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Regulating the Space Commons: Treating Space Debris as Abandoned Property in Violation of the Outer Space Treaty

Chelsea Muñoz-Patchen*

Abstract

Spacefaring nations face a growing problem of space debris, from tiny flecks of paint to nonfunctional satellites, littering Earth's orbit. Without action, this debris could lead to a cascade called the Kessler Syndrome, which would destroy existing objects in orbit and make space inaccessible. At present, no nation or company has begun cleaning the debris, and whether the law requires, or even allows, such a cleanup, is not settled in the literature. This Comment argues that the solution to this problem requires calling upon spacefaring nations to comply with the existing requirements of the space treaty regime, particularly the first principles of the Outer Space Treaty, to preserve the free use of space for all. In order to solve this tragedy of the commons, this Comment recommends regulating the use of this common resource. This Comment argues that space debris is abandoned property by combining the current definition of space debris and the doctrine of abandonment. Finally, the Comment proposes creating a market-share liability regulatory regime requiring abandoners to fund debris cleanup.

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I. INTRODUCTION

The U.S. and the Soviet Union are responsible for the initiation of the current treaty governing outer space activities, which entered into force in 1967.¹ The landscape of outer space activity has changed dramatically since then, both in the number of players in space and in the amount of activity.² One of the greatest threats to the ongoing use of outer space is space debris, a problem that many scholars believe has no solution under the current treaty regime.³ The most frequently cited issues are the absence of a binding definition of space debris,⁴ the impediment to clean up created by the current property and liability regime,⁵ and the nonbinding nature of the current debris mitigation guidelines.⁶

Consequently, many academics have called for a new treaty sensitive to the current state of space activity and the debris problem, or for serious modifications to the current regime.⁷ A new treaty would be useful, but this Comment suggests that space law as currently embodied in treaties, resolutions, and guidelines can be mobilized to address the problem of space debris cleanup.

This Comment argues that space debris is abandoned property that creates a negative externality in the common-pool resource of space. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (Outer Space

¹ G.A. Res. 2222 (XXI), Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Dec. 19, 1966) [hereinafter *Outer Space Treaty*]; Encyclopedia Britannica, *Outer Space Treaty*, <https://www.britannica.com/event/Outer-Space-Treaty> (last visited Feb. 3, 2018).

² Brian Beck, *The Next, Small Step for Mankind: Fixing the Inadequacies of the International Space Law Treaty Regime to Accommodate the Modern Space Flight Industry*, 19 ALB. L. J. SCI. & TECH. 1 (2009).

³ Joseph S. Imburgia, *Space Debris and Its Threat to National Security: A Proposal for a Binding International Agreement to Clean Up the Junk*, 44 VAND. J. TRANSNAT'L L. 589, 634 (2011); Agatha Akers, *To Infinity and Beyond: Orbital Space Debris and How to Clean It Up*, 33 U. LA VERNE L. REV. 285, 287 (2012); Gabrielle Hollingsworth, *Space Junk: Why the United Nations Must Step in to Save Access to Space*, SANTA CLARA L. REV. 239, 266 (2013); Gunnar Leinberg, *Orbital Space Debris*, 4 J.L. & TECH. 93, 100, 115–16 (1989); Lawrence D. Roberts, *Addressing the Problem of Orbital Space Debris: Combining International Regulatory and Liability Regimes*, 15 B.C. INT'L & COMP. L. REV. 51, 73 (1992).

⁴ See Imburgia, *supra* note 3, 593, 613 (2011); Marc G. Carns, *Consent Not Required: Making the Case that Consent is Not Required under Customary International Law for Removal of Outer Space Debris Smaller than 10CM*, 77 A.F. L. REV. 173, 186 (2017); Akers, *supra* note 3, at 287; Hollingsworth, *supra* note 3, at 255–56; Leinberg, *supra* note 3, at 100 (1989).

⁵ See Carns, *supra* note 4, at 190–91; Sremeena Sethu & Mandavi Singh, *Stuck in Space: The Growing Problem of Space Debris Pollution*, 2 U.K. L. STUDENT REV. 96, 98–99 (2014); Hollingsworth, *supra* note 3, at 256–57.

⁶ See Akers, *supra* note 3, at 303; Imburgia, *supra* note 3, at 616, 627.

⁷ See Akers, *supra* note 3; Imburgia, *supra* note 4, at 593.

Treaty),⁸ establishes that all nations must be able to freely access space. This language creates a commons in space, leading to a tragedy of the commons, while also making it possible to regulate spacefaring nations whose actions have restricted access to space and violated the Outer Space Treaty. This Comment argues that under the Outer Space Treaty, the U.N. can administer a market-share liability regime in which spacefaring nations must pay for space debris cleanup based on the percentage of debris for which they are responsible.

This Comment first discusses the current state of the space debris problem in Section II. It then examines the legal obstacles to the creation of an obligation to clean up space debris in Section III. In Section IV, this Comment clarifies the definition of space debris and determines that space debris is abandoned property. Section V examines the obligation of countries to clean up debris based on existing law, and suggests that existing law allows for the creation of a market-share liability regime to fund the cleanup of space debris.

II. BACKGROUND

As of January 2017, the U.S. Space Surveillance Network has been tracking about 23,000 pieces of space debris that measure over ten centimeters wide.⁹ The European Space Agency's statistical models estimate there may actually be 29,000 pieces over ten centimeters, 750,000 from one to ten centimeters, and 166 million from one millimeter to one centimeter in orbit.¹⁰ If even a small piece of debris between one and ten centimeters in diameter collides with a functioning space object, the object is likely to be severely damaged or completely destroyed due to the high orbital velocity of the debris.¹¹ Space agencies are only capable of detecting debris five to ten centimeters or larger in a low altitude orbit and three tenths of a meter to one meter in diameter in higher altitude orbits.¹² This Section provides background on what space debris is, explains why it poses such a threat to space activity, and discusses some existing proposals to deal with it.

⁸ See Outer Space Treaty, *supra* note 1.

⁹ European Space Agency, *Space Debris by the Numbers* (Jan. 2017), <https://perma.cc/X5ND-XC9R>.

¹⁰ *Id.*

¹¹ Joseph Kurt, *Triumph of the Space Commons: Addressing the Impending Space Debris Crisis Without an International Treaty*, 40 WM. & MARY ENVTL. L. & POL'Y REV. 305, 307 (2015).

¹² European Space Agency, *Frequently Asked Questions*, <https://perma.cc/97U2-BQD7> (last visited Apr. 27, 2018).

A. What is Space Debris?

Space debris can be categorized by how it is created. About twenty percent of trackable debris is “inactive payloads,” primarily consisting of inactive satellites that are no longer controllable.¹³ About twenty-six percent of trackable debris is “operational debris,” which includes intact objects launched with a prior space mission such as “fuel tanks, insulation panels, sewage, rocket bodies, bolts and straps.”¹⁴ Microparticulate matter cannot be tracked because it is so small, but it is the most common debris type and consists of propellant particles, gases, paint flecks, and rocket fuel.¹⁵ Space agencies and companies create these debris types by leaving launch vehicles or old satellites in orbit and building spacecraft with parts that may fly off; debris can also be created when astronauts drop items while on space walks.¹⁶ As space becomes more crowded, collisions between existing objects will likely produce new debris fragments.¹⁷

At forty-nine percent of trackable debris, “fragmentation debris,” consisting of small pieces of matter from collisions between space objects or accidental explosions, is the largest source of trackable debris.¹⁸ Some of this debris was created by the intentional destruction of space objects. For example, in 2007 China intentionally destroyed one of its weather satellites to test an anti-satellite missile, producing approximately 2,500 pieces of trackable debris, as well as many more small and untrackable pieces.¹⁹ Some of this debris can also be linked to the accidental break-up of space objects. In 2009, for example, a defunct Russian satellite crashed into a functioning private American communications satellite creating more than 2,000 pieces of orbital debris.²⁰ These two recent incidents alone account for a third of all the debris in Earth’s orbit.²¹

¹³ See Hollingsworth, *supra* note 3, at 242.

