TAKING UP SPACE BY ANY OTHER MEANS: COMING TO TERMS WITH THE NONAPPROPRIATION ARTICLE OF THE OUTER SPACE TREATY

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"Unless we are willing to settle down into a world that is our prison, we must be ready to move beyond Earth . . . ."[1]

Ever since man began travelling to space, we have been leaving debris behind us. Over the last 50 years of space travel, the amount of debris has been growing at a surprising rate. As of 2013, there were over 12,000 pieces of debris, consisting of expended booster rockets, spacecraft parts, and defunct satellites. This amount of debris poses a significant risk to future missions to space, as even a very small piece of debris can cause catastrophic damage to a functioning spacecraft. Under the current international legal regime governing space, however, addressing this problem is not straightforward. Ironically, it is exactly the open-access nature of space, guaranteed by the Outer Space treaty and other treaties, which threatens to hinder efforts to clean up space debris. If this problem is not addressed, we risk causing space to become unnavigable.

To ensure that space remains accessible to all, the Outer Space Treaty includes a nonappropriation article. This article makes it a violation of the treaty for any country to appropriate any aspect of space. Thus, to address the space debris problem, any proposed solution must not be undertaken by a single nation or group of nations, but rather must be international in character. The system proposed by this Note is a cap-and-trade system, which would incentivize individual nations to clean up space debris.

Part II of the Note discusses the nature of space debris and provides a background of the various international treaties governing space. Part III analyzes the requirements of these treaties and provides a framework for a solution to the space debris problem. Part IV recommends setting up an international regulatory agency to institute a cap-and-trade system. Finally, Part V concludes that such a system would be responsive to the requirements of the international space treaties, would further the Outer Space Treaty's goal of keeping

1. Isaac Asimov, Lecture at the College of William and Mary: Our Future in the Cosmos—Space (1983), *in* NASA, THE IMPACT OF SCIENCE ON SOCIETY 79, 80 (1985), *available at* http://www.spacequotations.com/sp482.pdf.

space accessible for all mankind, and would provide incentives for countries to reduce the amount of space debris.

I. INTRODUCTION

"Space: The final frontier."[2] A frontier more wild than the open and vast westward expanses the United States once held, more endless than the cold and empty reaches of Amerigo's Pacific, more colorful, beautiful, and unimaginable than any person, place, or thing on this tiny, insignificant (yet indescribably wonderful) little rock we call home. Space is not only the final frontier but also the next frontier. Space is the next outlet for the U.S. expansionist spirit, presenting an endless opportunity for a country, just as much as a species that continues to outgrow the space it has. If human beings could find a way to move into the vast frontier of the universe, be it through colonizing the moon, Mars, any of the other seven (or eight) planets in our own solar system, or even any of the more than eight hundred currently catalogued planets outside of our solar system, we would be tapping into a resource more bountiful than any before it.[3] In fact, even the near reaches of space have proven a valuable resource. Without utilization of the space near our planet, we would not have the GPS satellites that guide us, the communication satellites that connect us, the weather satellites that, sometimes, predict the future, or even the surveillance satellites that let us see the tops of all those buildings and trees when we are goofing off on Google Earth instead of reading for class or editing a Note.

The benefits accrued from space exploration are due in no small part to the open-access nature of the space resource.[4] The legal accessibility of space precluded many conflicts, and allowed for rapid progress in the field.[5] But this intense and rapid utilization of near space now threatens not only its own exploitability, it also threatens the availability of the endless frontier beyond it. Those with the capability to use space have done so and to a rapid extent.[6] This rapid expansion clutters the area around our planet (low earth and geostationary orbit)

2. Famous opening quotation of *Star Trek* series. *See, e.g.*, *Space: The Final Frontier*, THE PHRASE FINDER, http://www.phrases.org.uk/meanings/328700.html (last visited May 19, 2013).

3. *Catalog*, THE EXTRASOLAR PLANETS ENCYCLOPAEDIA, http://www.exoplanet.eu/catalog (last visited May 19, 2013).

4. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, art. I, Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 (proclaiming space to be the "province of all mankind") [hereinafter Outer Space Treaty]; David Tan, *Towards a New Regime for the Protection of Outer Space as the "Province of All Mankind*," 25 YALE J. INT'L L. 145, 160–64 (2000).

5. Leslie I. Tennen, *Towards a New Regime for Exploitation of Outer Space Mineral Resources*, 88 NEB. L. REV. 794, 807 ("Abrogation of article II would result in a multitude of claims to orbits, locations, and entire moons and other celestial bodies."); *id.* at 808 ("It is difficult to envision a scenario whereby the various claims would not overlap and thereby conflict. Thus, it is foreseeable that international tensions between claiming states would arise, with the concomitant potential for the export of armed conflict from the confines of this planet to the heavens.").

6. *See, e.g.*, Christopher D. Williams, *Space: The Cluttered Frontier*, 60 J. AIR L. & COM. 1139, 1141 (1995).

with spacecraft and the debris they create.[7] Though we can still get into, and occasionally through, the area around our planet, we may lose that ability if we fill up the space within it.[8] If we ever lose the ability to get off of our planet, we will have sealed the fate of humanity.[9] Whether we are wiped out by nuclear warfare, the depletion of all of our resources, a rogue asteroid, or even the inevitable death of the sun that supports us, we cannot survive as a species unless we find a way to leave this planet.[10]

This Note focuses on the one of the potential obstacles to leaving Earth: the space debris problem. Specifically, this Note analyzes potential bars the nonappropriation article of the Outer Space Treaty sets up against possible solutions to the space debris problem by looking at the characteristics of those acts, which have been acceptable under the Outer Space Treaty and those which count as "appropriation" under international law.[11]

Part II of this Note describes the characteristics of orbital space and the characteristics of the debris that threaten its access. It then gives a detailed background of the treaties that create the foundation of International Space Law and shows how their open-access philosophy contributes to the problem of space debris. Part II concludes by describing some specific actions in the space arena in the context of appropriation, and evaluating those actions' compliance with the nonappropriation article of the Outer Space Treaty.[12] Part III analyzes the various treaties and actions of space actors in an attempt to synthesize a rule that will give guidance on how to craft a legitimate regulatory body under international space law. Part IV suggests a cap-and-trade regime under international law, as well as stricter registration and monitoring guidelines. Part V concludes that, under the right circumstances, such a regime will be the best deterrent to the space debris problem, as well as a legitimate regime under international space law.

II. BACKGROUND

Outer space is "the province of all mankind."[13] It is the new western frontier, the next chance for humanity to continue its one great prerogative: expansion. Space is no longer just the hypothetical playground of curious minds, but a real and valuable resource. Since Sputnik first went into space in 1957,[14] mankind has consistently sent

7. *Id.* at 1141–42; *see* discussion *infra* Part II.B.

8. *See* Gunnar Leinberg, Note, *Orbital Space Debris*, 4 J.L & TECH. 93, 99–100 (1989).

9. *See* Asimov, *supra* note 1, at 92 ("There are so many benefits to be derived from space exploration and exploitation; why not take what seems to me the only chance of escaping what is otherwise the sure destruction of all that humanity has struggled to achieve for 50,000 years?").

10. *See infra* notes 16–21 and accompanying discussion.

11. Outer Space Treaty, *supra* note 4, at art. II.

12. *Id*.

13. *Id*. at art. I.

14. Tennen, *supra* note 5, at 803.

probes out into the depths of this new frontier and has determinedly populated the area surrounding our planet with more and more spacecraft, and rightly so. Through our use of satellites, we created a worldwide communications network, allowed people to use GPS devices, tracked weather systems, monitored enemy combat movements, and gathered more information about the universe we live in. These immediate gains are great and contribute immeasurably to creating the advanced society that we live in today, but they pale in comparison to what outer space offers us in the long run: survival.

The unavoidable truth is this: one day, our planet will no longer be able to support us.[15] Maybe we will destroy this planet with nuclear warfare.[16] Maybe we will deplete all of our resources, converting our planet into an inhospitable wasteland.[17] Maybe a new disease will come about that will obliterate life as we know it.[18] Maybe an asteroid will collide with our planet and destroy our ecosystem.[19] All of these are possibilities, however slight they may be. But, even if we get lucky and no such catastrophe as the ones listed above befall us, eventually, our sun will start to run out of fuel and will expand, engulfing this planet and wiping out any trace of its existence.[20] If we wish to survive as a species, we must realize that it is impossible to do so without eventually leaving this planet.[21]

We are now at a precarious point in the history of space exploration. The National Aeronautics and Space Administration (NASA), the U.S. agency invested in assuring man's conquest of space,

15. *See infra* notes 16–21 and accompanying discussion.

16. *See, e.g.*, Debora MacKenzie, *'Nuclear Winter' May Kill More Than a Nuclear War*, NEWSCIENTIST (Mar. 1, 2007, 7:00 PM), http://www.newscientist.com/article/dn11287-nuclear-winter-may-kill-more-than-a-nuclear-war.html (describing a new study that shows just how easy it would be to plunge the world into a nuclear winter which would, almost certainly, destroy civilization as we currently understand it).

17. *See, e.g.*, Fred Magoff, *Global Resource Depletion, Is Population the Problem?*, GLOBAL FAULTLINES (Jan.10, 2013), http://globalfaultlines.org/2013/01/10/global-resource-depletion-is-population-the-problem-by-fred-magdoff/ (calling into question the future sustainability of our current societal organization and pointing out shortages in crucial resources).

18. *See, e.g.*, Molly Billings, *The Influenza Pandemic of 1918*, STANFORD, http://virus.stanford.edu/uda/ (last modified Feb. 2005) (discussing the devastating pandemic that killed between twenty and forty million people and showing the destructive power that diseases like this one can have).

19. *See, e.g.*, *Asteroid Impact,* RISK-ED.ORG, http://www.risk-ed.org/pages/risk/asteroid_prob.htm (last visited May 19, 2013) (giving a summation of the probabilities of impact with meteors of different sizes, and suggesting that we are probably due for another 100m impact within the next 500 years or so).

