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ADDRESSING SPACE TOURISM'S ENVIRONMENTAL EFFECTS: MARINE ENVIRONMENT REGULATIONS AS A BASIS FOR REGULATING ORBITAL SPACE DEBRIS

Elena Mak*

ABSTRACT

With the success of private suborbital space flight, the space industry is now facing unprecedented growth as billionaires strive to accomplish the task of sending astrotourists into space. However, given the novelty of this objective, the current domestic and international legal regimes governing outer space and space travel are both confusing and outdated, and thus, they have not adequately accounted for space tourism activities. Given the projected growth of this industry, detrimental and dangerous environmental effects—such as an increase in orbital space debris—have become a pressing concern. These effects will not only affect the global climate on Earth but will likely pose additional obstacles to future space travel by cluttering the Earth's stratosphere. Therefore, this comment proposes a new international regulatory framework based on the London Protocol and the United Nations Convention on the Law of the Sea—two instances of international cooperation protecting the marine environment—in order to regulate the environmental effects stemming from space tourism activities.

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I. INTRODUCTION

The expansive mystery of outer space has captivated humankind since antiquity.[1] As developments in technology advance, humanity's fascination with exploring space has resulted in space tourism becoming a persistent ambition.[2] Indeed, space exploration has become a "prominent theme in popular culture," spreading through magazines, television, books, newspaper articles, and the Internet.[3] Nevertheless, despite public interest in expanding outwards towards the unknown, humans will still be constrained by the earthly consequences of interstellar travel.[4] Notably, continual space exploration and space tourism present dire environmental consequences to both the Earth and outer space environments.[5] Additionally, given the novelty of the space tourism industry, domestic and international regulatory schemes have not adequately

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[1] Erik Cohen & Sam Spector, *Introduction: The Dawn of a New Era?*, *in* 25 Tourism Soc. Sci. Series: Space Tourism: The Elusive Dream 1, 5 (Erik Cohen & Sam Spector eds., 2019).

[2] *See id.* at 5–6.

[3] *Id.* at 5.

[4] *Id.* at 4.

[5] *Id.* at 2.

accounted for these environmental implications.[6] To address this issue, this comment proposes a new uniform international regulatory framework based on the 1996 Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, 1972 (London Protocol), and the United Nations Convention on the Law of the Sea (UNCLOS). Part II examines both the history of space tourism and the history of space pollution, such as orbital space debris and rocket launch emissions. Part III discusses the current state of domestic and international law regulating the environmental effects of space tourism with a specific focus on the leading country in the space tourism industry: the United States. Finally, in Part IV, this comment proposes a new international legal framework to regulate space tourism's environmental effects based on the legal principles that formed and justified the London Protocol and UNCLOS.

II. BACKGROUND

A. The Beginnings of Private Space Flight

On October 4, 1957, the Soviet Union successfully launched "the first artificial satellite to orbit Earth:" Sputnik 1.[7] Unfortunately, this signaled a new "phase [in] the Cold War between the United States and the Soviet Union."[8] A year later, the United States created the National Aeronautics and Space Administration (NASA), which officially signaled the start of the Space Race between these two countries.[9] Following the launch of Sputnik 1, space technology continued to advance rapidly, such that the first human space flight was achieved by Russian Yuri Gagarin in 1961.[10] In addition to Gagarin's flight, the United States' successful Apollo 11 moon landing mission sparked public optimism that interstellar travel and space tourism would soon be possible.[11] Between the 1960s and 1970s, the 'Space Race' continued to captivate public interest in space exploration, "but disasters such as the Challenger space shuttle explosion in 1986" quickly curtailed

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[6] *Id.* at 4.

[7] *Oct 4, 1957 CE: USSR Launches Sputnik*, Nat'l Geographic (last updated Oct. 19, 2023), https://education.nationalgeographic.org/resource/ussr-launches-sputnik/ [https://perma.cc/5DPR-4HTW].

[8] *Id.*

[9] *Id.*

[10] Cohen & Spector, *supra* note 1, at 5.