¹⁴ *Id.*

¹⁵ *Id.* at 242–43.

¹⁶ Rep. of the Comm. on the Peaceful Uses of Outer Space to the General Assembly (UNCOPUOS), U.N. GAOR 62nd Sess., Supp. No. 20, Annex (June 15, 2007) [hereinafter Debris Mitigation Guidelines].

¹⁷ Marlon Sorge & Glenn Peterson, *How to Clean Space: Disposal and Active Debris Removal*, CROSSLINK (Dec. 10, 2015), <https://perma.cc/T3SA-CMEX>.

¹⁸ See Hollingsworth, *supra* note 3, at 242.

¹⁹ Emily M. Nevala, *Waste in Space: Remediating Space Through the Doctrine of Abandonment and the Law of Capture*, 66 AM. U. L. REV. 1495, 1497 (2017); Imburgia, *supra* note 3, at 593.

²⁰ See Nevala, *supra* note 19, at 1498.

²¹ See Kurt, *supra* note 11, at 309.

B. Definitions of Space Debris

In the Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space (the Guidelines), “space debris” is defined as “all man-made objects, including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional.”²² While the Scientific and Technical Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) only generated this definition for use in a nonbinding document, most nations have adopted the definition of space debris from the guidelines in their domestic law.²³ This definition thus reflects the most current accepted definition of space debris internationally.

Additional support for this definition can be found in the adoption of similar definitions by other organizations and agencies. The Space Debris Mitigation Guidelines of the Inter-Agency Space Debris Coordination Committee (IADC) define space debris as “all man made [sic] objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere that are non functional.”²⁴ The definition of space debris included in this document has been adopted by NASA, which defines orbital debris as “[a]rtificial objects, including derelict spacecraft and spent launch vehicle orbital stages, left in orbit which no longer serve a useful purpose.”²⁵ The International Academy on Aeronautics (IAA) similarly considers space debris to be a non-functional artificial object.²⁶ The International Law Association (ILA) also submitted a formal submission to UNCOPUOS in 1994, suggesting space debris be defined as “man-made 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.”²⁷ While this submission was not adopted by the UNCOPUOS, it does suggest that a sizeable group thought this was the proper definition and regime.

The definition of debris as non-functional man-made objects is useful to handle the threat posed by both fully intact large space objects and small pieces of debris. As scholars suggest, “[t]he function test could prove to be the optimal

²² See Debris Mitigation Guidelines, *supra* note 16, at 47.

²³ See Carns, *supra* note 5, at 189.

²⁴ Inter-Agency Space Debris Coordination Comm., IADC Space Debris Mitigation Guidelines art. 3.1 (2007), <https://perma.cc/YL99-BZSV> (last visited Mar. 2, 2018).

²⁵ NASA Handbook For Limiting Orbital Debris, 8719.14 21 (2008), <https://perma.cc/5U5S-WN5B> (last visited Mar. 2, 2018). [hereinafter NASA Handbook].

²⁶ See Sethu & Singh, *supra* note 5, at 98 (citing D. McKnight, W. Flury, & H. Sax, *IAA Position Paper on Orbital Debris*, 31 ACTA ASTRONAUTICA 169 (1993)).

²⁷ See Carns, *supra* note 5, at 187.

solution in defining and identifying space debris.”²⁸ A definition of space debris based on functionality seems to have strong support under the above definitions, including the definition within the Debris Mitigation Guidelines themselves. This definition of space debris also makes practical sense and eliminates barriers to removing non-functional items regardless of size, especially when paired with the common law doctrine of abandonment.

C. The Problem with Space Debris

Debris poses a threat to functioning space objects and astronauts in space, and may cause damage to the earth’s surface upon re-entry.²⁹ Much of the small debris cannot be tracked due to its size and the velocity at which it travels, making it impossible to anticipate and maneuver to avoid collisions.³⁰ To remain in orbit, debris must travel at speeds of up to 17,500 miles per hour.³¹ At this speed even very small pieces of debris can cause serious damage, threatening a spacecraft and causing expensive damage.³² There are millions of these very small pieces, and thousands of larger ones.³³ The small-to-medium pieces of debris include: “continuously shed fragments like lens caps, booster upper stages, nuts, bolts, paint chips, motor sprays of aluminum particles, glass splinters, waste water, and bits of foil,” and may stay in orbit for decades or even centuries, posing an ongoing risk.³⁴ Debris ten centimeters or larger in diameter creates the likelihood of complete destruction for any functioning satellite with which it collides.³⁵ Large nonfunctional objects remaining in orbit are a collision threat, capable of creating huge amounts of space debris and taking up otherwise useful orbit space.³⁶

²⁸ See Sethu & Singh, *supra* note 5, at 99.

²⁹ See Debris Mitigation Guidelines, *supra* note 16, at 47. In 1978, a Soviet nuclear-powered satellite fell from orbit and broke up, scattering radioactive debris over Canada. Sethu & Singh, *supra* note 5, at 101; Jason Koebler, *International Space Station Nearly Struck by Space Junk*, USNEWS (March 26, 2012) <https://perma.cc/5N7W-V35S> (reporting a scare when astronauts had to take shelter because space debris threatened to hit the International Space Station).

³⁰ See Sethu & Singh, *supra* note 5, at 100.

³¹ See Kurt, *supra* note 11, at 305; *What is an Orbit?*, NASA (July 7, 2010), <https://perma.cc/7GC4-QEK9>.

³² See Kurt, *supra* note 11, at 305; Sethu & Singh, *supra* note 5, at 100; Akers, *supra* note 4, at 293.

³³ See Kurt, *supra* note 11, at 305.

³⁴ See Sethu & Singh, *supra* note 5, at 99–100; Kurt, *supra* note 11, at 307.

³⁵ See Kurt, *supra* note 11, at 307.

³⁶ *Id.* at 329.

This issue is of growing importance as more nations and companies gain the ability to launch satellites and other objects into space.³⁷ From February 2009 through the end of 2010, more than thirty-two collision-avoidance maneuvers were reportedly used to avoid debris by various space agencies and satellite companies, and as of March 2012, the crew of the International Space Station (ISS) had to take shelter three times due to close calls with passing debris.³⁸ These maneuvers require costly fuel usage and place a strain on astronauts.³⁹ Furthermore, the launches of some spacecraft have “been delayed because of the presence of space debris in the planned flight paths.”⁴⁰ In 2011, Euroconsult, a satellite consultant, projected that there would be “a 51% increase in satellites launched in the next decade over the number launched in the past decade.”⁴¹

In addition to satellites, the rise of commercial space tourism will also increase the number of objects launched into space and thus the amount of debris.⁴² The more objects are sent into space, and the more collisions create cascades of debris, the greater the risk of damage to vital satellites and other devices relied on for “weather forecasting, telecommunications, commerce, and national security.”⁴³

The Space Debris Mitigation Guidelines⁴⁴ were created by UNCOPUOS with input from the IADC and adopted in 2007.⁴⁵ The guidelines were

³⁷ Kristin Houser, *Private Companies, Not Governments, Are Shaping the Future of Space Exploration*, FUTURISM (June 12, 2017), <https://perma.cc/P4XY-CJ7U>.

³⁸ See Akers, *supra* note 3, at 293–94.

³⁹ See Kurt, *supra* note 11, at 308.

⁴⁰ *Id.*

⁴¹ See Akers, *supra* note 3, at 292 (citing *10-year Forecast Shows Big Rise in Satellite Launches*, SPACE NEWS (Aug. 26, 2011), <https://perma.cc/ELP4-GL4L>).

⁴² See Akers, *supra* note 3, at 295.