20. A star with a mass similar to that of the sun will become a red giant as its life comes to an end. "Once core hydrogen burning ceases, the core shrinks, heating the surrounding hydrogen and triggering shell hydrogen burning. The new outpouring of energy causes the star's outer layers to expand and cool, and the star becomes a red giant." *See* ROGER A. FREEDMAN & WILLIAM J. KAUFMANN III, UNIVERSE 500–02 (6th ed. 2002). Though this is an event that would be far beyond our own (or anyone we can imagine's) foreseeable future, it is still an inevitable event. *Id.*

21. *See id.* Again, the point here is not one of urgency, but simply inevitability. While other disasters may be more pressing, only this one is completely certain. *See* discussion *supra* notes 16–20 and accompanying text.

stopped flying shuttles into outer space.[22] Instead of having a state-run space program, we are moving into a space age decided by the private sector.[23] Already, private companies are stepping in to fill the vacuum left by NASA's withdrawal from the field.[24] Market forces will hopefully drive research and development at a quicker pace than state control has and expedite our journey to the stars. For instance, space tourism is becoming a viable option[25] and requires private companies to build their spaceships from the ground up, allowing them to match the advances of NASA in a fraction of the time.[26] Soon, Virgin Galactic is even slated to start delivering scientific payloads into space.[27]

These advances, however, will be greatly hindered if access to space is restricted by any means. This must be the motivation behind the sections of the Outer Space Treaty that ensure "[o]uter space, including the moon and other celestial bodies, shall be free for exploration and use by all States without discrimination of any kind,"[28] and also that "[o]uter space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[29] The thinking behind this should be self evident: without such a nonappropriation principle, space would be subject to competing claims from various countries that would only be able to enforce these claims through military force.[30] Not only would those claims be nearly impossible to define, but they would cause a huge barrier to the open research and development aspect of space that has been so valuable to mankind's successes so far.[31] Political restrictions, however, are not the only means of cutting off the space resource. At the moment, space debris is an escalating problem that threatens to cut off our access to this resource or at least make access incredibly risky and volatile.[32] To understand this risk, it helps to first understand some of the mechanics of space exploitation.

22. *See* Kenneth Chang, *NASA Hitches a Ride on a Russian Craft, and Begins a New Dependent Phase*, N.Y. TIMES, Nov. 13, 2011, at A6.

23. *NASA Selects Virgin Galactic for Suborbital Flights*, VIRGIN GALACTIC (Oct. 8, 2011), http://www.virgingalactic.com/news/item/nasa-selects-virgin-galactic-for-suborbital-flights.

24. *Id*.

25. *Id*.

26. *See id*.

27. *Id*.

28. Outer Space Treaty, *supra* note 4, at art. I.

29. *Id*. at art. II.

30. Tennen, *supra* note 5, at 807–08.

31. If countries were allowed to claim territory in the space surrounding earth, nations that would want to enter or pass through that space would either have to put up with the headaches of violating the sovereign claims of other nations or simply not head up at all. This would, at the very least, impose extra costs; at most, it would halt exploration.

32. *See* discussion *infra* Part II.B.

A. The Characteristics of Orbital Space

The main areas of space immediately surrounding Earth are commonly referred to as Geosynchronous Earth Orbit (GEO) and Low-Earth Orbit (LEO).[33] GEO is the farther, or higher, of the two orbits, with many satellites in this area orbiting at altitudes in the tens of thousands of kilometers.[34] In this orbit, satellites often retain what seems to be a stationary position over a point on the earth's surface, because they orbit the earth at the same speed that the earth itself rotates.[35] These satellites will usually stay in orbit for a very long time, as they are not as susceptible to atmospheric drag and other environmental factors that will degrade the orbits of satellites in LEO.[36]

The LEO area extends from the upper boundary of airspace to about 4000 km.[37] Because these satellites are closer to Earth, they experience more atmospheric drag, which slows them down and causes them to move closer to Earth.[38] This problem is exacerbated by the fact that the closer to Earth they get, the more they are affected by Earth's gravity and the thicker atmosphere through which they travel.[39] The lifespan of a satellite in this area, however, varies drastically depending on its altitude, lasting anywhere from a few months to an estimated 20,000 years.[40] Satellites in LEO also have much more varied paths and locations.[41] This makes it much more difficult to define an area where a spacecraft will be in LEO than if it were in GEO because those spacecraft appear to be stationary.[42]

A piece of debris, like a satellite, interacts with more atmosphere the closer it is to Earth.[43] Debris closer to Earth can often take care of itself by either burning up in the atmosphere or returning to Earth; debris that is farther away, however, presents a significant hazard to functional spacecraft.[44] Not only does such debris remain in orbit for a particularly long time, but it also has a tendency to replicate itself.[45]

33. Williams, *supra* note 6, at 1144–45.
34. *Id*.
35. *Id*.
36. Michael W. Taylor, *Trashing the Solar System One Planet at a Time: Earth's Orbital Debris Problem*, 20 GEO INT'L ENVTL. L. REV. 1, 4 (2007).
37. Williams, *supra* note 6, at 1144–45.
38. Taylor, *supra* note 36, at 4.
39. *Id*.
40. *Id*. at 3–4, 6.
41. *See, e.g.*, *Real Time Satellite Tracking*, N2YO.COM, http://www.n2yo.com/?s=38075 (last visited May 19, 2013). This website allows you to track various different satellites in real time, showing their diverse paths across the heavens.
42. *See supra* note 35 and accompanying text.
43. *See* Taylor, *supra* note 36, at 4.
44. *Id.* at 6.
45. Williams, *supra* note 6, at 1145–46. For an explanation of the tendency to self-replicate, see *infra* Part II.B.

B. Space Debris

In general, space debris consists of "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."[46] As of January 2011, there were approximately 16,000 space objects catalogued by the U.S. Space Surveillance Network, only about 3,500 of which were functional spacecraft.[47] This leaves approximately 12,500 pieces of catalogued debris.[48] Interestingly, though spacecraft, mission-related objects, and rocket bodies increased fairly linearly since the start of the space age, fragmentation debris has drastically increased since 2007, jumping from approximately 4,000 pieces to approximately 7,000 pieces in the span of a year.[49] While this is due in large part to China's testing of an anti-satellite weapon in space,[50] it is also certainly due in part to the replicating nature of fragmentation debris.[51] For instance, in February 2009, an operational commercial U.S. satellite collided with a defunct Russian satellite, resulting in about 400 pieces of new debris.[52] This, intuitively, creates about 400 new chances for functional spacecraft to be damaged or destroyed.

For something to stay in orbit, it has to move very, very fast (from three to eight kilometers per second, or about 6,700 to 18,000 miles per hour, depending on the altitude of the object).[53] This is due to the physics that governs orbital mechanics.[54] Even in orbit, objects still feel the pull of Earth's gravity.[55] In essence, objects in orbit are constantly falling. Because the Earth is round, however, an object is able to counterbalance the effect of gravity by moving forward fast enough to match the rate of its fall.[56] But this requires a fantastic amount of speed, up to about thirty times that of a commercial airliner.[57] While intuitive that a collision between two satellites travelling at this speed would be

46. Tan, *supra* note 4, at 151 n.21.

47. *See* ORBITAL DEBRIS QUARTERLY NEWS, (NASA Orbital Debris Program, Houston, TX), Apr. 2013, at 10, *available at* http://www.orbitaldebris.jsc.nasa.gov/newsletter/pdfs/ODQNv17i2.pdf.

48. *See id* at 9–10. This includes about 9,000 pieces of fragmentation debris, which are created when spacecraft collide with each other or meteoroids in orbit about 2,000 pieces of mission related debris, which can be from parts jettisoned from spacecraft during missions or from tools and other objects lost during missions and about 2,000 rocket bodies, which are basically gas tanks that are used to get objects into space and are jettisoned once their fuel has been spent. *Id*. at 10.

49. *See Id*.

50. Taylor, *supra* note 36, at 1 n.2.

51. Williams, *supra* note 6, at 1145–46.

52. Natalie Pusey, Note, *The Case for Preserving Nothing: The Need for a Global Response to the Space Debris Problem*, 21 COLO. J. INT'L ENVTL. L. & POL'Y 425, 430 (2010). For a story of a more recent collision, see Agence France-Presse, *Ecuadoran Satellite Collides with Russian Space Junk*, THE RAW STORY (May 23, 2013 13:38 EDT), http://www.rawstory.com/rs/2013/05/23/ecuadoran-satellite-collides-with-russian-space-junk.

53. *See* DAVID WRIGHT ET AL., THE PHYSICS OF SPACE SECURITY: A REFERENCE MANUAL 20–21 (2005), *available at* http://www.amacad.org/publications/Physics_of_space_security.pdf.

54. *See id*.

55. *See id*.

56. Taylor, *supra* note 36, at 3.

57. *See* WRIGHT ET AL., *supra* note 53, at 20–21.

catastrophic, it is also the case that a small object could cause massive damage at this speed.[58]

The amount of damage caused by the collision of two objects is a function of the objects' momentum, which is the product of an object's mass and velocity.[59] Because of this, even a very small object can be extremely damaging if it is travelling fast enough.[60] For example, an average sized brick travelling at three kilometers per second (or about 6,600 miles per hour), which is on the lower end of the orbital speeds, would have as much momentum as a large horse travelling at about thirty-three mph.[61] Not only does space debris carry a large amount of momentum, but it is also often small enough that its impact will be concentrated into a small area, thus maximizing damage to that area.[62] This makes debris very dangerous to sophisticated machinery, such as satellites and spaceships that have various small parts that can be incredibly vulnerable.

Furthermore, debris does not vanish when it impacts or destroys a functional spacecraft. Instead, it multiplies: the collision creates more debris, and these new pieces of debris will fly out in multiple directions, cluttering space even more.[63] This, in turn, makes orbital space that much more cluttered and dangerous, which leads to more collisions, and the cycle continues.[64] If this problem is not dealt with, the amount of orbital debris could continue to increase until it makes certain parts of orbit unusable or unnavigable, even without the addition of more functioning spacecraft into orbit.[65]

The costs of space debris are not limited to merely the loss of functioning spacecraft. There is also the cost of shielding spacecraft from possible debris collisions.[66] This cost is two-fold: not only do launching parties have to spend the money to actually research and develop

58. *See infra* notes 59–61 and accompanying text.

