pollution that may provide a strong legal basis for spacefaring nations to remove space debris from the atmosphere: the polluter pays principle, the precautionary principle, and the prohibition against transboundary harm.¹²⁹

A. Polluter Pays Principle

The polluter pays principle is a longstanding normative doctrine of environmental law providing that nations engaging in polluting activities shall be

¹²³ Bodansky, *supra* note 116, at 671.

¹²⁴ See Paul B. Larsen, *Solving the Space Debris Crisis*, 83 J. AIR L. & COM. 475 (2018).

¹²⁵ *Id.* at 490.

¹²⁶ *Id.*

¹²⁷ Not all scholars agree that outer space territories (such as celestial bodies) are part of the “global commons” governed by the *Trail Smelter Case*’s holding. See generally Jennifer A. Purvis, *The Long Arm of the Law? Extraterritorial Application of U.S. Environmental Legislation to Human Activity in Outer Space*, 6 GEO. INT’L ENV’T. L. REV. 455 (1994).

¹²⁸ See Robert C. Bird, *Procedural Challenges to Environmental Regulation of Space Debris*, 40 AM. BUS. L.J. 635 (2003); see also Jared B. Taylor, *Tragedy of the Space Commons: A Market Mechanism Solution to the Space Debris Problem*, 50 COLUM. J. TRANSNAT’L L. 253 (2011).

¹²⁹ Larsen, *supra* note 124, at 490; see also *International Legal Research: International Environmental Law*, LOUIS L. BIRO L. LIBR., <https://perma.cc/N62Q-T9E7>.

held fully liable for the environmental costs of such activities.¹³⁰ The fundamental justification of the principle is that the party who creates the pollution ought to be the one to bear the brunt of the costs that result from the pollution, rather than the nation or the individuals that suffer from the environmental and economic costs as a result of the pollution.¹³¹

The polluter pays principle has appeared in various legal instruments concerning international environmental law, and has also informed domestic policies regarding environmental cleanup and sustainability efforts.¹³² It first appeared in a series of Guiding Principles published by the Organisation for Economic Co-operation and Development (OECD) for the purpose of establishing certain environmental control policies and measures for member countries to abide by and implement.¹³³

Most notably, the Rio Declaration on Environment and Development, which focuses on achieving worldwide “sustainable development,” codified the polluter pays principle.¹³⁴ Principle 16 of the Rio Declaration states that “[n]ational authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment.”¹³⁵ Including the polluter pays principle in the Rio Declaration signified a strong international sentiment that the principle clearly resonates with the fundamental purposes of environmental law and sustainability efforts.¹³⁶ The principle was also indirectly implemented in both the 2009 Copenhagen Accords and the 2016 Paris Agreement when signatories agreed to a carbon emissions taxation policy for the purpose of reducing air pollution in the ozone layer.¹³⁷

¹³⁰ Lin Feng & Jason Buhi, *The Copenhagen Accord and the Silent Incorporation of the Polluter Pays Principle in International Climate Law: An Analysis of Sino-American Diplomacy at Copenhagen and Beyond*, 18 *BUFF. ENV'T L.J.* 1, 12–13 (2011).

¹³¹ See Eric T. Larson, *Why Environmental Liability Regimes in the United States, the European Community, and Japan Have Grown Synonymous with the Polluter Pays Principle*, 38 *VAND. J. TRANSNAT'L L.* 541, 545 (2005).

¹³² See *id.* at 546.

¹³³ Organisation for Economic Co-operation and Development, *Recommendation of the Council on Guiding Principles Concerning International Economic Aspects of Environmental Policies*, OECD Doc. C(72)128 (May 25, 1972) [OECD Guiding Principles].

¹³⁴ U.N. Conference on Environment and Development, Rio Declaration on Environment and Development, U.N. Doc. A/CONF.151/26 (Vol. 1) (Aug. 12, 1992) [hereinafter Rio Declaration].

¹³⁵ *Id.* princ. 16.

¹³⁶ Larson, *supra* note 124, at 546.