⁴³ See Kurt, *supra* note 11, at 305; Akers, *supra* note 3, at 285–86.

⁴⁴ Debris Mitigation Guidelines, *supra* note 16. The guidelines include considerations such as:

- (1) Limiting debris released during normal operations
- (2) Minimizing the potential for break-ups during operational phases
- (3) Limiting the probability of accidental collision in orbit
- (4) Avoiding intentional destruction and other harmful activities
- (5) Minimizing potential for post-mission break-ups resulting from stored energy
- (6) Limiting the long-term presence of spacecraft and launch vehicle orbital stages in the low-Earth orbit (LEO) region after the end of their mission
- (7) Limiting the long-term interference of spacecraft and launch vehicle orbital stages with the geosynchronous Earth orbit (GEO) region after the end of their mission. *Id.* at ¶ 4.

⁴⁵ Debris Mitigation Guidelines, *supra* note 16, at ¶ 2.

developed to address the problem of space debris and were intended to “increase mutual understanding on acceptable activities in space.”⁴⁶ These guidelines are nonbinding but suggest best practices to implement at the national level when planning for a launch. Many nations have adopted the guidelines to some degree, and some have gone beyond what the guidelines suggest.⁴⁷ While the guidelines do not address existing debris, they do much to prevent the creation of new debris.

The Kessler Syndrome is the biggest concern with space debris. The Kessler Syndrome is a cascade created when debris hits a space object, creating new debris and setting off a chain reaction of collisions that eventually closes off entire orbits.⁴⁸ The concern is that this cascade will occur when a tipping point is reached at which the natural removal rate cannot keep up with the amount of new debris added.⁴⁹ At this point a collision could set off a cascade destroying all space objects within the orbit.⁵⁰ In 2011, The National Research Council predicted that the Kessler Syndrome could happen within ten to twenty years.⁵¹ Donald J. Kessler, the astrophysicist and NASA scientist who theorized the Kessler Syndrome in 1978, believes this cascade may be a century away, meaning that there is still time to develop a solution.⁵²

Fortunately, a common estimate suggests that the Kessler Syndrome could be avoided if five to ten large pieces of debris were removed per year.⁵³ Dealing with the problem of space debris, including avoiding the Kessler Syndrome, therefore involves not only avoiding the creation of new debris, but also the removal of the debris already in existence.⁵⁴

D. Proposed Solutions to Clean Up Space Debris

Countries and companies have devised devices to remove space debris. One solution that could be implemented before launch is a planned controlled

⁴⁶ *Id.* at Preface.

⁴⁷ *See* Carns, *supra* note 5, at 189; Kurt, *supra* note 11, at 317.

⁴⁸ *See* Akers, *supra* note 3, at 294; Kurt, *supra* note 11, at 309.

⁴⁹ *See* Sethu & Singh, *supra* note 5, at 100–01.

⁵⁰ *Id.*

⁵¹ *See* Kurt, *supra* note 11, at 316; NATIONAL RESEARCH COUNCIL, LIMITING FUTURE COLLISION RISK TO SPACECRAFT: AN ASSESSMENT OF NASA’S METEOROID AND ORBITAL DEBRIS PROGRAMS (2011).

⁵² *See* Kurt, *supra* note 11, at 316.

⁵³ *Id.* at 318.

⁵⁴ NATIONAL ACADEMY OF SCIENCES, NATIONAL ACADEMY OF ENGINEERING, INSTITUTE OF MEDICINE, NATIONAL RESEARCH COUNCIL, ANNUAL REPORT TO CONGRESS 17 (2011).

re-entry for space vehicles. This maneuver deorbits satellites at the end of their useful life and may prevent harm on the ground by guiding re-entry so any debris falls over uninhabited areas. However, this option requires extra fuel.⁵⁵ Another option is setting limited orbital lifetimes in which a space object would deorbit and re-enter. However, the current guideline of twenty-five years may be too long.⁵⁶ Deorbiting will only work for objects in low-earth orbit (LEO), because objects in a geosynchronous earth orbit (GEO) are too high to return to LEO and then re-enter.⁵⁷ Objects in a GEO orbit would be moved to a “graveyard orbit” where they do not interfere with other GEO satellites but remain space debris unless they can be removed by disposal technology.⁵⁸

Many solutions involve bringing space debris into a lower orbit in order to facilitate re-entry. An example of this is a “space tug,” which could boost an object into lower orbit or attach a drag enhancement to the object.⁵⁹ Another proposal, the “NERF ball” concept, involves launching gel at orbital debris to make it heavier and fall back to Earth more quickly.⁶⁰ If an object is taken into lower orbit and slowed down, it will fall out of orbit and re-enter Earth’s atmosphere. These solutions aimed at slowing down debris are more cost-effective than retrieval mechanisms, which would require a fully manned mission like a robotic arm mounted on a space shuttle to retrieve space objects.⁶¹

Large debris removal is more expensive and complex, making it more challenging to justify.⁶² One relatively cost-effective low-tech solution was created by the U.S. Defense Advanced Research Projects Agency (DARPA). DARPA’s Ballistic Orbital Removal system would launch water to act as a wall and slow down decommissioned space objects so they drop out of orbit.⁶³ Switzerland has also announced a plan to launch CleanSpaceOne, a project to

⁵⁵ See Sorge & Peterson, *supra* note 17.

⁵⁶ *Id.* With an expected increase in the number and rate of space objects launched into space, waiting twenty-five years to deorbit space objects would likely lead to the accumulation of space objects, crowding space and increasing the chance for collisions. A shorter period may help relieve the problem.

⁵⁷ See Akers, *supra* note 3, at 308–09. GEO is farther out from the Earth’s surface (at higher altitude) than Low-Earth Orbit so deorbiting satellites from farther out would have to pass through other orbits before passing through Earth’s atmosphere. This would be challenging and is not yet cost-effective. *Id.*

⁵⁸ *Id.* at 309.

⁵⁹ *Id.*; Sorge & Peterson, *supra* note 17.

⁶⁰ See Akers, *supra* note 3, at 309.

⁶¹ *Id.* at 308.

⁶² See Sorge & Peterson, *supra* note 17.

⁶³ See Akers, *supra* note 3, at 310.

collect space objects and bring them down for re-entry into the atmosphere.⁶⁴ Russia has invested in a \$2 billion nuclear-powered pod to fly in space for fifteen years, knocking debris out of space with its ion drive.⁶⁵ For smaller debris, solutions include lasers to knock debris into re-entry and other materials to “catch” debris, though these risk interference with working satellites.⁶⁶

III. LEGAL OBSTACLES

Many academics have called for a new treaty, which they believe is necessary in order to create a proper legal regime to handle the problem of space debris.⁶⁷ The Outer Space Treaty,⁶⁸ which remains the primary treaty governing space, was created in 1967 under the auspices of UNCOPUOS and has been followed by more specific treaties including the Convention on International Liability for Damage Caused by Space Objects (Liability Convention)⁶⁹ and the Convention on Registration of Objects Launched into Outer Space (Convention on Registration).⁷⁰

Many scholars complain that these treaties are outdated and have resulted in the current debris problem.⁷¹ The key concerns stem from the strong property ownership regime created by the space treaties, which some interpret to make the ownership of even an unidentifiable fleck possible.⁷² The existing treaties have also been criticized for failing to create an obligation on states to clean up or bear responsibility for space debris beyond the exceptional situation in which identifiable debris is involved in an accident and fault can be attributed under the Liability Convention.⁷³ These provisions create no obligation for spacefaring

⁶⁴ *Id.*

⁶⁵ See Kurt, *supra* note 11, at 319.

⁶⁶ See Sorge & Peterson, *supra* note 17; Nevala, *supra* note 19, at 1499.

⁶⁷ See Akers, *supra* note 3; Imburgia, *supra* note 3, at 634.

⁶⁸ See Outer Space Treaty, *supra* note 1.