[11] *See id.* at 5–6.

the public's enthusiasm within the United States.[12] Subsequently, government-sponsored space flights decreased as public interest in space exploration waned.[13] Ultimately, the collapse of the Soviet Union formally ended the Space Race.[14]

Following the end of the Space Race, while government-sponsored human space flights decreased, countries partaking in the space industry continued to launch satellites into Earth's orbit.[15] These satellites provided their corresponding countries with national defense advantages—including insight on enemy combat formations and movements, advance warning on missile attacks, and detailed navigation in desert terrains—during armed conflicts in the modern age.[16] Indeed, as satellite launch systems became more coveted, five space agencies—representing fifteen different countries—formed the International Space Station (ISS) after a decade of development.[17] Through the collaboration of these five agencies, the ISS symbolized a new age of cooperation in all space activities.[18]

During this new age of international space cooperation, NASA and other government space agencies continued to dominate space travel and exploration.[19] Nevertheless, private space companies arose, "collaborat[ing] with the government to produce the advanced technology needed for space flight."[20] The commercialization of the space industry reached its peak when the United States passed the Commercial Space Act of 1998,[21] which not only commercialized the ISS, but promoted commercial space flight at all levels.[22] Furthermore, in 2004, President George W. Bush announced a new Space Exploration Policy that redirected NASA to support the development of private space flight.[23] Following

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[12] Rachel Barton, *Technology and the History of Commercial Spaceflight*, PURDUE UNIV. POLYTECHNIC INST. (Feb. 2, 2022), https://polytechnic.purdue.edu/purdue-online/blog/technology-and-history-of-commercial-spaceflight [https://perma.cc/9BGS-79L9].

[13] *See id.*

[14] COHEN & SPECTOR, *supra* note 1, at 6.

[15] *A Brief History of Space Exploration*, AEROSPACE, https://aerospace.org/article/brief-history-space-exploration [https://perma.cc/9X8F-JWZS].

[16] *Id.*

[17] *History and Timeline of the ISS*, ISS NAT'L LAB'Y, https://www.issnationallab.org/about/iss-timeline/ [https://perma.cc/6VK8-6M6V].

[18] *A Brief History of Space Exploration*, *supra* note 15.

[19] *See* Barton, *supra* note 12.

[20] *Id.*

[21] Commercial Space Act of 1998, 51 U.S.C. § 20102.

[22] Barton, *supra* note 12.

[23] *See id.*

this announcement, the Federal Aviation Administration (FAA) licensed private companies to engage in commercial space flights.[24] Within that same year, on the 47th anniversary of the Sputnik 1 launch, private company Mojave Aerospace Ventures successfully launched their spacecraft *SpaceShipOne* into space for the second time in less than a week.[25] This success won Mojave Aerospace Ventures—a non-government organization team—the $10 million Ansari X Prize, and was the first privately funded human space flight in history.[26]

With this success, the Ansari X competition not only achieved its goal of boosting commercial space flight but also prompted the creation of new commercial space flight companies.[27] Indeed, after the Ansari X competition, billionaire Richard Branson licensed the *SpaceShipOne* technology and built an entire space flight company around it named Virgin Galactic.[28] In addition to Branson's creation of Virgin Galactic, notable entries into the commercial space flight industry include Elon Musk's SpaceX in 2002 and Jeff Bezos's Blue Origin in 2000.[29] To keep up with the increased interest in commercial space flight, Virgin Galactic unveiled *SpaceShipTwo* in 2009, a successor spacecraft to *SpaceShipOne* that aimed to carry passengers into space at a price of $250,000 per seat.[30] In other words, the creation of *SpaceShipTwo* was the result of a rising interest in commercial space flight and represented space tourism as a "logical development" of "humankind's [natural] desire to explore."[31]

B. Defining Space Tourism: Suborbital Private Space Flight

Despite the emergence of space tourism companies led by ambitious billionaires, the international community currently lacks

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[24] *Framing the Future Commercial Human Spaceflight Environment*, Aerospace (Sep. 21, 2023), https://aerospace.org/article/framing-future-commercial-human-spaceflight-environment [https://perma.cc/6447-BJB2].

[25] Rebecca Anderson & Michael Peacock, *Ansari X-Prize: A Brief History and Background*, NASA, https://history.nasa.gov/x-prize.htm [https://perma.cc/H95B-9U44].