¹³⁷ See Conference of the Parties, Copenhagen Accord, U.N. Doc. FCCC/CP/2009/L.7 (Dec. 18, 2009); Paris Agreement to the U.N. Framework Convention on Climate Change, Dec. 12, 2015, T.I.A.S. No. 16-1104.

While the outlines of the principle are fairly unclear in international jurisprudence, the modern (and prevailing) interpretation of the principle understands it to require polluters to bear the internalization of costs after achieving an “optimal level of pollution.”¹³⁸ Certain interpretations of the principle also require the polluter to invest in pollution prevention programs.¹³⁹

The polluter pays principle provides a strong legal basis for mandating active debris removal programs in outer space jurisprudence. Because space debris is considered pollution of outer space, the polluter pays principle may be triggered as a mechanism for ensuring that spacefaring nations are particularly careful when engaging in outer space pollution and launching space objects that may be more prone to breaking off into smaller, more dangerous and non-trackable pieces of debris.

The polluter pays principle provides a foundation for implementing a similar pollution-based tax that can be used to pay for spacefaring incidents that result in increased risk of space debris collisions and issues of liability. This idea of a “tax” on nations for participating in outer space exploration is further explored in Part VI in the form of a security deposit program. Furthermore, the principle triggers a strong affirmative responsibility for states to be held liable for space debris pollution, regardless of whether a collision has occurred. While the Liability Convention and the Outer Space Treaty address space object collisions,¹⁴⁰ because a collision is a rare phenomenon,¹⁴¹ holding states liable on the basis of simply creating the possibility of space debris would serve as a stronger incentive to reduce its proliferation.

A significant drawback to using the polluter pays principle as a stand-alone measure is its specific lack of foundation in outer space treaty language. Treaty language seldom refers to the problem of outer space “pollution.” Interestingly, however, the COPUOS Report that accompanied the drafting of the Outer Space Treaty “[u]rges that space activities be carried out in such a manner that States may share in the adventure and the practical benefits of space exploration, regardless of the stage of their economic or scientific development.”¹⁴² This language could implicate the polluter pays principle as a basis for preserving outer space as a common resource for all nations to utilize, and as such,

¹³⁸ Jonathan R. Nash, *Too Much Market? Conflict Between Tradable Pollution Allowances and the “Polluter Pays” Principle*, 24 HARV. ENV'T L. REV. 465, 475 (2000).

¹³⁹ See Robert V. Percival, *Liability for Environmental Harm and Emerging Global Environmental Law*, 25 MD. J. INT'L L. 37, 43 (2010).

¹⁴⁰ Liability Convention, *supra* note 37.

¹⁴¹ See Jonathan O'Callaghan, *What Is Space Junk and Why Is It a Problem?*, NAT. HIST. MUSEUM, <https://perma.cc/XVE2-T2K5>.

¹⁴² Comm. on the Peaceful Uses of Outer Space, Rep. of the Legal Subcomm. on Its Seventh Session, U.N. Doc. A/6042 (1965).

protecting against the pollution of such a resource to the point that triggers the Kessler Syndrome and renders outer space uninhabitable.

B. Precautionary Principle

While the polluter pays principle offers some preventative benefits, its strength lies in remedying past instances of pollution. By contrast, the precautionary principle—another customary international norm—uses a more forward-thinking framework to ensure that debris and other polluting agents do not accumulate in the first place.¹⁴³

Historically, international courts read the precautionary principle as “implying that precautions must be taken when a risk of environmental harm exists, even if conclusive scientific evidence is lacking.”¹⁴⁴ Simply put, the principle requires that, in cases where the risk of environmental harm exceeds a certain threshold requirement, a nation or an actor must respond and take preventative action or response even when the threat of such harm is uncertain.¹⁴⁵ The principle further purports that certain preventative measures are needed to protect the environment, even in the absence of a causal link coupled with scientific evidence.¹⁴⁶ The principle signifies the international community’s prioritization of protecting common resources and preventing pollution over state sovereignty.¹⁴⁷

The precautionary principle is articulated in several international instruments, which range from non-binding instruments such as reports to binding instruments like treaties. All of the formulations vaguely define the principle with different participants signing on to different versions of the principle.¹⁴⁸ The first major articulation of the precautionary principle was in the Ozone Layer Protocol of the Vienna Convention for the Protection of the Ozone Layer.¹⁴⁹ This articulation of the principle states that “parties to this

¹⁴³ See GLENN H. REYNOLDS & ROBERT P. MERGES, *OUTER SPACE: PROBLEMS OF LAW AND POLICY* 176 (1997).