59. *See Momentum and Its Conservation–Lesson 1: The Impulse-Momentum Change Theorem*, THE PHYSICS CLASSROOM, http://www.physicsclassroom.com/class/momentum/u4l1a.cfm (last visited May 19, 2013). Velocity is simply speed with a directional component. *See id*.

60. Williams, *supra* note 6, at 1144.

61. An average brick weighs about 2.5 kg, and a large horse weighs about 500 kg. The formula for momentum is p=mv, where p is momentum, m is object mass, and v is object velocity. Therefore, the momentum of the brick moving at 3 km/s would be 2.5 kg * 3km/s, or 7.5 kg km/s. A large horse with the same momentum would thus be travelling at .015 km/s (calculated by dividing the horse's momentum, 7.5 kg km/s, by its mass, 500kg), or about 33 mph (assuming a conversion rate of about 2200 mph per km/s.) *See Momentum and Its Conservation–Lesson 1: The Impulse-Momentum Change Theorem*, *supra* note 59; *see also* Williams, *supra* note 6, at 1144 ("A 3 mm piece of space debris travelling at 10 km/sec. has as much kinetic energy as a 12 lb bowling ball travelling at 60 mph.") (quoting Gunnar Leinberg, *Orbital Space Debris*, 4 J.L. & TECH. 93, 98 (1989)).

62. Though the amount of force delivered by any sized object with a certain momentum would be about the same, the amount of force per area would be much greater on an object with a smaller impact area. Force per area is the unit of pressure, and larger pressure would correspond to something like going farther down into the ocean. *See Pressure,* HYPERPHYSICS, http://hyperphysics.phy-astr.gsu.edu/hbase/press.html (last visited May 19, 2013).

63. Williams, *supra* note 6, at 1145–46.

64. *Id*.

65. *Id*. at 1146.

66. Taylor, *supra* note 36, at 19–20.

adequate shielding for their spacecraft, they also have to spend extra money for fuel to carry the objects into space.[67] The cost of maneuvering out of the path of debris similarly enters into the equation in two ways.[68] Maneuvering requires extra fuel and thus detracts from what could have been used to further the actual purpose of the spacecraft.[69] Furthermore, for maneuvering to even be effective, there must be prior warning that a collision with debris is imminent.[70] This requires a monitoring system, which requires its own resources to develop the necessary surveillance technology as well as to catalog and monitor debris.[71]

Though the dangerous and replicative nature of the space debris problem is well understood, the nature of the space resource makes it difficult to regulate this problem. First, space is a common resource, which subjects it to falling into a tragedy of the commons.[72] Second, because entities are not allowed to appropriate property in space, governing bodies find it difficult to enforce regulations in space that may help to stem the debris problem.

C. Space Treaty Framework

When the Space Age began in 1957 with the launch of Sputnik,[73] there was not much reason to have an international regime dealing with property rights in space. With the frontier open, however, it did not take long for international powers to realize that a decision had to be made on how to handle the space resource. Within ten years, the United Nations (U.N.) created the Committee on the Peaceful Uses of Outer Space (COPUOS) which, in turn, crafted and enacted the first governing body of space law, the Outer Space Treaty.[74] This treaty laid down the framework for the law that governs space, and over the next few years other new treaties dealt with more specific areas of space governance.

1. Outer Space Treaty

Entering into force in 1967, the Outer Space Treaty was the first large-scale, international treaty agreement governing the use and exploitation of outer space.[75] It is both a declaration of law as well as governing principles that should guide actors in the space arena in both

67. Shielding will increase the weight of the objects and, thus, the force necessary to put them into orbit. *Id*. at 20.

68. *Id*. at 19.

69. *Id*.

70. *Id*.

71. This monitoring function is accomplished in the United States by the U.S. Space Surveillance Network. *Id*. at 8, 12.

72. *See infra* Part II.C.6.

73. David Goldman, *Settlement and Sovereignty in Outer Space*, 22 U.W. ONTARIO L. REV. 155, 167 (1984).

74. Outer Space Treaty, *supra* note 4.

75. *Id*.

their actions and interpretation of the law of outer space.[76] The Outer Space Treaty is a lofty document, aiming to secure space as the "province of all mankind," making sure that all that have the ability have access to outer space.[77] As a rather broad and necessarily vague instrument, it has been interpreted by some as being more suggestion than rule.[78] Regardless of how one views it, the Outer Space Treaty is the starting point for any analysis on the proper actions of space actors.

Article I of the Outer Space Treaty sets up outer space as open to use and exploration by all who have the ability to do so.[79] This is most notably communicated in the clause declaring outer space the "province of all mankind."[80] Even this simple declaration, though, has been subject to some interpretation.[81] One possible interpretation is that the term "province" be interpreted to denote "an administrative district or territory . . . as Ontario is a province of Canada," which would set up a legal obligation to create an international agency to regulate outer space.[82] This, though, would probably put too much burden on this clause. Instead, the clause is best read as denoting that outer space is the *interest* of all mankind, and that all have a stake in it.[83] Another important clause in this Article is the "benefit" clause, stating that outer space activities "shall be carried out for the benefit and in the interests of all countries . . . ."[84] This, too, opens itself to interpretation.[85] One could interpret this to mean that any profits of any type, however derived from space exploration, must be split between all countries.[86] This, however, would be impracticable and unduly burdensome. Furthermore, it would reduce incentives to actually enter into space, which seems to be at odds with the inspiration of the "great prospects" of space exploration touted in the preamble of the Outer Space Treaty.[87] Instead, the correct interpretation probably only requires that the intangible benefits of space exploration and exploitation, such as new scientific knowledge and the benefits of international peace and cooperation, be shared amongst all countries.[88]

76. *See id*. at pmbl.
77. *Id*. at art. I.
78. "While it is admitted that the Outer Space Treaty itself was not intended to deal with all specific matters, the principles contained in the provisions of the Treaty were intended to form the basis of future agreements." Goldman, *supra* note 73, 156.
79. Outer Space Treaty, *supra* note 4, at art. I.
80. *Id.*
81. *See* Goldman, *supra* note 73, at 157–58.
82. *Id*.
83. *Id*. at 158.
84. Outer Space Treaty, *supra* note 4, at art. I.
85. *See* Goldman, *supra* note 73, at 157.
86. *Id*. at 157.
87. Outer Space Treaty, *supra* note 4, at pmbl.
88. Goldman, *supra* note 73, at 157. This also comports with other portions of the Outer Space Treaty, such as the reporting requirements in Articles V and XI. Outer Space Treaty, *supra* note 4, at art. V & XI.

Article II of the Outer Space Treaty is the shortest Article of the Treaty, yet has some of the most profound implications therein.[89] It is the main subject of this Note and reads in its entirety: "Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[90] The interpretation of Article II is fleshed out later in this Note,[91] but for now an introductory explanation will be given. Clearly, Article II prohibits any means of appropriation that may currently exist, or any means of appropriation that may be concocted in the future.[92] What that prohibition means in practice, however, is not so clear. For instance, the Article prohibits appropriation by means of occupation, but to interpret this as meaning that no nation would be allowed to send up an object which would occupy space (which is to say, any object) would be absurd, and directly at odds with the underlying thrust for exploration and exploitation of outer space.[93] So, clearly, a gap exists between what someone could argue is appropriation in the broadest sense of the word and what is actually prohibited by the Outer Space Treaty.[94] This Note analyzes this gap.[95]

The rest of the Outer Space Treaty expands on these concepts of freedom of use and cooperation and sets down more general guidelines for the governance of space.[96] While some of these are analyzed later, it is important to note that none of these Articles directly pertains to the problem of debris creation or control.[97] This goes back to the vague nature of the Outer Space Treaty, which is more like a constitution than a code of regulations or laws.[98]

2. Astronaut Agreement

In 1968, the Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space (Astronaut Agreement) was formed, which has now been ratified by over seventy-five countries.[99] The Astronaut Agreement deals with ways to assist astronauts that may be in danger, and also dictates how to

89. Outer Space Treaty, *supra* note 4, at art. II.

90. *Id.*

91. *See* discussion *infra* Part II.D.

92. Goldman, *supra* note 73, at 158.

93. *See* Stephen Gorove, *Interpreting Article II of the Outer Space Treaty*, 37 FORDHAM L. REV. 349, 352–53 (1969).

94. *See* discussion *infra* Parts II.D, III.B.

95. *See* discussion *infra* Part II.D.

96. For instance, Article III mandates that international law shall govern activities in outer space, and Article IV mandates that space be used only for peaceful activities. Outer Space Treaty, *supra* note 4, at arts. III & IV.

97. Outer Space Treaty, *supra* note 4.

98. *See supra* note 78 and accompanying text.

99. Tan, *supra* note 4, at 156, n.49.

handle space objects that return to Earth in foreign jurisdictions.[100] In general, the Astronaut Agreement requires parties subject to the agreement to return any spacecraft or pieces thereof that might land in their territory to the launching state, and it also requires parties subject to the agreement to render aid in the event that "the personnel of spacecraft" land in the party's territory.[101] Though much of this agreement is focused on what to do with spacecraft and personnel that return to Earth under adverse conditions, there are some portions that could be relevant to the space debris problem. For instance, Article 1 is a general notification requirement that mandates that any party subject to the agreement notify a launching party if information is obtained about any damage or accident to the launching party's spacecraft.[102]

By extension, even some of the portions of the Astronaut Agreement pertaining to terrestrial recovery could come to bear in the effort to control space debris. The Astronaut Agreement entered into force in 1968,[103] a time in which few probably foresaw the capabilities that mankind would come to have in space.[104] For instance, the Astronaut Agreement does not speak to the interaction between parties or spacecraft while the craft actually remain in space.[105] This may be because the idea that mankind would achieve the capability to do so, or that objects would be close enough to each other that such interaction would be practical, was far ahead of its time. Now, however, the idea is not so farfetched.[106] One example from the Astronaut Agreement which might affect the space debris issue is the requirement that a party subject to the agreement offer assistance in recovering spacecraft that fall into the high seas, under the jurisdiction of no state, when the party subject to the treaty is "in a position to do so."[107]

3. Liability Convention

In 1972, the Convention on the International Liability for Damage Caused by Space Objects (Liability Convention) was created, and provided guidelines for how to handle liability for damage caused by a space object.[108] This treaty, like the Outer Space Treaty, apportions responsibility for damage to the countries whose objects cause the damage, but neither treaty speaks specifically of the space debris

100. Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 (entered into force Dec. 3, 1968) [hereinafter Astronaut Agreement]; *see also* Tan, *supra* note 4, at 158.