⁶⁹ G.A. Res. 2777 (XXVI), Conventions on International Liability for Damage Caused by Space Objects (Nov. 29, 1971) [hereinafter Convention on International Liability].

⁷⁰ G.A. Res 3235 (XXIX), Convention on Registration of Objects Launched into Outer Space, arts. II(1), IV (Sept. 15, 1976) [hereinafter Convention on Registration]; G.A. Res. 62/101, Recommendations on Enhancing the Practice of States and International Intergovernmental Organizations in Registering Space Objects, art. 1(b) (Dec. 17 2007) [hereinafter Registration Recommendations].

⁷¹ See Beck, *supra* note 2, at 27; Carns, *supra* note 5, at 175–76; Hollingsworth, *supra* note 3, at 240; Sethu & Singh, *supra* note 5, at 98–99.

⁷² Mary Button, Note, *Cleaning Up Space: The Madrid Protocol to the Antarctic Treaty as a Model for Regulating Orbital Debris*, 37 WM & MARY ENV'T'L L. & POL'Y REV. 539, 552 (2013).

⁷³ See Akers, *supra* note 3, at 304; Beck, *supra* note 2, at 28; Hollingsworth, *supra* note 3, at 257.

nations to internalize their own space debris externalities, so too much debris is created. Meanwhile, other states are not required to intervene, and may wish to avoid causing an international incident by removing another nation's debris.⁷⁴ The treaties established strict property rights for "space objects" and their components but failed to define "space debris," which remained undefined until the nonbinding Debris Mitigation Guidelines were drafted in 2007, leaving scholars uncertain over whether space debris is owned as a component of space objects.⁷⁵ These issues are further explained below.

A. Ownership

The fear that nations may have of creating a dispute over their interference with another nation's space object, absent a clear legal right to do so, may be a major hindrance to unilateral space debris cleanup.⁷⁶ Even if an individual country or company is willing to invest time, cutting-edge technology, and millions of dollars⁷⁷ to create and deploy a mechanism that could remove debris, this fear may keep them from doing so.⁷⁸ To date, a cleanup device has not been deployed, despite some research and investment in prototypes.⁷⁹ With no clear incentive based in the treaties, countries have likely succumbed to the incentive to free ride, rather than make the investment themselves. Without an added incentive to deploy cleanup technology, the decision to take on the cost and risks of cleanup unilaterally for a country or company to preserve its own programs may be made too late to avert danger.

The Outer Space Treaty sets out basic principles for countries operating in space.⁸⁰ The treaty refers to space objects when describing what countries launch into space but includes no definition of space debris. Space objects are owned by

⁷⁴ James D. Rendleman, *Non-Cooperative Space Debris Mitigation*, 53 PROC. INT'L INST. SPACE L., 299, 299-300, 302 (2010).

⁷⁵ See Convention on International Liability, *supra* note 69, at art. I(d); Convention on Registration, *supra* note 70, at art. I(b); Debris Mitigation Guidelines, *supra* note 16, at ¶ 1; Lawrence Li, *Space Debris Mitigation as an International Law Obligation*, INT'L COMMUNITY L. REV., 297, 312 (2015) (describing how the Liability Convention's definition of space debris is encompassed within space objects); Sethu & Singh, *supra* note 5, at 98; Imburgia, *supra* note 4, at 593.

⁷⁶ See Nevala, *supra* note 19, at 1500.

⁷⁷ See Kurt, *supra* note 11, at 316-19.

⁷⁸ See Nevala, *supra* note 19, at 1500.

⁷⁹ See Section II.D, *supra*.

⁸⁰ See Akers, *supra* note 3, at 302. While countries are the parties to treaties they bear international responsibility for both governmental and nongovernmental activities carried out by that country. See Outer Space Treaty, *supra* note 1, at art. VI.

the launching state, regardless of whether the government or a private company conducts the launch.⁸¹

The strong property interest in space objects is evinced in the Liability Convention⁸² and the Convention on Registration.⁸³ The definition of space object in both of these conventions “includes component parts of a space object as well as its launch vehicle and parts thereof.”⁸⁴ Space objects thus have seemingly continuous ownership regardless of whether they are functional or nonfunctional, and whether they exist as an intact satellite or an errant paint chip.

The continuous nature of ownership is also reflected in the space object registration system. Launching states must register launched objects with the Secretary-General of the U.N. in a registry including basic information about the object and its location, updated to include the time that the object is no longer in orbit or no longer functional.⁸⁵ Launching states have jurisdiction and control over their registered objects’ component parts, a fact that does not change as they enter outer space or return to earth.⁸⁶ Launching states are also liable for any damage caused by their space objects.⁸⁷

B. Space Debris Should Not Be Considered a Space Object

One view is that space debris must be considered a space object.⁸⁸ This argument is rooted in the definition of “space object” located in Article I(d) of the Liability Convention and Article I(c) of the Convention on the Registration,

⁸¹ See Convention on International Liability, *supra* note 69, at art. I(c); Outer Space Treaty, *supra* note 1, at art. X.

⁸² Convention on International Liability, *supra* note 69.

⁸³ Convention on Registration, *supra* note 70, at art. 1(b).

⁸⁴ See Convention on International Liability, *supra* note 69, at art. I(d); Convention on Registration, *supra* note 70, at art. I(b).

⁸⁵ Convention on Registration, *supra* note 70, at arts. II(1), IV.

⁸⁶ Outer Space Treaty, *supra* note 1, at art. 7.

⁸⁷ See Convention on International Liability, *supra* note 69, at art. II; Outer Space Treaty, *supra* note 1, at art. 8. In order to recover a state that suffered damage presents the claim within a year of the occurrence or diligent discovery of the damage to the launching state through diplomatic channels or through the U.N. Secretary General. Convention on International Liability, *supra* note 69, at arts. VIII–X. Compensation will be determined with the goal of returning the state to the condition as if the damage had not occurred, if diplomatic negotiations don’t lead to settlement within a year the parties request a Claims Commission to make a final and binding decision on the merits, perhaps with assistance from the Secretary General. *Id.* at arts. XII–XIX.

⁸⁸ Li, *supra* note 75; Sethu & Singh, *supra* note 5, at 98; Imburgia, *supra* note 3, at 615–18.

which includes “component parts” in the definition of “space object.”⁸⁹ Many scholars have accepted this as an all-encompassing definition that necessarily includes space debris within it.⁹⁰

The problem with considering space debris to be a space object is that this term brings with it a strict property regime by which ownership extends to tiny fragments that may not be traceable to their original owners. Some have argued that this regime creates a barrier to unilateral space debris cleanup as the many unidentifiable objects would either be viewed by a nation as not their responsibility or as something to be avoided in case another nation later claimed ownership.⁹¹ Though it is highly unlikely that these small debris pieces could be sufficiently identified so as to support a viable claim, a hostile country could still make assertions credible enough to create international tension. The space object property rights regime also adds a clear barrier to the unilateral removal of larger identifiable space debris since countries do not want to remove other countries’ debris unless granted permission.

This Comment argues that the ownership of space debris should be treated differently than the ownership of space objects. In order to move past the current state of inaction, countries must not be concerned about the ownership of individual pieces of debris in ways that hinder cleanup. An appropriate solution would find a way to incentivize cleanup and impose liability without needing to identify the ownership of small pieces of debris.

IV. SPACE DEBRIS IS NON-FUNCTIONAL AND HAS BEEN ABANDONED

This Section of the Comment proposes, first, that there is an internationally accepted definition of space debris as non-functional, no longer useful, manmade objects in space.⁹² The Comment then examines how the common law doctrine of abandonment can be applied to space debris. This definition can either be used to free space debris from the space object property regime so that it may be cleaned up without fear of political fallout,⁹³ or to signal the negative-value of this property, subjecting it to the same regulatory treatment as abandoned trash. Taking the first view is useful because it creates a permissive

⁸⁹ See Sethu & Singh, *supra* note 5, at 98.