[26] *Id.*

[27] Mike Wall, *How SpaceShipOne and X Prize Launched Commercial Spaceflight 10 Years Ago*, Space.com (Oct. 3, 2014), https://www.space.com/27339-spaceshipone-xprize-launched-commercial-spaceflight.html [https://perma.cc/3XUC-LR34].

[28] *Id.*

[29] *Id.*

[30] *Id.*

[31] Annette Toivonen, *New Space Tourism Sustainability as an Evolving Concept*, 2 Highlights of Sustainability 75, 75 (2023).

an agreed-upon definition of space tourism.[32] Nevertheless, space tourism is generally considered as a specific subset of private human space flight.[33] Private human space flight includes all flights of humans who intend to enter outer space.[34] Therefore, as a subset of this category, space tourism can be most succinctly defined as "any commercial activity that offers customers direct or indirect experience with space travel,"[35] including the "activities of persons traveling to and staying in, outer space for leisure."[36]

While Virgin Galactic, Space X, and Blue Origin are considered the global pioneers of commercial space tourism companies, billionaire Dennis Tito is largely considered "the world's first 'astrotourist,'" as he paid $20 million to the Russian space agency to visit the ISS in 2001.[37] Since Tito's $20 million visit, the organizers of the Ansari X Prize have sought to lower the ticket price for space travel,[38] and the three leading commercial space companies have adopted the ultimate goal of making "space travel more accessible to civilians."[39] To achieve this goal, commercial space companies have been developing "Reusable Launch Vehicle technology" to reduce space flight costs.[40] For example, SpaceX's technology allows rockets to be recovered for future use such that their costs are "significantly cheaper than the existing government-led space agencies."[41] Still, the current state of space tourism remains elusive and expensive for the average customer.[42] Moreover, while flights to the moon to stay in a lunar hotel and plans to inhabit Mars remain "ambitious visions of the future of space travel," the current state of space tourism is limited to modest flights to Earth's orbit.[43] Despite this, private space companies remain the significant players for more ambitious future space

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[32] Frans G. von der Dunk, *The Regulation of Space Tourism*, *in* 25 TOURISM SOC. SCI. SERIES: SPACE TOURISM: THE ELUSIVE DREAM 177, 180 (Erik Cohen & Sam Spector eds., 2019).

[33] *See id.* at 181.

[34] *Id.*

[35] Stephan Hobe, *Legal Aspects of Space Tourism*, 86 NEB. L. REV. 439, 439 (2007).

[36] Von der Dunk, *supra* note 33, at 180.

[37] CARL CATER, *History of Space Tourism*, 25 TOURISM SOC. SCI. SERIES: SPACE TOURISM: THE ELUSIVE DREAM, 62, 62 (Erik Cohen & Sam Spector eds., 2019).

[38] DEREK WEBBER, *Current Space Tourism Developments*, 25 TOURISM SOC. SCI. SERIES: SPACE TOURISM: THE ELUSIVE DREAM 163, 164 (Erik Cohen & Sam Spector eds., 2019).

[39] Barton, *supra* note 12.

[40] Steven Freeland, *Up, Up and . . . Back: The Emergence of Space Tourism and Its Impact on the International Law of Outer Space*, 6 CHI. J. INT'L L. 1, 2 (2005).

[41] CATER, *supra* note 38, at 63–64.

[42] COHEN & SPECTOR, *supra* note 1, at 10.

[43] *Id.* at 5, 7.

travel as "[t]here is a very real possibility that the first human mission to Mars will be achieved not by NASA . . . but rather by private companies."[44]

Nevertheless, since the state of space tourism is currently limited to traveling as far as the Earth's orbit, to propose an adequate legal regulatory scheme, it is necessary to consider the important distinction between orbital and suborbital space activities.[45] Space travel is considered orbital if the space vehicle achieves "at least one full orbit around the Earth."[46] Examples of orbital space travel include flights to the ISS, such as Tito's $20 million flight.[47] Conversely, suborbital space travel refers to flights that do "not achieve at least one full orbit around the Earth."[48] The space flights achieved by Virgin Galactic and Blue Origin fall under this category.[49] Notably, due to public interest in cheaper space flights, space tourism's focus seems to have shifted from orbital to suborbital flights.[50] Additionally, interest in orbital space tourism activities, such as the development of a private space lunar hotel, remains uniquely American, as no other country has yet developed substantial private orbital space flight plans.[51] For these reasons, this comment will focus on the environmental effects of suborbital private space tourism.