101. Astronaut Agreement, *supra* note 100.

102. *Id*. at art. 1.

103. *Id.*

104. At the time the agreement was entered into, computers were mostly still the behemoths that would require an entire room to house. *See Timeline of Computer History*, COMPUTER HISTORY MUSEUM, http://www.computerhistory.org/timeline/?category=cmptr (last visited May 19, 2013).

105. Astronaut Agreement, *supra* note 100.

106. *See, e.g.*, *Real Time Satellite Tracking*, *supra* note 41.

107. Astronaut Agreement, *supra* note 100, at art. 3.

108. Tan, *supra* note 4, at 159.

problem.[109] Because of the nature of space debris, it is often difficult, if not impossible, to determine the owner of a particular piece of debris, and the Liability Convention only deals with actual destruction caused by a piece of debris, not the creation of the debris itself.[110]

The main reason that the Liability Convention fails to properly address the space debris problem is that it was probably motivated more by a worry about what happens when defunct spacecraft return to Earth than what will happen when objects collide in space.[111] This is shown through the differing treatment that is provided for liability for collisions on Earth versus liability for collisions in space.[112] Launching parties are "absolutely liable" if their spacecraft cause damage on Earth (or to aircraft within the boundaries of Earth-space).[113] If there is damage to another spacecraft in space, however, the launching party will "be liable only if the damage is due to its fault or the fault of persons for whom it is responsible."[114] Here, damage refers only to people or property, not to the actual space environment itself.[115] Further, the Liability Convention gives no definition of the word "fault," nor does it give any guidelines for an appropriate standard of care to be undertaken during space actions.[116]

Finally, there are some serious problems with the enforcement of the Liability Convention. Most of the text of the Liability Convention sets up the channels that must be used to recover damages in case of actions that fall under the purview of the treaty.[117] As is the case in many judicial proceedings, however, the complication and sluggishness of such proceedings will often create a barrier to their effective use, forcing parties to settle their claims independently of the Liability Convention and thus robbing the treaty of its full force.[118]

4. Registration Convention

In 1976, the Convention on Registration of Objects Launched into Outer Space (Registration Convention) was formed.[119] This convention requires countries to register any launches in a national database as well

109. *Id*. at 166.

110. *See* Convention on International Liability for Damage Caused by Space Objects, Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 (entered into force Oct. 9, 1973) [hereinafter Liability Convention].

111. Pusey, *supra* note 52, at 439.

112. *Id*.

113. Liability Convention, *supra* note 110, at art. II

114. *Id.* at art. III.

115. Pusey, *supra* note 52, at 439.

116. Liability Convention, *supra* note 110; *see also* Pusey, *supra* note 52, at 439.

117. Liability Convention, *supra* note 110, at art. VIII–XX.

118. *See* Pusey, *supra* note 52, at 439–40 (discussing the breakup and fall of a Soviet spacecraft into Canadian territory and the eventual independent settling of the claim, without the Soviet Union ever admitting fault for the damage caused due to the spacecraft's reentry).

119. Tan, *supra* note 4, at 159.

as the U.N. Space Objects Registry.[120] While this convention helped to establish ownership of spacecraft that may cause damage, it still does not deal with the problem of debris.[121]

The Registration Convention requires that launching states provide such information as nodal period, inclination, apogee, and perigee,[122] which give a good initial indication of any possible disruptions that may be encountered in orbit.[123] More information is required, however, for this to be truly useful in curbing the debris problem.[124]

5. Moon Agreement

In 1979, the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement) was formed.[125] This agreement supplements the Outer Space Treaty, reaffirming the nonappropriation article and adding extra guidelines to the exploitation of space resources.[126] Though the Moon Agreement includes a prohibition on the contamination of the moon and space environment, it is not specific enough to create any real guidelines in that regard.[127]

In large part, the Moon Agreement just reiterates the provisions of the Outer Space Treaty with specific reference to the moon.[128] For instance, the Moon Agreement requires that moon exploration be carried out "in accordance with international law," be done "exclusively for peaceful purposes," and that such exploration shall be "the province of all mankind."[129] As mentioned above, the Moon Agreement has a provision regarding the maintenance of the environment on and around the moon, but this has little application to the problem of space debris.[130]

A more interesting and useful application of the Moon Agreement comes from viewing how it affects the definition of "appropriation" in the Outer Space Treaty.[131] For instance, the Moon Agreement specifically provides for countries "[p]lac[ing] their personnel, space vehicles, equipment, facilities, *stations* and *installations* anywhere on or

120. Convention on Registration of Objects Launched into Outer Space, arts. II–IV, Nov. 12, 1974, 28 U.S.T. 695, 1023 U.N.T.S. 15 (entered into force Sept. 15, 1976) [hereinafter Registration Convention].

121. *See* discussion *infra* Part III.A.4.

122. Registration Convention, *supra* note 120, at art. IV.

123. These are some basic descriptors of an object's orbit, and can be used to calculate, to at least some degree of certainty, the object's path. *See* AIR UNIVERSITY, AIR UNIVERSITY SPACE PRIMER 8-11 (July 23, 2003), *available at* http://space.au.af.mil/primer/orbital_mechanics.pdf.

124. *See* Pusey, *supra* note 52, at 438 (suggesting "satellite orbital positions, notifications of orbit changes, and notifications if an object has broken apart").

125. Tan, *supra* note 4, at 159.

126. *Id*. at 159–60.

127. Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 18 I.L.M. 1434, 1363 U.N.T.S. 3 at art. 7 [hereinafter Moon Agreement].

128. *Id*.; Outer Space Treaty, *supra* note 4, at art. I–V.

129. Moon Agreement, *supra* note 127, at arts. 2–4; Outer Space Treaty, *supra* note 4, at arts. I, III & IV.

130. Moon Agreement, *supra* note 127, at art. 7.

131. Outer Space Treaty, *supra* note 4, at art. II.

below the surface of the moon."[132] This specific provision for stations and installations suggests that the erection of something like a permanent fixture would be allowable under the regime of the Outer Space Treaty. This means that occupancy of a specific portion of space, even for an indefinite period of time, would not actually constitute "appropriation by . . . use or occupation."[133] Further, the Moon Agreement's mandate that such use not interfere with similar uses of other countries suggests that countries may be allowed to exclude others or at least take some sort of priority in use.[134] This makes sense, since the goal of the nonappropriation article is to ensure the freedom of exploration and exploitation of space, not to keep people from occupying space.[135] This availability of exclusive use has important implications in later contexts and in evaluating possible regulatory solutions to the space debris problem.[136]

6. Tragedy of the Commons

While these treaties supplement the Outer Space Treaty and seem to recognize the potential problems of space debris, they do nothing to directly control the problem. First off, only countries that actually signed the treaty are subject to its rules.[137] And even those that have not signed are still entitled to treat the resource as a common resource, without worry of impeding the progress of other nations.[138] This is because the Outer Space Treaty guarantees that "there shall be free access to all areas of celestial bodies,"[139] and that "[o]uter space . . . is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[140] With the exception of barring certain specific types of use,[141] the Outer Space Treaty allows all into space who possess the desire and ability to travel there.

When a resource is a common resource, it is often subject to what is called the tragedy of the commons.[142] This idea refers to the inevitable depletion of a resource that is used by multiple actors who do not internalize the cost of their use.[143] It is often analogized to a group of herdsman using a pasture for grazing:

132. Moon Agreement, *supra* note 127, at art. 8 (emphasis added).
133. Outer Space Treaty, *supra* note 4, at art. II.
134. Moon Agreement, *supra* note 127, at art. 8.
135. Goldman, *supra* note 73, at 159.
136. *See* discussion *infra* Part II.D.4.
137. *See* Tan, *supra* note 4, at 170 (noting that "treaty law binds only those states which have accepted its obligations").
138. Outer Space Treaty, *supra* note 4, at art. I.
139. *Id.*
140. *Id*. at art. II.
141. *See, e.g.*, *id*. at art. IV (instructing nations "not to place in orbit around the earth any objects carrying nuclear weapons or any other kinds of weapons of mass destruction . . . .").
142. *See* Garrett Hardin, *The Tragedy of the Commons*, 162 SCIENCE 1243–44 (1968).
143. *Id*.