⁹⁰ See Li, *supra* note 75 (describing how the Liability Convention’s definition of space debris is encompassed within space objects); Sethu & Singh, *supra* note 5, at 98; Imburgia, *supra* note 4, at 615.

⁹¹ See Nevala, *supra* note 19, at 1500.

⁹² See Debris Mitigation Guidelines, *supra* note 16.

⁹³ See Nevala, *supra* note 19, at 1528–30.

cleanup regime, removing the potential barrier of ownership so that space debris could be freely claimed or disposed of by other spacefaring nations. However, this Comment ultimately advocates for the second view of space debris as property with no positive economic or subjective value, which, like trash, cannot be freely abandoned by its owner.⁹⁴ Land on which property would be abandoned on Earth is generally owned, and the disposal of property is regulated, sometimes through the use of a paid disposal service and sometimes by the imposition of fines.⁹⁵ This Section suggests a similar regime is needed in space to remedy a tragedy of the commons.

A. Space Debris Is Abandoned Property

Abandonment is an often-overlooked idea in property law scholarship.⁹⁶ Common law cases establish a general right to abandon chattel property, though there has been debate as to whether these cases represent a right to abandon or merely serve to determine ownership.⁹⁷ A common view in Anglo-American law, supported by Professor Lior Strahilevitz, holds that the law establishes a free right to abandon chattel property and allows for these items to be freely repossessed by the former owner or a new owner.⁹⁸ In order to qualify as abandoned property, the property must be abandoned unilaterally with no intended recipient; otherwise, the property would simply pass from the ownership of one party to the other without existing in an abandoned, freely claimable state.⁹⁹ Strahilevitz's interpretation of abandonment law supports the position that space debris has been abandoned. As abandoned property, space debris would not be subject to the property rights of the original launching state and would be free to be disposed of by other parties.

As Strahilevitz recognizes, confusion about whether property has been abandoned creates social costs, as finders may be deterred from claiming or destroying property given the potential existence of another owner with superior title. This can be seen in the current levels of inaction on the cleanup of space debris and concerns voiced in the literature.¹⁰⁰ Clear categorization of abandoned property in space is greatly needed, and a functional test combining space debris and the law of abandonment provides this clarity.

⁹⁴ See Lior Jacob Strahilevitz, *The Right to Abandon*, 158 U. PA. L. REV. 355, 363–64 (2010).

⁹⁵ *Id.*; Eduardo M. Peñalver, *The Illusory Right to Abandon*, 109 U. MICH. L. REV. 191, 204, 208 (2010).

⁹⁶ See Strahilevitz, *supra* note 94, at 358; Peñalver, *supra* note 95, at 192.

⁹⁷ See Strahilevitz, *supra* note 94; Peñalver, *supra* note 95.

⁹⁸ See Strahilevitz, *supra* note 94.

⁹⁹ *Id.* at 360.

¹⁰⁰ See Nevala, *supra* note 19, at 1500; Rendleman, *supra* note 74, at 299–302.

Despite Strahilevitz's general view that chattel property can be unilaterally abandoned, he recognizes an exception for property without subjective or market value.¹⁰¹ In practice, the abandonment of this type of property is often regulated and would not be categorized as unilateral abandonment.¹⁰² To be unilaterally abandoned, no other party can be the recipient of transferred property.¹⁰³ For this reason, it is not unilateral abandonment when someone disposes of trash in a receptacle managed by a private or public disposal service.¹⁰⁴

Property without subjective or market value—like trash, pollution, or, as this Comment argues, space debris—imposes costs on society if it is unilaterally abandoned.¹⁰⁵ Because of this, the abandonment of trash and other unwanted goods is regulated to either prevent unilateral abandonment or force abandoners to bear the costs of cleaning up.¹⁰⁶ The state may fine a litterer, demand that someone trying to dump larger property properly sell or dispose of it, or arrange for public trash disposal and contract with property owners to dispose of their trash for a fee.¹⁰⁷ Governments also regulate pollution to prevent its release and require remediation by owners.¹⁰⁸

The treatment of this type of debris also aligns with Professor Eduardo Peñalver's view that unilateral abandonment is not the legal norm.¹⁰⁹ Contrary to the general regime described by Strahilevitz, Peñalver argues that the common law is generally suspicious of abandonment and that the non-abandonment of land operates such that chattel abandonment is almost never unilateral; rather, it is bilateral because someone owns the land on which the property is

¹⁰¹ See Strahilevitz, *supra* note 94, at 364.

¹⁰² See Peñalver, *supra* note 95, at 203–04; Strahilevitz, *supra* note 94, at 363–64.

¹⁰³ See Strahilevitz, *supra* note 94, at 360.

¹⁰⁴ *Id.* at 364.

¹⁰⁵ See Strahilevitz, *supra* note 94, at 363.

¹⁰⁶ *Id.*

¹⁰⁷ See Peñalver, *supra* note 95, at 204–05.

¹⁰⁸ See Strahilevitz, *supra* note 94, at 363. In the U.S., the Resource Conservation and Recovery Act (RCRA) regulates hazardous waste with permit requirements and corrective action requirements. J. Stanton Curry et al., *The Tug-of-War between RCRA and CERCLA at Contaminated Hazardous Waste Facilities*, 23 Ariz. St. L.J. 359, 360–61 (1991). Additionally the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) identifies and requires remedial action for contaminated sites, which can be performed by the liable party, a third party, or the government to be paid for the liable party or if none can be found a special government fund. *Id.* at 361, 367–70.

¹⁰⁹ See Peñalver, *supra* note 95, at 195–96.

abandoned.¹¹⁰ Thus, chattels can only be abandoned if the landowner consents. Otherwise, the law seeks to punish those who abandon rubbish, and both private and public disposal services are used (at a cost) to remedy the problem.¹¹¹ In space there is no private land because it has been established as a commons.

One way of dealing with this problem is to adopt Strahilevitz's view; once chattels are abandoned, they are owned by no one¹¹² and may be freely cleaned up by another party. The Anglo-American common law test for abandonment requires the presence of two factors: (1) the intention of the owner to relinquish their interests in the property without intending it to go to any specific person and (2) a voluntary act effectuating that intent.¹¹³ The first factor is difficult to ascertain on its own and is usually determined by an overt act.¹¹⁴

Debris fragments would be deemed abandoned because the owner either let them go, destroyed an object intentionally, or they were involved in an accident and were not retrieved or disposed of because they were unwanted and no longer valuable. Any intact satellites would be considered abandoned if they were registered but the registry represented that they were no longer functional.¹¹⁵ This act would satisfy the "voluntary act" prong of the abandonment test because the state that the satellite was launched from would have represented to the international community that it no longer plans to use the object by changing this description in the registry. Thus, these nonfunctional items would be considered abandoned space debris. This basis for determining whether property is abandoned allows an owner or a third party to have confidence in whether something is abandoned space debris, which can be cleaned up unilaterally.

Using abandonment in this way would avoid the fear of potential geopolitical disputes over space property, which may be hindering current cleanup efforts. One proposed solution would check debris and intact satellites against the U.N. registry, other debris tracking mechanisms, and the owners information.¹¹⁶ Under this proposal debris would be excluded from the abandoned property regime because, owners are likely unaware of their ownership of smaller debris particles, though owners would likely waive their

¹¹⁰ See Peñalver, *supra* note 95.

¹¹¹ *Id.* at 204, 208.

¹¹² *Id.* at 196; Strahilevitz, *supra* note 94, at 376.

¹¹³ See Strahilevitz, *supra* note 94, at 376.

¹¹⁴ See Peñalver, *supra* note 95, at 196.

¹¹⁵ See Registration Recommendations, *supra* note 70, at ¶ (2)(b)(ii).