Even within the subset of suborbital space travel, many different methods and vehicles carry passengers into space: space objects and aircraft.[52] International space treaties have defined the term "space object" as any man-made artifact intended to be flown to an altitude generally considered to be outer space.[53] Space objects entail launching a space capsule from the top of a rocket, which then separates from the rocket when the capsule reaches the necessary altitude of suborbital flight.[54] On the other hand, the International Civil Aviation Organization (ICAO) defines an aircraft as any "machine which can derive support in the atmosphere from the reactions of the air" other than the reactions

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[44] *Id.* at 7.
[45] Von der Dunk, *supra* note 33, at 181.
[46] *Id.*
[47] *See id.*
[48] *Id.*
[49] *Id.* at 5.
[50] Hobe, *supra* note 36, at 439–40.
[51] Von der Dunk, *supra* note 33, at 181.
[52] Hobe, *supra* note 36, at 443.
[53] *Id.* at n.19.
[54] *Id.* at 440.

of the air against the Earth's surface.[55] This method uses an aircraft to lift a space cabin until it reaches a certain altitude, at which point the cabin separates from the aircraft to reach higher altitudes, continuing into suborbital flight.[56]

These different terms are important because they affect how a launch is regulated.[57] Indeed, space objects and aircraft are controlled by entirely different regulatory agencies and applying both would result in "confusing and conflicting legal regimes."[58] However, space tourism activities may include the use of either an aircraft, space object, or both.[59] Thus, either air law, space law, or both might apply depending on the method of suborbital space travel used.[60] While international space law has relatively light regulations, air law includes a more expansive legal regulatory regime.[61]

In addition to the different regulations imposed by air and space law, no international legal agreement currently exists that defines the specific altitude where the boundary between air and space law ought to be set, creating further confusion in these regimes.[62] This boundary line is significant because it would specify whether air law or space law should apply.[63] The United Nations has taken the position that the lack of a specific boundary defining space is necessary because this boundary would be "impossible to create," given the dynamic nature of Earth's atmosphere.[64] The United States also adopts this view and has made clear that imposing a boundary line would not only impede technological growth within the space industry but would also create an arbitrary line, causing further confusion.[65] Moreover, a main point of contention raised by the United States is that there is currently no need for such a delimitation, as there is no "practical problem to address," and the regulatory regime of suborbital vehicles has "not been hampered by the absence of any delimitation of outer space."[66] However, the global increase in space programs,

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55 *Id.* at 443.
56 *Id.* at 440.
57 Von der Dunk, *supra* note 32, at 185.
58 *Id.*
59 *Id.*
60 *Id.*
61 *Id.*
62 *Id.*
63 *Id.*
64 Bhavya Lal & Emily Nightingale, *Where is Space? And Why Does That Matter?*, Space Traffic Mgmt. Conf. 8 (2014).
65 *Id.*
66 *Id.*

especially suborbital space travel, suggests that the international community needs to come to an agreement regarding the definition of outer space.[67] While the surrounding debate concerning outer space's jurisdiction extends beyond this comment's scope, it will consider both United States air law and international space law as both regimes currently apply to private suborbital space flights at varying points of the flight.

C. The History of Space Debris and Rocket Launch Emissions

As the space industry was previously led by government-sponsored missions, and thus there were a limited number of launches each year, space exploration's environmental impacts were considered "negligible compared to other industries."[68] As a result, there was no widespread consideration of environmental effects.[69] However, the number of yearly launches has drastically increased, and private space companies have stated goals that exceed these numbers, aspiring to launch about 1,000 flights per year.[70] Thus, the space industry is facing "unprecedented growth," leading to growing concerns of rocket launch emissions and space debris becoming a significant source of pollution for both the environment on Earth and in space.[71]

Concerning the problem of rocket launch emissions, the increased growth in rocket launches poses the risk that "space vehicles will heavily impact climate change as a result of stratospheric ozone depletion."[72] This is because the propellants used to launch rockets into space can "emit up to three hundred tons of carbon dioxide directly into the upper atmosphere."[73] Moreover, rocket launches also emit byproducts of carbon-based fuels, such as aluminum oxide and black carbon, which trap heat and absorb sunlight, contributing to the warming climate.[74] Furthermore, black carbon has been defined by the U.S. Environmental

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[67] *Id.* at 10–13.