> As a rational being, each herdsman seeks to maximize his gain. Explicitly or implicitly, more or less consciously, he asks, "What is the utility *to me* of adding one more animal to my herd?" This utility has one negative and one positive component.
>
> 1. The positive component is a function of the increment of one animal. Since the herdsman receives all the proceeds from the sale of the additional animal, the positive utility is nearly +1.
>
> 2. The negative component is a function of the additional overgrazing created by one more animal. Since, however, the effects of overgrazing are shared by all the herdsmen, the negative utility for any particular decision-making herdsman is only a fraction of -1.
>
> Adding together the component partial utilities, the rational herdsman concludes that the only sensible course for him to pursue is to add another animal to his herd. And another; and another . . . . But this is the conclusion reached by each and every rational herdsman sharing a commons. Therein is the tragedy.[144]

Because space is the "province of all mankind,"[145] nothing stops a desiring actor from sending up most kinds of satellites. That actor reaps all of the rewards of its endeavor, but will be able to distribute many costs (such as debris creation) among all spacefaring nations.[146] Without a legal regime in place to comprehensively deal with the problem of space debris, nations and private actors will continue to pollute the space resource.[147] Any legal solution offered to deal with the problem, however, must conform to the nonappropriation article of the Outer Space Treaty, else it will be invalid and unenforceable under international law.[148] The big question is, then, what counts as appropriation, and what would be allowable under the nonappropriation article of the Outer Space Treaty?[149]

D. Appropriation

Though the Outer Space Treaty flatly prohibits national appropriation of space,[150] it leaves unanswered many questions as to what actually counts as appropriation. As far back as 1969, scholars wondered about the implications of this article.[151] While it is clear that a nation may not claim ownership of the moon, other questions are not so clear. Does the prohibition extend to collecting scientific samples?[152] Does creating

144. *Id*.
145. Outer Space Treaty, *supra* note 4, at art. I.
146. This is the defining characteristic of the Tragedy of the Commons. *See* Hardin, *supra* note 142, at 1243–44.
147. Because they have no internalized cost, rational actors will continue to expend the resource. *Id*.
148. Outer Space Treaty, *supra* note 4, at art. II.
149. *Id*.
150. *Id*.
151. *See, e.g.*, Gorove, *supra* note 93, at 349.
152. *Id.* at 350.

space debris count as appropriation by occupation? While the answers to these questions are most likely no, simply because of the difficulties that would be caused otherwise, there are some questions that are more difficult to answer, and more pressing.

As commercial space flight becomes more and more prevalent,[153] the question of whether private entities can appropriate property in space becomes very important. Whereas once it took a nation to get into space, it will soon take only a corporation, and scholars have pondered whether these entities will be able to claim property in space.[154] Though this seems allowable, since the treaty only prohibits "national appropriation,"[155] allowing such appropriation would lead to an absurd result. This is because the only value that lies in recognition of a claim is the ability to have that claim enforced.[156] If a nation recognized and enforced such a claim, this enforcement would constitute state action.[157] It would serve to exclude members of other nations and would thus serve as a form of national appropriation, even though the nation never attempted to directly appropriate the property.[158] Furthermore, the Outer Space Treaty also requires that non-governmental entities must be authorized and monitored by the entities' home countries to operate in space.[159] Since a nation cannot authorize its citizens to act in contradiction to international law, a nation would not be allowed to license a private entity to appropriate property in space.[160]

While this nonappropriation principle is great for allowing free access to space, thereby encouraging research and development in the field, it makes it difficult to create or police a solution to the space debris problem. A viable solution will have to work without becoming an appropriation. There is, however, very little substantive law on what actually counts as appropriation in the context of space.[161] So, the best way to see what is and is not allowed is to look both at the general international law regarding appropriations and to look at the past actions of space actors to see what has been allowed (or at least tolerated) and what has been prohibited or rejected.

153. *See, e.g.*, Olivier M. Ribbelink, *The Protocol on Matters Specific to Space Assets*, 12 EUR. REV. PRIVATE L. 37, 38 (2004).

154. Gorove, *supra* note 93, at 351–52.

155. Outer Space Treaty, *supra* note 4, at art. II.

156. Tennen, *supra* note 5, at 805.

157. *Id*. at 806.

158. *Id*. at 805–06.

159. Outer Space Treaty, *supra* note 4, at art. VI.

160. Tennen, *supra* note 5, at 806.

161. For example, when a Nevada court had the chance to decide whether or not a private individual could claim rights to an asteroid, it passed on the question of appropriation and instead based its negative answer to the question on the fact that the agency through which the plaintiff registered his ownership of the asteroid never actually purported to give title to property in space. Nemitz v. United States, CV-N030599-HDM (RAM), 2004 WL 3167042, at *1–2 (D. Nev. Apr. 26, 2004) *aff'd sub nom*. Nemitz v. N.A.S.A., 126 F. App'x 343 (9th Cir. 2005).

1. Sources of International Law

In trying to decide whether or not something will constitute appropriation for purposes of Article II of the Outer Space Treaty, it would be helpful to be able to look at a casebook or reporter, find cases relevant to the question, and synthesize a rule from these opinions. Unfortunately, there is no such corollary that has the information necessary to make an informed decision on this subject, so we must look to other sources of international law.

The first relevant source of international law is the body of treaties that regulate a certain subject area.[162] These have been discussed above,[163] and though they give a good background for the ideals behind the international law governing outer space, they do not do enough to actually give any "prescriptions for action in situations of choice . . . ."[164] So, to find a body of law that can answer the question of what constitutes appropriation, we will have to look to customary international law. Customary international law is formed through the accession of the international community to actions of others.[165] While treaties only bind those states that sign the treaty, customary international law binds the entire international community.[166] Thus, if we can see what sorts of acts the international community has acceded to and accepted as legitimate, we can begin to see the contours of what "appropriation" actually is.

2. Non-Space Appropriation

In general, nations have appropriated areas by some sort of physical ceremony, such as establishing colonies or planting a flag.[167] There have been no decent standards set up, however, for determining whose claim was superior in instances in which claims competed.[168] Instead, these claims would only survive if they were backed up by military power, and the superior claim would belong to the victor of the struggle over the disputed territory.[169] From this, it is clear that any nation which tried to exclude other nations from any portion of space through use of force would be considered to have appropriated, or at least attempted to appropriate, that portion of space, and it would be prohibited from doing so.[170] In fact, there is a good chance that the possibility of such a scenario, multiplied by the number of interested parties in space, helped

162. *See* Tan, *supra* note 4, at 165.
163. *See supra* discussion at II.C.
164. Tan, *supra* note 4, at 165.
165. While this is an extremely simplified discussion of what customary international law is and how it arises, it will do for the purposes of this discussion. *See id*. at 170–71.
166. With the exception of persistent objectors. *See id*. at 170.
167. Tennen, *supra* note 5, at 804.
168. *Id*.
169. *Id*.
170. *Id*.

to inspire the drafters of the Outer Space Treaty to include the nonappropriation article.[171]

Also, the classical version of property law gives dominion to the owner of an article of land from the center of the earth to the reaches of the heavens.[172] While this presents obvious problems for objects in LEO, which move over large amounts of landspace very quickly and thus would go through many different parcels of property,[173] it seems like it could be applied to objects in geostationary orbit, since they stay over one piece of land indefinitely.[174] If this were the case, would countries that lie under the orbit of a geostationary satellite already have claim to that area that predated the Outer Space Treaty, or would they be subject to having satellites hanging over them against their wills?

3. The Bogotá Declaration

In 1976, equatorial countries tried to claim geostationary orbit as their property.[175] This declaration, however, was rejected by nations not party to it, and it only had the support of its eight signatory nations.[176] While this was clearly a violation of the nonappropriation article, it did not stop these countries from trying to control this resource, despite some of them being signatories of the Outer Space Treaty.[177] Because of its lackluster reception, though, it is safe to say that this act did not comport with the Outer Space Treaty.

The implications of this should be fairly obvious, but they are worth expounding upon. Put simply, it cements the idea that a nation cannot simply, of its own authority, claim to own a portion of space.[178] It also rejects the idea that anyone may have owned some portion of space before the Outer Space Treaty went into effect.[179] This basically clears the slate for property rights in space, again ensuring that nobody simply owns any portion of space by right of claim.[180] But, as will be discussed later, it seems that this restriction is only of real consequence when the actor attempting to claim ownership rights over space is a specific nation

171. *Id*.

172. *See, e.g*., Edwards v. Sims, 24 S.W.2d 619, 620 (Ky. Ct. App. 1929) ("Cujus est solum, ejus est usque ad coelum ad infernos (to whomsoever the soil belongs, he owns also to the sky and to the depths), is an old maxim and rule."). This rule, of course, has severe trouble adapting to the age of space exploration.

173. Taylor, *supra* note 36, at 5–6.

174. *Id*. at 6.

175. Declaration of the First Meeting of Equatorial Countries, Bogota, Colom., Dec. 3, 1976, *reprinted in* II MANUAL ON SPACE LAW 383 (Nandasiri Jasentuliyana & Roy S. K. Lee eds., 1979).

176. Tennen, *supra* note 5, at 809 n.70.

177. Brazil, Ecuador, Indonesia, Kenya, and Uganda have ratified the treaty, while Colombia and Congo have signed the treaty, leaving only Zaire without any involvement in the treaty. Outer Space Treaty, *supra* note 4, at Signatory List.

178. *Id*. at art. II.

179. Tennen, *supra* note 5, at 808.

180. Outer Space Treaty, *supra* note 4, at art. II.

or group of nations, as opposed to the international regulatory community at large.[181]

4. The International Space Station

The International Space Station presents a unique application of the nonappropriation principle. All spacecraft must inherently occupy some amount of space. If this were to constitute appropriation by occupation and thus violate the nonappropriation article, the result would be absurd and would render the nonappropriation article unenforceable. The International Space Station, however, is different from regular satellites in that it actually contains a livable area within itself, making it a sort of man-made celestial body.[182] Thus, it would seem that any exclusion of any party from the space *inside* the spacecraft would count as appropriation by exclusion. It would even stand to reason that any claim of ownership of any part of the spacecraft would be appropriation by claim of sovereignty. In fact, the Intergovernmental Agreement on Cooperation in the Detailed Design, Development, Operation, and Utilization of the Permanently Manned Civil Space Station (ISS Agreement) sets up a regime of national control, ownership, and exclusion.[183] So why does this not count as appropriation?

Though it may seem that the International Space Station has appropriated the space it occupies through the terms of the ISS Agreement, this agreement has one important bit of language to keep it safe.[184] Specifically, the ISS Agreement says that "[n]othing in this agreement shall be interpreted as . . . constituting a basis for asserting a claim to national appropriation over outer space or over any portion of outer space."[185]

The effectiveness of such a proclamation may make it seem that it is enough for an actor merely to *say* that it is not appropriating space. That cannot be the case, however, because any actor could make such a claim and then act in direct violation of it. Something more subtle must be going on in the context of the International Space Station.

One of the saving graces of the International Space Station must be that the ISS Agreement makes sure that the space station complies with the general principles guiding the exploration and exploitation of outer space.[186] Indeed, the space station is a cooperative effort, furthering the

181. *See* discussion *infra* Part II.D.5.