¹¹⁶ See Nevala, *supra* note 19, at 1526.

rights in this situation.¹¹⁷ This proposal supposes that once abandonment is established, the doctrine allows a state or company to remove debris without a formal transfer of ownership, making it an easier and safer task.¹¹⁸ Authors have also made similar arguments advocating that the law of salvage and law of finds would allow the unilateral recovery or destruction of a satellite or fragment if it were considered abandoned according to maritime law.¹¹⁹

One may question whether the fear of wrongfully removing owned debris is well-founded, particularly in the case of fragmentary debris, and thus whether it is a real cause of the collective failure to clean up space debris. There seems to be a more pressing need to create the right incentives for parties to undertake the expensive act of cleaning up. Allowing for the continuation of free abandonment and merely clarifying that a third party is allowed to clean it up does not solve this fundamental problem. Neither the article that suggests using the U.N. registry to decide abandonment, nor the literature drawing upon maritime law, argue that there is a legal obligation to clean up debris or propose using market-share liability; they only seek to establish the ability of other parties to clean up debris.

B. The Tragedy of the Space Commons

The real cause of the space debris problem is rooted in the fact that space was established as a commons in the 1967 Outer Space Treaty and in subsequent treaties as “the province of all mankind,”¹²⁰ “free for the exploration and use by all States.”¹²¹ This makes it vulnerable to the phenomenon known as the “tragedy of the commons.”¹²² Each company or nation operating in space finds it cheaper to freely release their wastes and not pay to clean them up, akin to the problem of pollution.¹²³ Consequently space is overused, and just as the overgrazed pasture is no longer usable, space debris threatens the continued use of space.¹²⁴ With no legal regime to coerce the parties to deal with the problem

¹¹⁷ *Id.* at 1531.

¹¹⁸ *Id.* at 1529–30.

¹¹⁹ R. Cargill Hall, *Comments on Salvage and Removal of Man-Made Objects from Outer Space*, 9 PROC. ON L. OUTER SPACE 117 (1966); Rendleman, *supra* note 74, at 308.

¹²⁰ *See* Outer Space Treaty, *supra* note 1, at art. I.

¹²¹ *Id.*; Kurt, *supra* note 11, at 311.

¹²² Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243 (1969); Kurt, *supra* note 11, at 310–11.

¹²³ *See* Hardin, *supra* note 122, at 1245.

¹²⁴ *See* Kurt, *supra* note 11, at 311.

of space debris, they will continue to pollute and leave their debris in Earth's orbit.¹²⁵

To date, no binding international regulation requiring space debris to be cleaned up has been recognized. One scholar, Lawrence D. Roberts, has argued that regulation and expanded liability should be used to address the tragedy of the commons as it applies to space debris.¹²⁶ As previously discussed, both Strahilevitz and Peñalver have recognized the regulation of and charging for chattel abandonment as a common solution to the negative externalities created by this activity.¹²⁷

There is a general presumption that U.S. law does not apply extraterritorially, which is meant to avoid conflicts with other sovereigns, and doing so would likely be problematic under the Outer Space Treaty.¹²⁸ However, the doctrine of abandonment may be a norm with international force.” The right to abandon property is found in other common law countries.¹²⁹ Civil law countries also generally recognize the right to abandon chattel property.¹³⁰ Argentina, for example, has a permissive regime where “the first claimant of abandoned property becomes the new owner.”¹³¹ Germany allows for the abandonment of movable objects as long as intent is present.¹³² Chile and Italy have similar laws about unowned items becoming the property of anyone who wants to claim them.¹³³ Thus, applying the doctrine of abandonment to space debris would not be an extension of U.S. sovereignty into space,¹³⁴ but the application of a consensus view tracking how many nations view abandoned property under their own law and comporting with the more recent definitions and treatments of space debris discussed in Section II.B of this Comment above.

In the next Section, this Comment will make the case that binding regulations to clean up space debris can be found in the principles of the Outer

¹²⁵ Timothy Justin Trapp, Note, *Taking Up Space by Any Other Means: Coming to Terms with the Nonappropriation Article of the Outer Space Treaty*, 2013 U. ILL. L. REV. 1681, 1696 (2013).

¹²⁶ See Roberts, *supra* note 3, at 73.

¹²⁷ See Peñalver, *supra* note 95, at 204–05; Strahilevitz, *supra* note 94, at 363.

¹²⁸ See Outer Space Treaty, *supra* note 1, at arts. I, II; Nevala, *supra* note 19, at 1513-14.

¹²⁹ See *Armory v. Delamirie*, 93 Eng. Rep. 664 (K.B. 1722); *Stewart v. Gustafson* (1998), 171 Sask. R. 27 (Can. Sask. Q.B.).

¹³⁰ See Strahilevitz, *supra* note 94, at 395; CASES, MATERIALS AND TEXT ON PROPERTY LAW 1010 (Sjef van Erp & Bram Akkermans eds., 2012).

¹³¹ See Strahilevitz, *supra* note 94, at 395 (citing CÓD CIV. art. 2559 (Arg.)).

¹³² Bürgerliches Gesetzbuch [BGB] [CIVIL CODE] § 959, <https://perma.cc/558N-WFTA>; Strahilevitz, *supra* note 94, at 394.

¹³³ See Strahilevitz, *supra* note 94, at 395 (citing Cód. Civ. art. 606 (Chile) & C.C. art. 923 (It.)).

¹³⁴ See Nevala, *supra* note 19, at 1513.

Space Treaty. Additionally, the requirement of free access to space can be leveraged to create a market-share liability obligation to pay for space debris cleanup.

V. THE OBLIGATION TO CLEAN UP SPACE DEBRIS

While many academics think a new treaty is necessary to create the obligation to clean up space debris,¹³⁵ this Comment argues that existing treaties are sufficient to create this obligation. The basic principles governing activity in space, including the rights to free exploration and access laid out in the Outer Space Treaty and echoed in other texts, are sufficient to create obligations that must be upheld by spacefaring nations. The creation and continued existence of debris by spacefaring nations violates these basic requirements of operation in space. Accordingly, states must clean up any debris they create or remain in violation of the treaty—an obligation that becomes more salient as the density of debris in space increases.

A. Legal Principles Governing Activity in Space

The Outer Space Treaty¹³⁶ states:

The exploration and use of outer space, including the Moon and other celestial bodies, *shall be carried out for the benefit and in the interests of all countries*, irrespective of their degree of economic or scientific development, and shall be the *province of all mankind*. Outer space, including the Moon and other celestial bodies, *shall be free for exploration and use by all states* without discrimination of any kind, on a basis of equality and in accordance with international law, and *there shall be free access to all areas of celestial bodies*.¹³⁷

The Treaty also requires that states “shall conduct all their activities in outer space . . . with due regard for the corresponding interests of all other State Parties.”¹³⁸ The Outer Space Treaty is a widely adopted and binding document in the space law regime. The principle that space is to be used in a way that it remains available to all is clearly stated in the Outer Space Treaty and is also echoed in other space treaties. For example, the Annex of Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting notes that every state “has an equal right to conduct activities in the field of international direct television broadcasting by satellite” and that “[a]ll

¹³⁵ See Akers, *supra* note 3; Imburgia, *supra* note 3.

¹³⁶ See Outer Space Treaty, *supra* note 1.

¹³⁷ *Id.* at art. 1 (emphasis added).