[68] Liz Goldstein, *What Should Regulators Pay Attention to as Rocket Launches Become More Commonplace?*, Geo. Env't. L. Rev. (Apr. 7, 2022), https://www.law.georgetown.edu/environmental-law-review/blog/the-environmental-impacts-of-the-new-space-race/ [https://perma.cc/UL9E-DKVW].

[69] *Id.*

[70] *Id.*

[71] Alec Fante, *Who is Manning the Ship? The Environmental and Legal Questions Facing the Emerging Commercial Space Tourism Market*, 34 Vill. Env't. L. J. 33, 41–42 (2023).

[72] *Id.* at 43.

[73] *Id.*

[74] Goldstein, *supra* note 69.

Protection Agency (EPA) as a "major component of soot."[75] While a single rocket launch only emits a small amount of carbon, the projected increase in space flights raises a concern about the net amount of carbon emissions.[76] Additionally, some scientists have noted that "some rockets can emit approximately 10,000 times more black carbon particles than modern turbine engines found in airplanes and jets."[77] With these findings, the continued rise of space tourism suggests that a more comprehensive regulatory scheme should be implemented at an international level to combat these potential effects. However, private space companies have recently begun to indirectly address the danger of rocket launch emissions.[78] For example, SpaceX has seen success with Falcon 9—a reusable launch vehicle—and is continuing to research and develop better classes of such vehicles.[79] Despite their potential benefits, these developments are largely created to lower launch costs and are not motivated by environmental considerations.[80] Therefore, while maintaining low rocket launch emissions is an important issue to consider in the space tourism industry, given the incentives to lower these emissions, the solution proposed by this comment will largely focus on addressing the problem of space debris.

Another growing problem is space debris, also known as "space junk" or "space garbage." The Inter-Agency Space Debris Coordination Committee (IADC) defines space debris in its Space Debris Mitigation Guidelines as "all man-made objects including fragments and elements thereof, in Earth orbit or re-entering the atmosphere, that are non-functional."[81] Space debris has generated more widespread criticism from recent space activities' generation of uncontrollable space debris that not only threatens space objects but future human space flight.[82] "Space debris is

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[75] *Id.*

[76] Fante, *supra* note 72, at 43.

[77] Goldstein, *supra* note 69.

[78] *See generally* Eric Brown, *Boosting Rocket Reliability at the Material Level*, MIT News (Nov. 28, 2023), https://news.mit.edu/2023/boosting-rocket-reliability-material-level-1128 *[*https://perma.cc/WMP8-8JFR*]*.

[79] *See id.*

[80] *See id.*

[81] IADC Steering Group and Working Group 4, IADC–02–0, IADC Space Debris Mitigation Guidelines (2020).

[82] Lilian Sour, *Who is Going to Take Out the Trash?: Addressing Space Debris Under International Law*, Pub. Int'l Pol'y Grp. (Mar. 14, 2022), https://www.publicinternationallawandpolicygroup.org/lawyering-justice-blog/2022/3/14/who-is-going-to-take-out-the-trash-addressing-space-debris-under-international-law *[*https://perma.cc/P7ZN-B4SE*]*.

dangerous for space activities for several reasons."[83] For example, space debris, of all sizes, "travels at a high speed in orbit," leading to potential collisions that can destroy or damage satellites.[84] Additionally, space debris can "remain in high altitudes for years," where it increases the risk of colliding with other satellites as the clutter accumulates and grows in size.[85] To illustrate the dangers of this growth, there are currently "about 2,000 active satellites orbiting Earth" and 3,000 inactive ones "littering space."[86] Furthermore, space debris that is left at a higher altitude may continue to orbit Earth for "hundreds or even thousands of years."[87]