¹⁴⁴ Daniel Kazhdan, *Precautionary Pulp: Pulp Mills and the Evolving Dispute Between International Tribunals over the Reach of the Precautionary Principle*, 38 *ECOLOGY L.Q.* 527, 528 (2011) (citing *Pulp Mills on the River Uruguay (Arg. v. Uru.)*, Judgment (Apr. 20, 2010)).

¹⁴⁵ *Id.* at 529.

¹⁴⁶ See generally James E. Hickey, Jr. & Vern R. Walker, *Refining the Precautionary Principle in International Environmental Law*, 14 *VA. ENV'T L.J.* 423 (1995) (proposing a framework to refine the scope of the precautionary principle’s application to be in a consistent and applicable way).

¹⁴⁷ *Id.* at 430–31.

¹⁴⁸ *Id.* at 432.

¹⁴⁹ Protocol on Substances that Deplete the Ozone Layer, Sept. 16, 1987, 1522 U.N.T.S. 29 [Montreal Protocol] (“Determined to protect the ozone layer by taking precautionary measures to control equitably total global emissions of substances that deplete it, with the ultimate objective of

protocol . . . [should be] taking precautionary measures to control equitably total global emissions of substances that deplete [the ozone layer].”¹⁵⁰

The U.N. Environment Programme (UNEP) made a more explicit reference to the precautionary principle in a 1989 Report “recommend[ing] that all Governments adopt the ‘principle of precautionary action’ as the basis of their policy with regard to the prevention and elimination of marine pollution.”¹⁵¹ Most notably, the precautionary principle appears in the Rio Declaration, a binding legal instrument for most of the states privy to outer space treaty law.¹⁵² The Rio Declaration sets forth that “in order to protect the environment, the precautionary approach shall be widely applied by States Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”¹⁵³

Because several environmental treaties characterize the pollution activities covered under the precautionary principle to be those that have “irreversible” effects¹⁵⁴, the principle squarely applies to the issue of space debris pollution. Hundreds of thousands of pieces float in outer space with no feasible way of tracking them, and Earth impacts from space debris are increasing.¹⁵⁵ While the definition of an “irreversible” effect is not clearly defined, it may refer to events or actions that cascade into future problems and risks for a long period of time thereafter. Under this definition, an example of an irreversible effect would be the dumping of oil into the ocean, causing long-lasting effects on marine life, drinking water, and sea levels for decades to come.

The precautionary principle, therefore, provides the second customary normative legal basis invoking an affirmative duty for states to be more forward-thinking in their creation of space debris. Because the precautionary principle has appeared in both binding and non-binding legal instruments dealing with strikingly similar premises (though in different settings), it may be implicitly read into the language found in the Liability Convention outlining causation. The Liability Convention assumes liability in the case of a collision between a space object and Earth, de-emphasizing the need for scientific evidence or establishing

their elimination on the basis of developments in scientific knowledge, taking into account technical and economic considerations.”).

¹⁵⁰ *Id.*

¹⁵¹ U.N. Environment Programme, Rep. of the Governing Council on the Work of Its Fifteenth Session, U.N. GAOR Supp. No. 25, U.N. Doc. A/44/25 (1989).

¹⁵² Rio Declaration, *supra* note 134.

¹⁵³ *Id.* at 879.

¹⁵⁴ *Id.*

¹⁵⁵ See Antonia Noori Farzan, *From a Texas Dental Office to the Canadian Tundra, Here's Where Space Debris Has Crashed to Earth*, WASH. POST (May 8, 2021), <https://perma.cc/S877-99LR>.

causation.¹⁵⁶ This logic is similar to the crux of the precautionary principle, establishing some level of per se responsibility on behalf of parties engaging in the harmful activities, and a duty for those parties to prevent harm to the extent required.