182. Agreement Among the Government of Canada, Governments of Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station, Jan. 29, 1998, T.I.A.S. No. 12927, art. 1 ¶ 1 [hereinafter ISS Agreement] (noting that the ISS shall be "permanently inhabited").

183. *Id*.

184. *Id*. at art. 2.

185. *Id*.

186. David C. Stewart, *Resolution of Legal Issues Confronting the International Space Station Project: A Step Forward in the Development of Space Law*, 29 VA. J. INT'L L. 745, 750 (1989).

goal of international harmony through space exploration.[187] The agreement establishing the space station also directly states that it "will enhance the scientific, technological, and commercial use of outer space," thus furthering the Outer Space Treaty's goal of making sure that use is for the benefit of all.[188] Furthermore, the ISS Agreement provides that the International Space Station will be used for peaceful purposes, again complying with the Outer Space Treaty's mandate of the same.[189] By complying with the underlying principles of the Outer Space Treaty, it seems that the International Space Station gains legitimacy and is thus not subject to stricter interpretations of the nonappropriation article.[190]

Another characteristic of the International Space Station that separates it from other acts of appropriation is that it is a multi-national entity.[191] Though different nations do have different rights with respect to certain parts of the spacecraft, those rights are subject to a multi-national agreement.[192] Thus, it may accurately be said that while there has been no *national* appropriation of space, there has been *international* appropriation of space, which may be allowed under the current regime.[193]

The combination of the international character of the International Space Station and its compliance with the underlying principles of the Outer Space Treaty allow it a presumed legitimacy,[194] or these aspects have at least kept any nation from attacking it under the nonappropriation article of the Outer Space Treaty.[195] This creates further leeway in the application of the nonappropriation article and may allow for a similar international cooperation in the regulation of the creation of space debris.

5. The International Telecommunications Union

Because of their unique properties, GEO orbits are "strategic for telecommunication and broadcasting" and also constitute "a limited resource."[196] It is for this reason that the International Telecommunications Union (ITU) allocates orbital sites in the GEO

187. *Id*. at 750; *see also* Outer Space Treaty, *supra* note 4, at pmbl.
188. ISS Agreement, *supra* note 182, at art. 1; Outer Space Treaty, *supra* note 4, at art. I.
189. ISS Agreement, *supra* note 182, at art. 1; Outer Space Treaty, *supra* note 4, at art. IV.
190. Outer Space Treaty, *supra* note 4, at art. II.
191. ISS Agreement, *supra* note 182, at art. 2.
192. *Id*.
193. *Id*. The argument that private appropriation must count as national appropriation (because it is worthless unless recognized by a nation) does not necessarily extend to international appropriation. Since it is the international tribunal that would recognize such a claim, and not any nation specifically, such a method of appropriation would not necessarily violate the edict of the nonappropriation principle. *Cf.* Tennen, *supra* note 5, at 805–06.
194. *See supra* notes 190–93 and accompanying text.
195. Outer Space Treaty, *supra* note 4, at art. II.
196. Susan Cahill, *Give Me My Space: Implications for Permitting National Appropriation of the Geostationary Orbit*, 19 WIS. INT'L L.J. 231, 231 (2001).

area.[197] Though the ITU is a technical administration, as opposed to a legislative body, its resolutions are almost always complied with by the international community.[198] It is tasked with allocating the communication spectrum as well as the physical orbital sites for geostationary orbit, but only the latter is relevant to this discussion.[199]

The ITU prohibits private rights to orbital sites.[200] Instead, only governmental entities can claim orbital slots.[201] Private entities can, however, make use of the orbital slots through one of two means.[202] First, private entities can go through the national regulatory authority, such as the U.S. Federal Communications Commission, and have their application then forwarded to the ITU.[203] This, in essence, means that the nation itself is still the entity staking a claim to the orbital slot, and the private user is simply allowed to use the slot.[204] Second, a private entity can gain usage rights to a geostationary orbital slot through membership in an Intergovernmental Satellite Organization (ISO).[205] ISOs are comprised of national governments, which are the "parties" to the treaty, and the private entities that own and operate the satellites, which are the "signatories" to the treaty.[206] ISOs, due to their international character, are able to skip the process of going through national regulatory authorities and can instead interact with the ITU directly. Thus, ISOs claim rights to orbital slots in their own names, as opposed to making claims in the name of a specific nation.[207]

The ITU uses two systems to allocate orbital slots, the *a priori* system and the *a posteriori* system.[208] The *a priori* system allows nations to claim future rights to orbital slots, based on certain criteria, even when they do not yet have the capability to enter those slots.[209] The *a posteriori* system is a need-based system, which allocates rights on a first-come, first-served basis.[210] Entities are also allowed to consent to the consumption of their slots by other entities.[211] This dual-system approach is meant to strike a balance between making sure that space-capable nations can acquire slots when needed while ensuring that developing nations will have the ability to claim slots when they develop the capability to occupy them.[212] This strikes a chord with the mandate of the

197. *Id*. at 231–32.
198. *Id*. at 232.
199. *Id*. at 233.
200. *Id*. at 234.
201. *Id*.
202. *See id*. at 235.
203. *Id*.
204. *Id*.
205. *Id*.
206. *Id*.
207. *Id*.
208. *Id*. at 238.
209. *Id*. at 238–39.
210. *Id*.
211. *Id*. at 239.
212. *Id*. at 239–40.

Outer Space Treaty that space remains the "province of all mankind," not just the province of those who are currently able to exploit it.[213]

The issues presented in relation to the nonappropriation article of the Outer Space Treaty should be clear.[214] The ITU has, quite blatantly, created something akin to "property interests in outer space."[215] It allows nations to exclude others from their orbital slots, even when the nation is not currently using that slot.[216] This is directly in line with at least one definition of outer-space appropriation.[217] The ITU even allows nations with unused slots to devise them to other entities, creating a market for the property rights set up by this regulation.[218] In some aspects, this seems to effect exactly what those signatory nations of the Bogotá Declaration were trying to accomplish, albeit through different means.[219]

Though the legitimacy of such a regime may be questionable, it remains in effect, showing that it is at least tolerable under the edict of the nonappropriation article of the Outer Space Treaty.[220] There must, therefore, be something about the ITU that differentiates it from something like the Bogotá Declaration.[221] The most immediate difference is the character of the body promulgating the regulation. The Bogotá Declaration is an agreement between eight countries claiming rights to all space above them.[222] The ITU's regulations are promulgated under the auspices of the U.N.[223] While the Bogotá Declaration is an international agreement, it is still a very limited cooperation.[224] The ITU, through the U.N., comprises the largest possible cooperation of international actors, giving it an *inter*national character as opposed to simply a *multi*national character.[225] Furthermore, the allocation of orbital slots by the ITU is a response to the limited character of geostationary orbits.[226] While the Bogotá Declaration was probably promulgated in response to a few nations' fears that they may be excluded from the

213. Outer Space Treaty, *supra* note 4, at art. I.

214. *Id.* at art. II. This may be why "no consensus has been reached on the legal status and regulation of [geostationary] orbits." Cahill, *supra* note 196, at 231.

215. Cahill, *supra* note 196, at 243.

216. *Id*. at 239.

217. *Id*. at 236 ("Appropriation of outer space, therefore, is 'the exercise of exclusive control or exclusive use' with a sense of permanence, which limits other nations' access to it.") (*quoting* Milton L. Smith, *The Role of the ITU in the Development of Space Law*, 17 ANNALS AIR & SPACE L. 157, 165 (1992)).

218. *See* Cahill, *supra* note 196, at 244 (discussing Tonga's "rental and auctioning of slots"). The ITU recognized the problems with this sort of use, however, and promulgated new regulations requiring that "a majority of slots applied for be used directly by the requesting country." *Id*.

219. *See* discussion *supra* Part II.D.3.

220. Outer Space Treaty, *supra* note 4, at art. II. It is important to note, however, that some countries have challenged the legitimacy of the regulation, and some, such as Indonesia and Thailand, have even "launched satellites into areas allotted to other countries." Cahill, *supra* note 196, at 247.

221. *See* discussion *supra* Part II.D.3.

222. *Id*.

223. Cahill, *supra* note 196, at 232.

224. *See* discussion *supra* Part II.D.3.

225. Cahill, *supra* note 196, at 232.

226. *Id*. at 231.

space arena,[227] the allocation system of the ITU is a measure to make sure that the GEO resource is efficiently managed for the use of all mankind.[228]

III. ANALYSIS

There are a few options for how to deal with the problem of space debris. The first would be to simply let things proceed as they are. It should be clear that this will not suffice, due to the common-resource nature of outer space.[229] Part III.A below discusses why the treaty framework as it stands is not enough to ensure the preservation of the space resource. There is also the possibility of expanding the interpretation of the Outer Space Treaty and the other treaties regarding use of space to require space actors to address the debris problem. For instance, the Outer Space Treaty includes a mandate that space exploration "be carried out for the benefit and in the interests of all countries . . . ."[230] This could be read to require that space exploration be carried out in such a way to ensure access to those countries not currently technologically advanced enough to reach it, which would include addressing the debris problem. While this seems feasible, it would be quite a stretch in interpretation, and it would offer no actual guidelines on *how* to address the problem.

If the treaties that comprise international space law are not enough as they stand, then something else must be done. As discussed previously, the nonappropriation article of the Outer Space Treaty appears to stand in the way of any such regulation.[231] This presents two options for regulation: either abrogate the nonappropriation article of the Outer Space Treaty, or act in a way that is in compliance with that article. While abrogation of the nonappropriation article would seem to make things simpler, it would come with a host of other problems. Without such a principle, there would be a race for states to make claims to "orbits, locations, and entire moons and other celestial bodies."[232] These claims could be founded on a host of theories, and there would almost certainly be some overlap between the claims of various states.[233] This could lead to armed conflict, on the ground or in space, which would put a significant damper on the open access characteristic of space and possibly even lead to accelerated debris creation.[234] This would be counterproductive, and so instead of trying to abrogate the nonappropriation article of the Outer Space Treaty, some sort of

227. *See id*. at 240.
228. *Id*. at 235.
229. *See* discussion *supra* Part II.C.6.
230. Outer Space Treaty, *supra* note 4, art. I.
231. *See* discussion *supra* Parts II.C.1 and II.D.
232. Tennen, *supra* note 5, at 807.
233. *Id*. at 807–08.
234. *Id*. at 808.

regulation must be promulgated that will both satisfactorily address the debris problem and comport with the strictures of nonappropriation.