Space debris has long been a major environmental concern, evidenced by NASA scientist Donald Kessler's "Kessler syndrome" hypothesis that he proposed in 1978.[88] Kessler's hypothesis predicts that collisions between space debris can create even more debris, growing the amount of space debris exponentially such that parts of Earth's orbit could be rendered unusable.[89] More recently, the Aerospace Corporation's Center for Space Policy and Strategy raised concerns in its 2018 report about the potential problems of space debris in Earth's orbit.[90] Additionally, regarding space tourism specifically, space debris "could . . . accumulate on destination sites," like the Moon, which is already cluttered with "nearly four hundred thousand pounds of man-made material."[91] However, even with the IADC's definition, there is currently no legal concept of space debris agreed upon and recognized under international space law, and thus, there are no legal regulations governing it.[92] Nevertheless, despite not being explicitly mentioned in any treaty, Article IX of the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial

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[83] *Id.*

[84] *Id.*

[85] *Id.*

[86] Jonathan O'Callaghan, *What is Space Junk and Why is it a Problem?*, NAT'L HIST. MUSEUM, https://www.nhm.ac.uk/discover/what-is-space-junk-and-why-is-it-a-problem.html [https://perma.cc/BPW2-X44W].

[87] *Id.*

[88] Chris Impey, *Analysis: Why Trash in Space is a Major Problem with No Clear Fix*, PBS NEWS HOUR (Sep. 3, 2023), https://www.pbs.org/newshour/science/analysis-why-trash-in-space-is-a-major-problem-with-no-clear-fix [https://perma.cc/4K7C-VUVH].

[89] *Id.*

[90] Fante, *supra* note 72, at 42–43.

[91] Molly M. McCue, *A Regulatory Scheme for the Dawn of Space Tourism*, 55 VAND. J. TRANSNAT'L L. 1087, 1098 (2022).

[92] Freeland, *supra* note 41, at 20.

Bodies (Outer Space Treaty) requires member states to utilize outer space "with due regard to the corresponding interest of all other State Parties."[93]

III. THE CURRENT LEGAL REGULATORY FRAMEWORK

In order to properly advocate for a revised legal regulatory framework, it is necessary to consider the current state of both domestic and international law, as the international agreements governing space may be "weakened by their reliance on states to internally regulate space activity originating within their borders."[94] While several countries have gotten involved in space exploration and other space related activities, the United States nevertheless continues to dominate the space tourism industry.[95] This is because while many of the new competitors in the space exploration industry may rival the United States in terms of space exploration, their "primary interest seems to be in the exploitation of resources on other celestial bodies rather than in the development of space tourism."[96] Additionally, although new countries are rising as potential players in the space industry, they "are still 'at an early stage of . . . space technology development'" and have not yet gotten involved in the space tourism industry.[97] Moreover, the three leading private space tourism companies—Virgin Galactic, Blue Origin, and SpaceX—are all licensed in and launch from the United States.[98] Thus, while there are other players within the space tourism industry, the majority of this industry's environmental effects will likely originate from private space companies that launch from the United States.[99] Therefore, this comment will specifically examine the United States' domestic legal regulations concerning commercial space flight and its environmental effects. The results of this examination show that, despite the promising environmental space policies proposed by

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

[94] McCue, *supra* note 92, at 1096.

[95] COHEN & SPECTOR, *supra* note 1, at 8.

[96] *Id.*

[97] *Id.*

[98] *See FAA Commercial Human Space Flight Recognition*, FED. AVIATION ADMIN., https://www.faa.gov/space/human_spaceflight/recognition [https://perma.cc/V89C-T9LU].

[99] *See* Anna Fleck, *Who's Responsible for Space Junk?*, STATISTA.COM (Sept. 22, 2022), https://www.statista.com/chart/28309/countries-creating-the-most-space-debris/ *[*https://perma.cc/WHH8-QUL7*]*.

the United States, the environment of outer space may not be within the scope of this regulatory framework.[100] Therefore, a lasting solution to protect the future of the outer space environment must be codified in an updated international agreement.[101]