The precautionary principle is a more practical fit with how space operations function and what actually contributes to the proliferation of space debris.¹⁵⁷ To the extent that states can predict which of their actions create more debris, they can adjust the way they plan and execute space launches to mitigate the risk of debris creation. For example, if a satellite is launched into space for a specific purpose and is no longer needed in outer space once its duties are performed, states may be more incentivized to return the defunct satellite to Earth in order to comply with international legal norms.

Two questions remain unresolved when considering how to apply the precautionary principle to new forms of pollution that garner the attention of the international community. The first is what constitutes “serious or irreversible damage”—that is, how much pollution is necessary for the precautionary principle to be triggered as an obligation for a state. The second question to consider is what exactly the “precautionary approach” consists of, given the growing scientific evidence showing space debris as a significant pollution issue.¹⁵⁸ Thus, “it is unclear whether precaution is a recommendation, an obligation, or some intermediate duty.”¹⁵⁹

C. Prohibition Against Transboundary Harm

While both the polluter pays principle and the precautionary principle focus on the duty states owe to the general commons and shared resources, the prohibition against transboundary harm focuses on the duty states owe to each other. Liability for transboundary harm is one of the oldest international customary legal principles invoked in cases of interstate disputes arising from damages caused by another nation.¹⁶⁰

The prohibition against transboundary harm was initially defined in the *Trail Smelter Arbitration* cases in 1938 and 1941, which also helped shape the

¹⁵⁶ See Liability Convention, *supra* note 37.

¹⁵⁷ See generally Sandeepa Bhat, *Application of Environmental Law Principles for the Protection of the Outer Space Environment: A Feasibility Study*, 39 ANNALS AIR & SPACE L. 323 (2014) (analyzing various customary law principles that are commonly studied with respect to environmental law, and its relative strength in being applied to issues of outer space law).

¹⁵⁸ Hickey, *supra* note 146, at 437.

¹⁵⁹ *Id.*

¹⁶⁰ A.E. Boyle, *Globalising Environmental Liability: The Interplay of National and International Law*, 17 J. ENV'T L. 3, 3 (2005).

polluter pays principle's role in international environmental jurisprudence.¹⁶¹ In the *Trail Smelter Arbitration* cases, the arbitrators considered a dispute between the U.S. and Canada over air pollution that originated in Trail, British Columbia and resulted in farmland damage in both Canada and Northwestern U.S., mainly Washington State.¹⁶² Originally, the Washington farmers sought remedies from the company operating the smelter, but when that was unsuccessful, the U.S. brought diplomatic causes of action against Canada.¹⁶³

The case was tried before the International Joint Commission (IJC), which eventually recommended an award of damages amounting to 350,000 USD for the farmers. The U.S. was unsatisfied with this amount.¹⁶⁴ The two countries agreed to go to arbitration, and the arbitration tribunal subsequently considered, among other issues, (1) to what extent the Trail smelter had caused transboundary damage, and (2) what compensation, beyond the amount of 350,000 USD must be paid to the farmers.¹⁶⁵ Ultimately, the tribunal held that

no State has the right to use or permit the use of its territory in such a manner as to cause injury by fumes in or to the territory of another or the properties or persons therein, when the case is of serious consequence and the injury is established by clear and convincing evidence.¹⁶⁶

This passage ultimately became known as the “no harm rule” that evolved into the customary international law principle of the prohibition against transboundary harm, and it serves as a strong basis for constituting general obligations between states towards each other.¹⁶⁷

The prohibition against transboundary harm, also referred to as *sic utere tuo ut alienum non laedas*, prohibits nations from using their property to harm another nation's property or persons.¹⁶⁸ The prohibition has been repeatedly emphasized in various international legal instruments, both binding and non-binding. Principle 2 of the Rio Declaration provides that all signatory states have “the responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other states or areas beyond the limits of national jurisdiction.”¹⁶⁹ Underpinning the policy behind the prohibition against

¹⁶¹ *Id.*

¹⁶² *Trail Smelter Arbitration*, (U.S. v. Can.), Arbitral Trib., 3 U.N. Rep. Int'l Arb. Awards 1911 (1941) [hereinafter *Trail Smelter Arbitration*].