¹³⁸ *Id.* at art. 9.

states are entitled to and should enjoy the benefits from such activities.”¹³⁹ This principle is repeated again, with a more obvious equitable concern, in the Principles Relating to Remote Sensing of the Earth from Outer Space, which require that “[r]emote sensing activities shall be carried out for the benefit and the interests of all countries, irrespective of their degree of economic, social or scientific and technological development, and taking into particular consideration the needs of developing countries.”¹⁴⁰

Additionally, GA Resolution 1721 International Cooperation on the Peaceful Uses of Outer Space states, “[o]uter space and celestial bodies are free for exploration and use by all States in conformity with international law and are not subject to national appropriation.”¹⁴¹ Some Aspects Concerning the Use of Geostationary Orbit also recognizes that some developing countries will need to be accommodated in orbiting bands to retain equitable access.¹⁴² Further, the nonbinding Space Debris Mitigation Guidelines suggest that spacecraft and launch vehicles in LEO be removed in a controlled fashion and that GEO regions be left in an orbit above this region such that they will not interfere with, or return to, this region.¹⁴³

What’s more, some scholars have pointed out that defunct satellites remaining in orbit violate Article 35 of the Recommendation of the International Telecommunication Union Convention and Article 29 of the World Administrative Radio Conference. Both of these treaties prohibit disturbances and interference in radio frequencies, with the latter specifically noting interference by inoperative satellites.¹⁴⁴ They also suggest that debris is a cause of pollution in violation of Article IX of the Outer Space Treaty, which says that studies and activities should not be conducted in a way that creates potentially harmful interference with other states’ use of outer space without consultation.¹⁴⁵ Lastly, the E.U. Draft Code allows for unilateral debris removal

¹³⁹ G.A. Res. 37/92, Principles Governing the Use by States of Artificial Earth Satellites for International Direct Television Broadcasting, ¶ 5 (Dec. 10, 1982) [hereinafter Principles Governing Television Satellites].

¹⁴⁰ G.A. Res. 41/65, Principles Relating to Remote Sensing of the Earth from Outer Space, Principle II (Dec. 3, 1986) [hereinafter Principles Relating to Remote Sensing].

¹⁴¹ *Id.*

¹⁴² U.N. Legal Subcommittee, *Some Aspects Concerning the Use of Geostationary Orbit*, 39th Sess., U.N. Doc. A/AC.105/738, annex III (Mar. 31, 2000).

¹⁴³ *See* Debris Mitigation Guidelines, *supra* note 16, at art. 4.

¹⁴⁴ *See* Sethu & Singh, *supra* note 5, at 101; The World Administrative Radio Conference, Geneva, U.N. Doc. A/AC.105/C.1/CRP.4, art. 29 (1979); Recommendations of the International Telecommunication Union Convention, Nairobi, UN Doc. A/AC.105/572, art. 35 (1982).

¹⁴⁵ *See* Sethu & Singh, *supra* note 5, at 102 (noting however that this provision is nonbinding and noncoercive); Outer Space Treaty, *supra* note 1, at art. IX.

“to reduce the creation of outer space debris,’ ‘justified by the inherent right of individual or collective self-defense as recognized in the U.N. Charter,’ or for ‘imperative safety considerations.’”¹⁴⁶

The same basic principles of operation in space are identified in the fundamental Outer Space Treaty as well as in legal documents governing specific activities in space. The requirement that space activities be exercised with due care for those of other nations and without interfering or restricting their access to space is foundational to legal space operations. Consequently, if spacefaring nations create debris that undermines free access to space, they are in violation of the Outer Space Treaty and likely also at least one treaty relating to a specific use of space, such as those applying to television, radio or remote sensing. For a polluting nation to continue using space, it must regain compliance with the governing treaties by mitigating the creation of space debris and cleaning up the debris it has created.

B. Failing to Clean Up Space Debris Violates These Legal Principles

If one considers the orbital space taken up by debris and the collision threat posed by debris, it becomes hard to claim that states are not violating the basic norms of spacefaring. Debris and other nonfunctional objects serving no useful purpose take up orbital space, which could be used by other nations. If, or when, the Kessler Syndrome cascade is reached, the contributing nations will have made segments of Earth’s orbit unusable for any nation. Thus, according to some scholars, the very existence of space debris is illegal internationally according to the initial Outer Space Treaty of 1967.¹⁴⁷ They suggest that this treaty, which “states that all activities must be carried on for the ‘benefit and interests of all countries,’ and that outer space shall never be subject to national appropriation” is now part of customary international space law.¹⁴⁸ They argue that leaving space debris violates

Principle 21 of the 1972 Stockholm Declaration which allows states to exploit their resources pursuant to their own environmental policies, provided that their activities do not cause damage to areas beyond their national jurisdiction. Thus, a defunct satellite or space debris left behind in any orbit violates the Outer Space Treaty because: (a) it does not produce a

¹⁴⁶ See Li, *supra* note 75, at 332; *International Code of Conduct for Outer Space Activities*, European Union, Draft Version 31, ¶ 4.2 (Mar. 2014).

¹⁴⁷ See Sethu & Singh, *supra* note 5, at 102; Outer Space Treaty, *supra* note 1.

¹⁴⁸ See Sethu & Singh, *supra* note 5, at 102.

benefit for mankind; (b) its use is not in the interest of all countries; and (c) it occupies a portion of space, causing national appropriation.¹⁴⁹

Even short of a cascade removing or limiting the availability of space debris can, and indeed has, begun to affect the use of space. As described earlier, debris has caused the ISS and other space objects to use fuel to avoid collisions or risk the destruction of their craft and loss of life.¹⁵⁰ There is already crowding in the geostationary orbit, used especially for communications satellites, causing fear of collisions and signal overlap.¹⁵¹ Initial access to space has been delayed because the launches of new spacecraft have had to be held back due to the risk of debris in their path.¹⁵² Other protective measures that spacefaring nations are contemplating include launching with more fuel to allow for avoidance maneuvers and protective shields—both of which cost money and add extra weight, requiring more fuel.¹⁵³ These protective measures, which must be added due to the conduct of existing spacefaring nations, serve as an extra barrier to space access by increasing the cost of space operations.

Thus, states creating debris violate other nations' right to use space as enshrined in the space treaty regime, and they violate their own obligations to not appropriate space.

C. Using Market-Share Liability to Implement the Obligation to Clean Up Space Debris

In this Subsection, this Comment argues for extending the concept of market-share liability and establishing a U.N.-run fund to be distributed to parties for costs incurred when cleaning up space debris. This subsection will introduce market-share liability and then describe how it could be more effectively used not as compensation for loss, but as part of a regulatory device aimed at reducing the amount of existing space debris.

Market-share liability has been suggested as a way to deal with the difficulty of identifying the individual ownership of objects and it could be put to use in the obligation to clean up debris.¹⁵⁴ Market-share liability would allow for the apportionment of responsibility based on the respective contribution to the risk,

¹⁴⁹ *Id.*

¹⁵⁰ *See* Kurt, *supra* note 11, at 308.

¹⁵¹ *See* Beck, *supra* note 2, at 25.

¹⁵² *See* Kurt, *supra* note 11, at 308.

¹⁵³ *Id.*

¹⁵⁴ *See* Sethu & Singh, *supra* note 5, at 106; Mark J. Sundahl, Note, *Unidentified Orbital Debris: The Case for a Market-Share Liability Regime*, 24 HASTINGS INT'L & COMP. L. REV. 125 (2000).

and would not require the identification of individual pieces of space debris.¹⁵⁵ Market-share liability has already been successfully applied where multiple parties contribute to a dangerous situation, but where it is virtually impossible to tie a particular party to the harm caused.¹⁵⁶

Market-share liability was created in 1980 in the case *Sindell v. Abbott Laboratories*.¹⁵⁷ In *Sindell*, the Supreme Court of California devised the concept in response to a case in which pharmaceuticals that were marketed to pregnant women caused cancer in their children at least a decade later.¹⁵⁸ Since the latent period was so long, the women naturally could not remember the specific pill manufacturer out of two hundred such manufacturers.¹⁵⁹ The court found that each defendant's market share could be determined fairly accurately, and therefore used market share as a basis for the apportionment of liability.¹⁶⁰ While market-share liability has not been broadly adopted, this is likely because cases with fungible products and a serious causation problem are rare.¹⁶¹

Academics have taken this idea and sought to apply it to space debris, which has similar fungibility and causation issues, but their applications have been limited to a tort-like context.¹⁶² One author suggested that whenever a collision occurs due to an unidentifiable piece of debris and a functional space object, liability and compensation should be apportioned "among spacefaring nations equal to the percentages of the total debris population for which the particular nation is responsible."¹⁶³ This mechanism frees the victim from having to prove causation by a specific nation, when that would be virtually impossible.¹⁶⁴ There will be difficulties calculating the percentage with precision in such a system, but there is fairly accurate information from the U.N.,

¹⁵⁵ See Sethu & Singh, *supra* note 5, at 106–05.