While there are many possibilities as to what sort of regulation would be preferable, this Note focuses on a cap-and-trade system.[235] This system is preferable because "[t]radable allowances are more cost-effective, generate more innovation and facilitate greater global participation than any other resource management strategy."[236] Having established the type of regulation which should be used, all that remains is to ensure that the regulation is propagated in a way that obeys the nonappropriation article of the Outer Space Treaty.

For a regulatory body to be legitimate in light of the Outer Space Treaty, it must exist and operate without violating the nonappropriation article thereof.[237] The proper interpretation of this article is not inherently apparent, however, and so the evaluation of any given regulation requires the analysis of certain factors.[238] The vagueness of the Outer Space Treaty should be embraced rather than shunned, however, as it allows the body of international space law to adapt to changing conditions rather than to stagnate.[239] Part III.B of this Note analyzes the space actions discussed in Part II.D above to see what actions can pass scrutiny under the nonappropriation article of the Outer Space Treaty. Part III.B concludes by proposing that, to be legitimate, a regulation must be of an international character, must comport with the underlying principles driving international space law, and must be a proportionate response to a concern with international implications.

A. Treaty Framework Analysis

1. Outer Space Treaty

The Outer Space Treaty is a grand list of principles and ideals that is meant to ensure that space remains open to access for all who possess the will and capacity to travel to it.[240] These provisions, however, are very general, and as such do not create any particular obligations or responsibilities for the states party to it.[241] It could be argued that this vagueness allows for an interpretation that mandates action to curb problems that affect all space actors, such as the problem of space debris. But, even if this were the case, it gives no guidance on what to do about

235. A full analysis of why a cap-and-trade system would be the best system for dealing with the space debris problem is material for another Note entirely. Luckily, such a Note has been written. *See* Jared B. Taylor, Note, *Tragedy of the Space Commons: A Market Mechanism Solution to the Space Debris Problem*, 50 COLUM. J. TRANSNAT'L L. 253 (2012).

236. *Id*. at 279.

237. Outer Space Treaty, *supra* note 4, at art. II.

238. *See* discussion *supra* Part II.D.

239. Outer Space Treaty, *supra* note 4; *see also infra* notes 240–242 and accompanying text.

240. *See* discussion Part II.C.1

241. *See* Tan, *supra* note 4, at 165–66 ("Where a treaty provides only for general goals and statements of policy, it is itself 'soft' and is devoid of any significant legal content.").

the problem. It is therefore more useful to try to understand the principles of the Outer Space treaty as just that—principles—instead of trying to stretch the language to achieve a desirable outcome.

Though counterintuitive, the vagueness of the Outer Space Treaty actually allows it to be more active in the creation of a body of international law. Because it is vague, it creates no hard-line legal obligations in and of itself.[242] Instead, the Outer Space Treaty creates a guideline that must be followed. Under the doctrine of customary international law, this creates a metric by which to measure the actions of space actors.[243] As other states accede to these actions, they grow into a body of customary law, which will not only bind those parties to the treaty, but also the international community at large.[244] Thus, by being vague, the Outer Space Treaty is actually more powerful.

2. Astronaut Agreement

There are a few portions of the Astronaut Agreement which could be relevant to the debris problem. For instance, Article 1 mandates the reporting of any information about damage sustained to a launching party's spacecraft.[245] While it may not seem like much, the speedy reporting of damage to spacecraft can help fix liability for the debris creation on at least one of the involved parties.[246] Since one of the biggest hurdles in controlling the debris problem is determining who is liable for what debris, this reporting requirement can offer a start to identification of liable parties. There is also the provision which requires able parties to offer assistance in recovering spacecraft that have fallen into the high seas.[247] It is not too far of a stretch to imagine the area of space itself to be treated similarly to those portions of the high seas which are under no state's jurisdiction.[248] By extension, then, one may argue that the Astronaut Agreement also requires that states party to the treaty, which are in a position to do so, offer assistance in recapturing and returning space objects that become damaged or dysfunctional while still in orbit.[249] If so, this could cut down on the amount of dysfunctional objects in orbit, which both constitute space debris in and of themselves as well as create the possibility for the creation of more debris.[250]

242. *See id*.
243. *See* discussion *supra* Part II.D.1.
244. *See* discussion *supra* Part II.D.1.
245. Astronaut Agreement, *supra* note 100, at art. 1.
246. This being the party whose spacecraft has been damaged. Though there are some instances in which the party whose debris has caused the damage will also be identifiable, oftentimes the debris will be too small to be accurately attributable to any particular source. *See supra* note 47.
247. Astronaut Agreement, *supra* note 100, at art. 3.
248. Goldman, *supra* note 73, at 166.
249. Reading the Astronaut Agreement as such, however, may be too much of a stretch. There is an argument, though, that the vagueness of the agreement, as with other agreements, may be properly interpreted to allow just such stretched applications. *See supra* note 247 and accompanying text.
250. *See* discussion *supra* Part II.B; *see also supra* note 47 and accompanying text.

While there are some instances of places where the Astronaut Agreement could be relevant to the debris problem, they are few and would require some creative interpretations. This makes sense, as the Astronaut Agreement is focused on the safety of those people who enter space, not the security of the space environment as a whole.[251] As such, the Astronaut Agreement is not, in and of itself, nearly enough to address the debris problem.

3. Liability Convention

The Liability Convention, with its focus on damage caused to spacecraft, may seem like a good place to look for a treaty that deals with the debris problem.[252] It is, however, insufficient. First, the only damage covered by the Liability Convention is damage to people or property, "not to the space environment itself."[253] This precludes any attempt to use the Liability Convention to hold liable any country that intentionally contributes to the space debris problem, such as a country jettisoning spacecraft parts after they have become unnecessary.

Another barrier to using the Liability Convention as a means to preserve orbital space is its lack of a definition for the word "fault."[254] While it is clear that a malevolent actor that intentionally piloted its satellite into that of another country would be at fault,[255] other situations are not so apparent. The more likely scenario would instead be one where debris originating from a country's spacecraft unintentionally collides with another country's functional spacecraft. In that instance, it is unclear what sort of actions on the defunct spacecraft's country's part would be required to impose liability.[256] This is because there has been no standard of care set up with regard to the space resource, and even if there were, it would be nearly impossible to prove fault in cases of space collision because of the impracticality of collecting physical evidence.[257] Because of these problems, and others, the Liability Convention is not sufficient to curb the debris problem.[258]

251. Astronaut Agreement, *supra* note 100.

252. Liability Convention, *supra* note 110.

253. Pusey, *supra* note 52, at 439.

254. *Id*.

255. *See* Liability Convention, *supra* note 110, at art. III ("In the event of damage being caused . . . to a space object of one launching State . . . by a space object of another launching State, the latter shall be liable . . . if the damage is due to its fault or the fault of persons for whom it is responsible.").

256. Pusey, *supra* at note 52, at 439.

257. *Id*.

258. *See* Tan, *supra* note 4, at 168–70 ("The specificity of damage, the requirement of fault, and the difficulty of identification all contribute to the impotence of the Liability Convention and the Registration Convention in the protection of the outer-space environment from debris pollution.").

4. Registration Convention

The Registration Convention may also seem to have some relevance to the debris problem, since it allows for better tracking of space objects, and thus better advance warning to avoid collisions that could create debris.[259] But it has shortfalls. For instance, while requiring that countries launching space objects register these objects in both a national and U.N database, there is no requirement (and arguably, no viable method) for registering or documenting debris that may come from spacecraft either at the end of their lives or during operation.[260]

Also, though this treaty is a good start, it is not sufficient to accurately catalog the positions of space objects in such a way as to ensure that they do not interact with each other.[261] While the Registration Convention permits parties to the treaty to provide more information (than just nodal period, inclination, apogee, and perigee), it does not require it, and it thus lacks the force necessary to ensure proper accounting of space objects.[262]

The advantages of having a more robust accounting system for objects in space should be self-evident. At present, it may seem like the information currently required is enough to prevent any large-scale collisions or destruction.[263] But, as more and more objects are put into space,[264] it will become more and more necessary to have some sort of accurate model of the positions of spacecraft at any given time. This will allow space actors to prevent those collisions that create debris, instead of just reacting to them.

5. Moon Agreement

The Moon Agreement prohibits the contamination of the moon and the space environment.[265] It does so, however, vaguely and, as such, does not actually create any hard legal obligations with which to ensure the protection of that environment.[266] It is actually very similar to the Outer Space Treaty and in effect just works to specifically apply the principles of the Outer Space Treaty to the moon.[267]

Even if one were to look at the Moon Agreement in conjunction with all of the treaties that came before it, there are not enough legal obligations to ensure that the space debris problem is properly dealt

259. Registration Convention, *supra* note 120.
260. Tan, *supra* note 4, at 168–70.
261. Pusey, *supra* note 52, at 438.
262. Registration Convention, *supra* note 120, at art. IV.
263. This, however, is not entirely true. *See supra* note 52 and accompanying text.
264. *See supra* note 52.
265. Moon Agreement, *supra* note 127, at art. 7.
266. The only real rule here is that "[i]n exploring and using the Moon, States Parties shall take measures to prevent the disruption of the existing balance of its environment . . . ." *Id*. at art. 7.
267. *Compare* Moon Agreement, *supra* note 127, at art. 7, *with* Outer Space Treaty, *supra* note 4, at art. IX.

with.[268] The treaties create a body of principles, but they do not have the specific obligations necessary to legally coerce actors to comport with some sort of debris mitigation program.[269] As such, some regulation must be promulgated in addition to the treaty framework. The next Part of this Note analyzes what characteristics such a regulatory regime must have if it is to withstand scrutiny under the nonappropriation article of the Outer Space Treaty.