A. U.S. Domestic Regulations: Do They Apply To Outer Space?

In 1984, Congress passed the Commercial Space Launch Act with the goals of promoting economic growth through the use of the outer space environment and encouraging private companies within the United States to "provide launch vehicles, reentry vehicles, and associated services."[102] This Commercial Space Launch Act also established the Office of Commercial Space Transportation (AST), which was transferred from the Department of Transportation (DOT) to the FAA in 1995.[103] Congress has since amended and re-codified the Commercial Space Launch Act of 1984 at 51 U.S.C. 50902–50923 (Act).[104] The Act authorizes the DOT and delegates to the AST to "oversee, authorize, and regulate both launches and reentries of launch and reentry vehicles, and the operation of launch and reentry sites . . ." within the United States.[105] Furthermore, the Act directs the FAA to facilitate and promote commercial space flight, which include flights carrying paying customers.[106] The AST also issues licenses to private companies, allowing them to fly paying customers into space.[107]

While the Act clearly represents the United States' promotion of commercial space flight as a method to stimulate national economic growth, the government nevertheless has to grapple with the general public's growing concerns for sustainability and environmental protection.[108] On January 1, 1970, President Nixon

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[100] *See* Michael Ellis, *Keep Environmental Red Tape Out of Outer Space*, The Heritage Found. 5–6 (Aug. 6, 2021), https://www.heritage.org/government-regulation/report/keep-environmental-red-tape-out-outer-space [https://perma.cc/37VE-GAJU].

[101] *Id.* at 10.

[102] 51 U.S.C. §§ 50901–03.

[103] Fed. Aviation Admin., *About the Office of Commercial Space Transportation*, https://www.faa.gov/about/office_org/headquarters_offices/ast [https://perma.cc/9RKT-DEZ7].

[104] Fed. Aviation Admin., *Commercial Space Transportation*, https://www.faa.gov/regulations_policies/faa_regulations/commercial_space [https://perma.cc/3S6S-NXPG].

[105] *Id.*

[106] *Id.*

[107] *See About the Office of Commercial Space Transportation*, *supra* note 104; *see also Commercial Space Transportation License Number: LRLO 16-092* (July 29, 2016).

[108] Fante, *supra* note 72, at 36.

signed into law the National Environmental Policy Act (NEPA) in response to growing public concern over the effects of human activity on the environment.[109] NEPA requires federal agencies to consider the potential environmental effects of their proposed actions during their decision-making processes.[110] Advocates for NEPA argued that without a national environmental policy, federal agencies would not properly consider the environmental effects in implementing their agencies' missions.[111] NEPA also established the Council on Environmental Quality (CEQ) to monitor the state of the environment and provide advice to the President concerning environmental issues.[112] Most federal agencies view NEPA as an "umbrella statute" which acts as a "framework to coordinate or demonstrate compliance with any study, review, or consultation required by any other environmental laws."[113]

Because the FAA, along with NASA and the Federal Communications Commission (FCC), are the federal agencies that regulate commercial space flight activities, they must adhere to NEPA's requirements when proposing an action.[114] Under NEPA, the issuance of a license or a permit by the AST is considered a "significant regulatory action."[115] Thus, to issue a license that would authorize a private company to fly private individuals, the AST must follow the requirements set out by NEPA.[116] This means that the AST must first review any potential environmental effects of issuing such a license and then consider reasonable alternatives.[117]

Under the licensing process required by NEPA, two main levels of review apply to the licensing process: Environmental Assessments (EA) and Environmental Impact Statements (EIS).[118] EAs simply "describe the anticipated environmental impacts of a

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109 Linda Luther, CONG. RSCH. SERV., RL33152, THE NATIONAL ENVIRONMENTAL POLICY ACT: BACKGROUND AND IMPLEMENTATION 1 (2008).

110 U.S. ENV'T PROT. AGENCY, *What is the National Environmental Protection Policy Act?* (Oct. 5, 2023), https://www.epa.gov/nepa/what-national-environmental-policy-act *[*https://perma.cc/8TEL-MYX5*]*.

111 Luther, *supra* note 110.

112 *Id.*

113 *Id.* at 2.

114 Fante, *supra* note 72, at 37.

115 *See id.* at 37, 43; FED. AVIATION ADMIN., 88 FR 65835, MITIGATION METHODS FOR LAUNCH VEHICLE UPPER STAGES ON THE CREATION OF ORBITAL DEBRIS (2023).

116 FED. AVIATION ADMIN., *Environmental Review Process*, https://www.faa.gov/space/environmental *[*https://perma.cc/FFC6-8J77*]*.