¹⁵⁶ See Sundahl, *supra* note 154, at 127.

¹⁵⁷ 26 Cal. 3d 588 (1980).

¹⁵⁸ *Id.* at 594.

¹⁵⁹ *Id.* at 596, 609.

¹⁶⁰ *Id.* at 613.

¹⁶¹ See Sundahl, *supra* note 154, at 143.

¹⁶² Peter T. Limperis, Comment, *Orbital Debris and the Spacefaring Nations: International Law Methods for Prevention and Reduction of Debris, and Liability Regimes for Damage Caused by Debris*, 15 ARIZ. J. INT'L & COMP. L. 319 (1998); Roberts, *supra* note 3 (arguing for a market-share liability pool to be called upon when debris damages another's space object, building on the Liability Treaty); Sundahl, *supra* note 154, at 143.

¹⁶³ See Limperis, *supra* note 162, at 340.

¹⁶⁴ *Id.*

including registry, sampling, mathematical models, and other records of known collisions and the resultant debris.¹⁶⁵

Without strong buy-in, it may be challenging to get this rarely used domestic tort theory to apply in international space law, especially with the potential for disputes over the proper apportionment of market share.¹⁶⁶ The states primarily responsible for existing debris are the U.S., Russia, and China – powerful countries unlikely to be pleased with this newfound expense.

That said, though these nations would be paying the highest cost, this would be proportional to their respective contributions to the problem. Indeed, these nations may welcome this remedy, because their space activity is threatened by the proliferation of space debris and they likely value continuing their extensive and advanced use of space. This solution solves the free rider problem and would compensate any nation or company that cleans up space such that any nation (like the U.S., Russia, or China) fearing the collapse of its space program and unwilling to bear all the cleanup costs itself would see this as an attractive solution. It is even possible that liable states like the U.S. and Russia will be eager to aid in debris identification, so as to add to other states' liability.¹⁶⁷

This regulatory remedy would resolve the current tragedy of the commons. By assigning responsibility for the cost of cleanup, nations or companies would be incentivized to begin cleanup operations, because they would know that others will not freeride on their costly efforts. Instead, they will have guaranteed compensation from those responsible. Obtaining the funds is crucial, particularly since the high cost of deploying existing technology to destroy space debris has been a hindrance thus far.¹⁶⁸

Using market-share liability is also a useful way to compensate victims of debris collisions and to incentivize spacefaring nations to avoid creating new debris in the future.¹⁶⁹ However, this does not do enough to remedy the persistent existence of space debris, which is threatening the very continuation of space activity. The Outer Space Treaty creates an obligation on states to carry out space activities “for the ‘benefit and interests of all countries,’ and that outer space shall never be subject to national appropriation.”¹⁷⁰ To uphold their obligations under this treaty, nations should not be creating debris, because it

¹⁶⁵ See Sundahl, *supra* note 154, at 144–45; Beck, *supra* note 2, at 35; Akers, *supra* note 3, at 294–95; Imburgia, *supra* note 3, at 595–97, 599–601, 604.

¹⁶⁶ See Sethu & Singh, *supra* note 5, at 107–08.

¹⁶⁷ See Sundahl, *supra* note 154, at 148.

¹⁶⁸ See Carns, *supra* note 5, at 175.

¹⁶⁹ See Limperis, *supra* note 162, at 340.

¹⁷⁰ See Sethu & Singh, *supra* note 5, at 102; Outer Space Treaty, *supra* note 1, at arts. I, II.

interferes with the ability of others to conduct their space activities, or perhaps keeps them from space altogether. Due to this legal violation, and the negative externality created by property abandonment, states should be required to pay for the disposal of debris in proportion to the amount they create. While the creation of debris may be unavoidable, there are existing practices that can greatly minimize the proliferation of debris, and any debris that is nonetheless created can be dealt with through market-share liability payments.

This collection of market-share disposal payments would not simply be a tax on operations or tort compensation for harmful acts. Instead, once liability is apportioned, (and this could be done on an ongoing or periodic basis to reflect new developments), nations or companies undertaking actions to clean up space would be compensated for their costs by the nations responsible according to their percentage of responsibility. The U.N. Office for Outer Space Affairs (UNOOSA) could allocate the percentage of liability, drawing on its role in promoting international cooperation and the peaceful use of outer space, as well as preparing reports and studies.¹⁷¹ If any disputes were to arise from non-payment, familiar procedures could be employed—perhaps by drawing from other notable space treaties that provide “established procedures for the peaceful settlement of disputes, in accordance with the Charter of the United Nations.”¹⁷² In many of the space treaties and conventions, including the Liability Convention, disputes and claims can be brought to the Secretary-General of the U.N.¹⁷³ These bodies could be utilized here to assure fairness in allocating liability and handling routine compensation disputes.

This new regulatory regime can thus be grounded in the existing space treaty regime and administered by existing authorities. It would resolve the incentive problems that exist in the international commons of space through regulation that allocates the cost of debris cleanup to those who have created and continue to create it. The regime can also adapt as the outer space marketplace and the actors who comprise it shift over time, and as the registry of space objects, incidents, and tracking capabilities improves. This regulatory regime also ultimately would allocate cleanup funds to parties who would like to

¹⁷¹ *Roles and Responsibilities*, U.N. OFF. OUTER SPACE AFF., <https://perma.cc/SD85-SETU> (last visited Feb. 3, 2018).

¹⁷² G.A. Res. 47/68, Agreement on Principles Relevant to the Use of Nuclear Power Sources in Outer Space, Principle 10 (Dec. 14, 1992); Principles Relating to Remote Sensing, *supra* note 140; Principles Governing Television Satellites, *supra* note 139, at ¶ 7.

¹⁷³ See Convention on International Liability, *supra* note 69, at art. IX; G.A. Res. 34/68, Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, art. 15 ¶ 3 (Dec. 5, 1979).

continue to operate in space, removing the disincentive to carry the cost in the face of potential freeriding.

VI. CONCLUSION

Space debris poses a serious threat to the continued use of space. Many have called for a new treaty to solve the perceived failure of the current space treaty regime to address debris clean up and define space debris.¹⁷⁴ This Comment has demonstrated that the existing treaties, resolutions, and guidelines create a definition of space debris as nonfunctional objects, separate from space objects. This Comment has also shown that space debris has been abandoned and must be regulated in order to rid the space commons of this negative externality. This Comment has demonstrated that the existing treaty regime can be used to enforce an obligation to clean debris up. This is based on first principles such as free access, included in the original Outer Space Treaty and reflected in other specific treaties and guidelines for outer space activities. This Comment has shown how failing to clean up space debris violates the Outer Space Treaty and has proposed a market-share liability regime under which debris-creating nations fund the cleanup.

This Comment has provided an avenue for bringing practice and understanding into accordance with the existing legal regime in international space law. An obligation to clean up is critical for the removal of the debris that already exists in space and, in line with the Debris Mitigation Guidelines, preventing the creation of any new debris. The Outer Space Treaty establishes space as a common resource. In order to preserve this common resource for all, spacefaring nations must be held to regulations that make them internalize the costs created by their debris.¹⁷⁵

¹⁷⁴ See Akers, *supra* note 3; Imburgia, *supra* note 3.

¹⁷⁵ See Kurt, *supra* note 11, at 308 (describing the costs created by space debris).