¹⁶³ Jutta Brunnee, *Transboundary Harm in International Law: Lessons from the Trail Smelter Arbitration*, 102 AM. J. INT'L L. 395, 395 (2008).

¹⁶⁴ *Id.*

¹⁶⁵ *Trail Smelter Arbitration*, *supra* note 162, at 1911.

¹⁶⁶ *Id.* at 1965.

¹⁶⁷ Brunnee, *supra* note 163, at 395.

¹⁶⁸ Boyle, *supra* note 160.

¹⁶⁹ Rio Declaration, *supra* note 134, princ. 2.

transboundary harm is the idea that states are generally unrestricted in the way they use natural resources within their jurisdictions so long “as they do not interfere with the interests of other states enjoying the same right.”¹⁷⁰

There are strong indications of the presence of the prohibition against transboundary harm in the outer space liability treaty regime. For example, in the Liability Convention, the argument has been made that “states were already prepared to accept liability for transboundary environmental harm in specific areas,” and consequently the Convention adopted mechanisms of reparation that states owe each other in the case of damages.¹⁷¹ Because the Liability Convention makes space objects the responsibility of the “Launching State,” there exists a framework for mitigating (and avoiding altogether) the possibility of transboundary harm, and providing avenues of recourse in the event that transboundary harm occurs.

In the International Law Commission’s Report detailing the draft articles on the Prevention of Transboundary Harm from Hazardous Activities, the preamble notes that “the freedom of States to carry on or permit activities in their territory or otherwise under their jurisdiction or control is *not unlimited*.”¹⁷² To the extent that states create space debris from the space objects they launch, this creates a risk of causing transboundary harm, first, to space objects under the jurisdiction of other states, and second, to the actual physical jurisdiction of the state itself in the scenario in which the space debris reenters Earth’s atmosphere. Thus, minimizing the creation of space debris best fulfills the state’s implicit duty, arising from the language of the Liability Convention, to prevent the risk of creating transboundary harm to other states.

The most compelling adoption of the prohibition against transboundary harm in international outer space liability jurisprudence is in the U.N. General Assembly’s Declaration of Legal Principles Governing the Activities of the States in the Exploration and Use of Outer Space.¹⁷³ In this Resolution, the General Assembly declared that the exploration and use of outer space would be guided by several principles, with Principle 6 strongly reflecting a duty of non-transboundary harm:

In the exploration and use of outer space, States shall be guided by the principle of co-operation and mutual assistance and shall conduct all their activities in outer space with due regard for the corresponding interests of other States. If a State has reason to believe that an outer space activity or experiment planned by it or its nationals would cause potentially harmful

¹⁷⁰ Thomas Gehring & Markus Jachtenfuchs, *Liability for Transboundary Environmental Damage Towards a General Liability Regime?*, 4 EJIL 92, 92 (1993).

¹⁷¹ *Id.* at 102.

¹⁷² Int’l Law Comm’n, Rep. on the Work of Its Fifty-Third Session, U.N. Doc. A/56/10, at 371 (2001) (emphasis added).

¹⁷³ G.A. Res. 18/1962 (Dec. 13, 1963).

interference with activities of other States in the peaceful exploration and use of outer space, it shall undertake appropriate international consultations before proceeding with any such activity or experiment. A State which has reason to believe that an outer space activity or experiment planned by another State would cause potentially harmful interference with activities in the peaceful exploration and use of outer space may request consultation concerning the activity or experiment.¹⁷⁴

Most notably, Principle 6 provides a state with an affirmative obligation to inform other states if any of its activities give rise to concern to the other state's property or activities during the course of their space exploration. This Principle gives states a basis for arguing that a launching state owes a certain standard of care in providing notice, mitigating harm, and ensuring that outer space remains free for exploration.