B. Legitimate Characteristics of Space Actions

1. International Character

A regulatory body, or agreement, must be of an international character to withstand scrutiny under the nonappropriation article of the Outer Space Treaty.[270] This is seen first through a close examination of the article itself.[271] The article prohibits "national appropriation,"[272] which prohibits outright appropriation through national claims, such as the Bogotá Declaration,[273] as well as appropriation by claim of private individuals.[274] Though the Bogotá Declaration consisted of multiple countries, it intended to serve only the interests of those countries, casting it as a multinational agreement rather than an international agreement.[275] Compare this to the agreement creating and dictating the use of the International Space Station.[276] Though the agreement regarding the International Space Station was also entered into by a relatively small number of countries, the purpose of the agreement was to foster a cooperation which would advance the state of knowledge regarding space and thus benefit all mankind.[277]

The importance of having an agreement with an international character can also be seen by looking at the continued existence of the ITU.[278] Though the process of allocating orbital space and excluding nations from particular slots seems to be an obvious case of appropriation, the ITU has not been abolished.[279] This is in part because of the fact that the ITU is a part of the broadest possible international coalition, the U.N.[280] It has a more international character than the agreement regarding the International Space Station, and, as such, is able

268. *See* Tan, *supra* note 4, at 168–70.
269. *Id*. at 165–66.
270. *See* Outer Space Treaty, *supra* note 4, at art. II.
271. *Id*.
272. *Id*.
273. *See* discussion *supra* Part II.D.3.
274. *See* Tennen, *supra* note 5, at 805–06.
275. *See* discussion *supra* Part II.D.3.
276. ISS Agreement, *supra* note 182.
277. *Id*.
278. *See* discussion *supra* Part II.D.5.
279. *Id*. *But see supra* note 224.
280. *See* Cahill, *supra* note 196, at 232. *See also* discussion *supra* Part II.D.5.

to successfully effect outcomes even closer to broad-stroke appropriation.[281]

2. Comporting with Underlying Principles of International Space Law

Comporting with the principles of international space law may be the most important and direct prerequisite to complying with the edicts of the Outer Space Treaty.[282] If the purpose of the regulation or agreement is to ensure open access to space, to reap benefits that can be spread to all mankind, and to foster international cooperation in space, then there is a high chance that the regulation will withstand nonappropriation scrutiny.[283]

This is where the Bogotá Declaration most clearly fails. Though enacted in hopes of maintaining the open access of space, it only attempted to ensure access for the few countries party to the treaty.[284] The allotment procedures of the ITU, on the other hand, are carried out in the furtherance of ensuring access to all space actors, current or future.[285] The International Space Station is a clear example of falling in line with these principles.[286] It was created and is maintained through international cooperation, it is used for scientific research that benefits all mankind, and it has a minimal impact on open access to outer space.[287]

3. Proportional Response to International Concern

Similar to the requirement that a regulation or agreement be of an international character, any such regulation or agreement should be a proportional response to a situation of international concern. The logic here is simple: a greater incompatibility with a strict reading of the nonappropriation article will be tolerable if it is solving a larger problem.

The Bogotá Declaration was too great of a response to a problem that affected, at least directly, only those countries party to the declaration.[288] Conversely, the International Space Station was not really responding to any great international concern, but it created such a small conflict with the nonappropriation article that it retains its legitimacy.[289] The allotment procedures of the ITU walk a fine line here.[290] While granting property rights in orbital slots is a drastic response that creates a great tension with the nonappropriation article of the Outer Space

281. *See* discussion *supra* Part II.D.4.
282. *See* Outer Space Treaty, *supra* note 4.
283. *Id.* at preamble.
284. *See* discussion *supra* Part II.D.3.
285. *See* discussion *supra* Part II.D.5. There is some suggestion that the ITU's current procedures may not be the most ideal way to effect these policies, however, which may contribute to its shaky legitimacy. *See* Cahill, *supra* note 196, at 240–48.
286. *See* discussion *supra* Part II.D.4.
287. *Id*.
288. *See* discussion *supra* Part II.D.3.
289. *See* discussion *supra* Part II.D.4.
290. *See* discussion *supra* Part II.D.5. *But see* Cahill, *supra* note 196, at 247.

Treaty, it is arguably a necessary response to ensure the open access to the GEO area of outer space to current and future spacefaring nations.[291] It is important to note the problems with the current ITU regime, however, as proof that the ITU probably exists at the boundaries of a tolerable balancing of this equation.[292] Therefore, it probably represents a limit to what sort of actions can be taken by the international community, at least in response to a problem of a magnitude similar to that of preserving the GEO space.

IV. RECOMMENDATION

To effectively combat the space debris problem, a cap-and-trade system should be set up that will both be effective and withstand scrutiny under the nonappropriation article of the Outer Space Treaty.[293] As such, an international regulatory agency should be created to serve two functions: first, the agency should impose an international limit to the addition of debris and should then apportion these allowances to nations based on their current use of space. The total allowable debris addition should be recalculated yearly based on the state of the space environment, and individual allowances should also be recalculated annually to account for changes in the abilities and needs of different nations. Second, the agency should allot specific LEO area orbital trajectories, such as the ITU allots GEO orbital slots.[294] Though this will be more difficult than allocating GEO slots, since those slots appear stationary while LEO orbital paths are constantly in motion,[295] it can be done.

First, an international electronic database should be produced which tracks the current location of all space objects registered in the Space Object Registry, which should include all spacecraft launched into space.[296] It should also record, to the greatest extent possible, the location and trajectory of any debris. This database should be updated daily to represent the most accurate portrayal of the location and trajectory of space objects by the nations responsible for those space objects. Second, this database should be used to calculate predictions of where spacecraft will be in the future, and LEO orbital slots should be defined both in time and space, as opposed to being defined purely by location. This may seem difficult, but it is actually made quite simple by the use of computers.[297] Though these calculations will become less accurate over longer periods of time, the constant updating of the

291. *See* discussion *supra* Part II.D.5.
292. *See* Cahill, *supra* note 196, at 246–48.
293. *See supra* note 220 and accompanying text.
294. *See* discussion *supra* Part II.D.5
295. *See* discussion *supra* Part II.A.
296. *See, e.g.*, Registration Convention, *supra* note 120.
297. *See, e.g.*, *Real Time Satellite Tracking*, *supra* note 41 (allowing users to monitor satellite orbits and predict their locations).

database will allow these predictions to be constantly updated as well, so that they will be accurate for at least the immediate future. When a nation applies for a trajectory slot, the agency should only allocate that slot if it can be entered into and sustained for a certain amount of time without requiring a trajectory modification of any other spacecraft.[298]

With a workable allocation system in place, the agency should be in conformity with the nonappropriation article of the Outer Space Treaty. To ensure this, it is important that, in allocating slots, both the interests of current space-faring nations, as well as those without the capability to get into space, are provided for. To do so, the agency should only allow actual physical entry into trajectory slots to those who comport with the cap-and-trade regime, while allowing claims to such slots to all nations, on bases similar to those of the ITU.[299] This will ensure that this agency will not run into some of the problems that the ITU did when it began.[300] In doing this, the agency will be comporting to the ideal that space be preserved for all mankind. Furthermore, since the purpose of the agency would be to mitigate the debris problem, its purpose would be ensuring future access to space. This, in connection to the fact that this is an international agency responding proportionately to an international problem,[301] will allow the agency to withstand scrutiny under the nonappropriation article of the Outer Space Treaty.[302]

V. CONCLUSION

Space debris poses a threat to future open access to the space environment. Without some sort of action, the problem will continue to escalate, putting at risk the sustainability of the space around our planet. An international regulatory authority that operated under the U.N. to institute a cap-and-trade regulation system and to allocate LEO orbital trajectories is the best way to curb the space debris problem[303] while staying within the mandate of the nonappropriation article of the Outer Space Treaty.[304] The allotment of trajectories would ensure that everyone has fair access to the resource, as well as facilitate the reduction of space debris caused by collision.[305] A cap-and-trade system would

298. This window would depend on the current state of the space environment, and its dimensions should be decided on annually, after careful research both into the state of the space environment as well as the implicit costs to nations that have to change their own trajectories.

299. *See* Cahill, *supra* note 196, at 238–40.

300. *See* discussion *supra* Part II.D.5; *see also* Cahill, *supra* note 196 at 240–46 (noting problems of nations selling or leasing orbital slots for profit as well as the Bogota Declaration's attempt by some nations to reserve geosynchronous slots to the exclusion of others).

301. Much as the ITU was responding to the limited availability of the GEO resource, this agency would be responding to the limited availability and possible degradation of the LEO resource. *See* discussion *supra* Part II.D.5.

302. *See* discussion *supra* Part III.B.

303. *See* Taylor, *supra* note 235, at 264–65.

304. Outer Space Treaty, *supra* note 4, at art. II.

305. With a better warning system in place, spacecraft will be more likely to avoid the collisions that create debris. *See supra* notes 70–71 and accompanying text.

make sure that the proliferation of further debris is curbed, as well as incentivize actors to contribute to cleaning up the space resource.[306] Since such an agency would operate under the authority of the U.N., it would be of an international character, similar to the ITU.[307] Moreover, since the purpose of the regulation would be to curb the space debris problem, it would fall directly in line with the principle of ensuring continued access to the space resource for all mankind.[308] Finally, since the regulation would benefit those nations currently acting in space as well as those who will explore space in the future, without unduly favoring one or the other as some have claimed the ITU allocation procedures have done,[309] it is a proportional response to an international concern.[310] Thus, the suggested system represents the best way to handle the debris problem without effecting a prohibited appropriation of space.

306. *See* Taylor, *supra* note 235, at 277–78.
307. *See* discussion *supra* Parts II.D.5, III.B.1.
308. *See* discussion *supra* Part III.B.2.
309. *See, e.g.*, Cahill, *supra* note 196, at 238–40.
310. *See* discussion *supra* Part III.B.3.