The prohibition against transboundary harm is a forward-thinking approach establishing responsibilities that states owe to each other. The prohibition does not and cannot expect states to completely avoid collisions caused by space debris; to the extent that debris pieces are difficult to track, this would present an undue burden, particularly for the nations that are responsible for the bulk of space debris production (the U.S., China, and Russia). Rather, the prohibition is better suited to be used—in conjunction with the polluter pays principle and the precautionary principle—to provide a strong legal framework for states to participate in active debris removal, implement stricter safety standards regarding the satellites and space objects they launch, and perform stronger tracking measures to trace large floating pieces.

VI. SECURITY DEPOSIT FOR SPACEFARING ACTIVITIES

While the three customary international law principles discussed above provide a good theoretical basis for imposing obligations on spacefaring nations, there is still the issue of what actual compliance with these principles would look like. Several enforcement proposals address implementing measures of active debris removal (ADR) and executing stricter requirements for tracking pieces of space debris.¹⁷⁵

This Part argues for the novel solution of establishing a system of refundable security deposits. Under this system, any time a state wishes to engage in spacefaring activity, it must first make a deposit with the U.N.—in other words, the security deposit serves as a *de facto* permit to participate in a specified spacefaring activity. The deposit would be used to pay damages for harms caused by the depositing state.

¹⁷⁴ *Id.* princ. 6.

¹⁷⁵ See, e.g., Melissa K. Force, *Active Space Debris Removal: When Consent is Not an Option*, 29 AIR & SPACE L. 9 (2016).

This proposal serves three distinct purposes. First, it serves as a depository for victim states¹⁷⁶ to collect damages resulting from debris-related incidents. Second, it provides a strong incentive for nations to manage risks related to the proliferation of space debris upfront rather than litigating post hoc disputes regarding debris-related collisions that have already occurred. And third, it creates a tangible form of state accountability and transparency in the international governance of outer space law.

The system works as follows: Suppose State A wants to launch a satellite into space in 2018. Under the security deposit system, State A would need to buy a permit through the relevant U.N. governing body, as an impartial third party, to perform this launch. Once State A performs the launch, the money collected through the various permits would serve as a depository for victim states to collect damages that result to their citizens or property. So, if State A's satellite proliferates pieces of space debris that then collide with State B's satellite, State B can recover the appropriate amount of damages directly from the U.N. governing body.

If State B considers this amount insufficient, State B can then choose to litigate or engage in diplomatic discussions with State B for the possible recovery of more damages, similar to the case of Kosmos 954. If it is unclear whether the piece of debris that collided with State B's satellite is from State A, State B can nevertheless recover the requisite amount of damages from the depository. The only distinction here is that State B would no longer have the ability to litigate further with the owner of the colliding debris.

Assuming State A's satellite launch is successful and does not result in any collisions with other satellites, the U.N. governing body may refund State A its deposit upon the successful completion of the satellite's mission. This can be accomplished in several ways. First, and most obvious, the launch may be considered complete when State A ensures the successful return of the satellite into Earth's atmosphere. State A would need to demonstrate either that all its rocket parts are intact or that it has engaged in cleanup efforts to gather any parts that have gone astray. Second, State A may partially recover its deposit if it demonstrates that the satellite will passively continue to orbit with no significant risks of detaching debris. Lastly, State A may recover its entire deposit if it shows that the satellite has landed on a celestial body as planned without debris breakage.

¹⁷⁶ Under the current liability regime, victim states litigate on behalf of their citizens for any recovery of damages for harms caused to their citizens or their property. Similarly, this proposal would extend this framework of victim states representing their private citizens both in the process of purchasing permits for private and commercial space launches, and for potential recovery of damages caused to a private company's satellites.

There are two options to consider for pricing the actual cost of the security deposit. The first option is a flat fee approach, where every launching state pays a uniform amount to receive clearance to launch a satellite or spacecraft. A flat fee approach would heighten the barriers to entry, as discussed below, because smaller and newer spacefaring nations would have much greater difficulty in fulfilling the cost of paying the deposit. The second option combines the market-share liability approach (discussed in Part IV.B) by pricing the cost of the deposit relative to the launching state's level of spacefaring activity. Under the second option, states like the U.S. and China, who have considerably more GDP devoted to spacefaring efforts, would pay a higher fee per launch compared to smaller nations. This option provides more leeway for smaller states to possibly enter into the space race by potentially lowering their deposit cost and reduce the barriers to entry involved in space exploration that may result from the deposit-refund approach.

This deposit-refund proposal is modeled after two successful examples of deposit-refund systems in response to pollution. The first example is in the implementation and enforcement of "bottle bills." A bottle bill is a container deposit law that requires a minimum refundable deposit on beverage containers as a way of incentivizing a high rate of reusing and recycling such bottles.¹⁷⁷ Bottle bills have been used as a tool in several U.S. states and in all Canadian provinces to reduce the amount of solid waste that goes into landfills along with the overall amount of beverage container litter.¹⁷⁸ In 2018, the U.K. announced its own version of a bottle bill after rising concerns with marine pollution.¹⁷⁹

Bottle bills have been successful in all the U.S. states in which they have been implemented. Shortly after the enactment of most bottle bills in the late 1990s and early 2000s, the data reflected a significant increase in recycling rates for aluminum in enacting states compared to the national average recycling rate.¹⁸⁰ A bottle bill reflects the justifications for the polluter pays principle: plastic bottle consumers should internalize the costs of the pollution they create. The security deposit proposal similarly reflects the polluter pays principle by forcing launching states to account for the relatively steep cost of buying a launch permit during their space exploration planning.

Bottle bills also reflect the forward-thinking nature of the precautionary principle by forcing polluters to manage the risk of creating this negative

¹⁷⁷ For more background, see *Bottle Bill Resource Guide: What is a Bottle Bill?*, CONTAINER RECYCLING INST., <https://perma.cc/6T3B-L23F>.

¹⁷⁸ *Id.*

¹⁷⁹ *United Kingdom*, CONTAINER RECYCLING INST., <https://perma.cc/SR4B-K8JX>.

¹⁸⁰ Brett Godush, *The Hidden Value of a Dime: How a Federal Bottle Bill Can Benefit the Country*, 25 VT. L. REV. 855, 856 (2001) ("Recycling rates for aluminum in states already with bottle bills have reached 80% as compared to a national average in 1998 of only 55%.").

externality upfront and reducing the very risk of creating the pollution, rather than simply causing the pollution and paying for it afterwards. The security deposit proposal similarly reflects the precautionary principle in requiring launching states to demonstrate cleanup efforts and tracing methods to establish that they have picked up all the satellite's parts to the extent they are trackable. This is the key benefit to the deposit-refund proposal with respect to space debris: it emphasizes the importance of preventative measures to reduce the risk of orbital debris proliferation, rather than the traditional focus of ensuring proper cleanup efforts.

The second example focuses on the U.N.'s ability to require permits for a state's extraterritorial activity. In the London Convention of 1972,¹⁸¹ the contracting parties recognized that they have a "responsibility to ensure that activities within their jurisdiction or control do not cause damage to the environment of other States or of areas beyond the limits of national jurisdiction."¹⁸² The London Convention provides that the dumping of waste or other matter requires either a special or general permit, depending on the type of matter being dumped.¹⁸³ In this context, "dumping" mainly refers to a "deliberate disposal."¹⁸⁴ As such, this example would only be analogous to spacefaring states leaving defunct satellites in space after they serve their intended purpose.

Both these examples point to a legal precedent of states implementing proactive measures through the collection of deposits or the issuance of permits to reduce pollution levels. A similar enactment of a deposit system would work to reduce the level of space debris pollution in outer space. The enactment falls squarely within the jurisprudence of the three customary international law principles—the precautionary principle, the polluter pays principle, and the prohibition against transboundary harm—with which all nations are obligated to comply.

The major critique of a deposit system is the creation of barriers to entry for space exploration, particularly for smaller countries that already struggle with the extremely high cost of building and launching space objects. There is a significant likelihood that because smaller and newer states have less resources devoted to space exploration compared to other national priorities, the deposit system may exacerbate the issue. This Comment's deposit-refund solution could work around this new barrier to entry by proposing mechanisms for either issuing more national debt, borrowing money against the cost of purchasing

¹⁸¹ Note that this was the same year that the Liability Convention was passed.

¹⁸² Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters, Dec. 29, 1972, 26 U.S.T. 2403, T.I.A.S. No. 8165 [London Convention].

¹⁸³ *Id.* art. IV.

¹⁸⁴ *Id.* art. III.

permits or utilizing insurance companies to help bridge the gap in cost, provided that a country can establish that the risk of leaving orbital debris in space is low. States already use insurance companies to insure spacecraft from damage caused by collisions with space debris, and insurance is often leveraged in these circumstances due to its ability to protect against low possibilities of very expensive costs for damage.¹⁸⁵ States may also couch the cost of the deposit within either its income tax or, if alternatively the state wants to target only the space industry, then the deposit cost be couched within a private space entity's output tax rather than within the general income tax.¹⁸⁶

Furthermore, states may find an international adoption of a deposit-system to be overbearing and outside the U.N.'s jurisdiction. Rather, states may want to develop their own individual policies regarding their "space object bills" that better suit the individual state's economic status, its contribution to space debris pollution, and its political circumstances, similarly to how bottle bills are currently legislated on a state-by-state basis. The deposit-refund solution can similarly address this concern by deferring to states on the means by which they fundraise to pay for the refundable deposit. In addition, the U.N. may encourage states to develop diplomatic relations with respect to space exploration so that states may share the burden of participating in the deposit-refund program. Lastly, this solution retains the ability of individual states to self-regulate private space actors within their jurisdiction, ultimately giving states the lion's share of control over the state's contribution to space debris pollution.

However, overarching international treaty language reflecting such a requirement would codify the three customary legal principles and their corresponding obligations. In the bottle bill context, the U.S. Congress is now considering a federal bottle bill to replicate the success of U.S. states in reducing litter.¹⁸⁷ An international security deposit system accounts for damages in liability better than the market-share proposal because it ties the deposit to each individual nation's space activity, rather than looking at the general market share of space exploration to determine a nation's buy-in. In a depository system, a state would pay exactly the amount in deposits that it contributes in space objects. Thus, a treaty implementing this system would adequately reduce the risk of space debris proliferation and promptly resolve disputes.

¹⁸⁵ See Alexander W. Salter, *Space Debris: A Law and Economics Analysis of the Orbital Commons*, 19 STAN. TECH. L. REV. 221, 230 (2016) ("Market premiums for insurance against space risk totaled \$800 million in 2011, while losses arising from damage totaled at \$600 million.").

¹⁸⁶ See generally Don Fullerton & Ann Wolverton, *Two Generalizations of a Deposit-Refund System* (Nat'l Bureau of Econ. Rsch., Working Paper No. 7505, 2000).

¹⁸⁷ See Godush, *supra* note 180.

VII. CONCLUSION

Space debris, and the possibility of the Kessler Syndrome, pose an existential threat to the future of space exploration. Existing proposals focus on market solutions and privatized avenues for resolving post hoc issues of liability arising from space debris collisions. This Comment has demonstrated that certain customary international law doctrines, specifically the polluter pays principle, the precautionary principle, and the prohibition against transboundary harm, form the legal basis for an affirmative duty of spacefaring nations to engage in removal efforts of space debris. This duty goes beyond the responsibilities states have under the nonbinding COPUOS Space Debris Mitigation Guidelines.

This Comment has also recommended an effective mechanism by which states can fulfill their legal obligations, arguing that a security deposit system is the proper way to create an upfront incentive for nations to manage the risks accompanying their outer space activities. Such a system is consistent with international law efforts to clean up marine debris, an issue that has many conceptual similarities to the one examined here.

Overall, this Comment has provided several pathways for international organizations to place obligations on states engaged in space exploration to ensure that such exploration is done in a manner sensitive to the crisis of space debris. Creating both a preemptive obligation—via the security deposit—to reduce the risk of increasing space debris, and a post-launch obligation—via rules of customary international law—to clean up existing space debris, will help address the pollution of outer space. Future scholarship on this issue is needed to further explore connections between outer space law and other deposit-refund models that aim preserve common resources.