117 Fante, *supra* note 72, at 38.

118 *Environmental Review Process*, *supra* note 117.

proposed action."[119] On the other hand, if significant impacts are expected, then the agency must prepare an EIS.[120] EISs contain more detail, mitigation measures, and increased opportunities for public involvement.[121] However, an agency does not have to prepare an EA or an EIS if they do not believe an activity will have an effect on the environment.[122] This is possible by applying a categorical exclusion to the activity.[123] In other words, when applying categorical exclusions, a federal agency does not have to produce either EAs or EISs.[124]

In 2021, Virgin Galactic received FAA approval for a full Commercial Launch license, which was the first time that the FAA licensed a space company to fly commercial customers,[125] and it met "the verification and validation criteria required by the FAA."[126] However, scholars have pointed out that the AST's obligations under NEPA do not expressly require an examination on the environmental effects of outer space during its licensing process.[127] Thus, some commentators contend that Congress did not intend for NEPA to apply to the outer space environment.[128]

When looking at the plain language of NEPA, it does not expressly discuss outer space, which supports the argument that NEPA does not apply to the outer space environment.[129] Moreover, the CEQ has even explicitly stated that NEPA does not apply to "[e]xtraterritorial activities or decisions," which furthers the contention that NEPA only applies within the United States borders.[130] This question over NEPA's scope is further highlighted in NASA's and the FCC's adherence to NEPA.[131] In addition to the AST's licensing process, NASA is required to follow NEPA's

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119 *Id.*

120 *Id.*

121 *Id.*

122 Fante, *supra* note 72, at 38.

123 *Id.*

124 *Id.*

125 Virgin Galactic, *Virgin Galactic Receives Approval From FAA for Full Commercial Launch License Following Success of May Test Flight* (June 25, 2021), https://www.virgingalactic.com/news/virgin-galactic-receives-approval-from-faa-for-full-commercial-launch *[*https://perma.cc/4QR3-PXFV*]*.

126 *Promoting Safety, Innovation, and Competitiveness in U.S. Commercial Human Space Activities: Hearing Before the S. Com., Sci., & Transp. Comm.*, 118th Cong. 1 (2023) (testimony of Sirisha Bandla, Vice President, Virgin Galactic).

127 Ellis, *supra* note 101, at 6.

128 *See, e.g.*, *id.* at 3.

129 *See id.*

130 *Id.*

131 *Id.* at 5.

regulation process to address orbital space debris.[132] To comply with NEPA, NASA must produce EAs concerning orbital space debris when it reenters the atmosphere, but it is not required to examine debris in outer space.[133] Finally, the FCC governs satellite communications in space and, under NEPA, the FCC has used categorical exclusions to review satellite licenses.[134] Thus, because of the FAA's, NASA's, and the FCC's application of NEPA requirements, commentators criticize NEPA for providing ambiguous guidelines and for having a vague scope.[135]

The question of NEPA's application to outer space reached the D.C. Circuit Court of Appeals in 2022.[136] While the facts of this case did not concern space tourism specifically, the court did discuss the environmental effects of space debris and whether NEPA requirements should have been applied.[137] Specifically, in 2018, the FCC authorized SpaceX to deploy and operate its new Starlink satellite system under the conditions that SpaceX provided the agency with an updated orbital debris mitigation plan for the system and ensured that its license conforms with future FCC rules.[138] Starlink is composed of several satellites that are connected like a constellation, which would significantly extend high-speed Internet access from outer space to more locations, specifically rural areas.[139] In 2020, ViaSat—a competing satellite communication company—filed a petition to challenge the FCC's approval of SpaceX's Starlink system, arguing that the FCC failed to adequately consider the environmental effects of the system under NEPA's requirements.[140] Among other environmental concerns, ViaSat argued that the Starlink system would result in direct collisions with other existing satellites and thus increase orbital space debris.[141] In 2021, the FCC reviewed ViaSat's challenge and noted "that it is not clear that all of the issues raised by these parties are within the scope of NEPA."[142] Nevertheless, "out of an abundance of caution," the FCC determined that NEPA

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132 Fante, *supra* note 72, at 39.

133 *Id.*

134 *Id.*

135 *See* Ellis, *supra* note 101, at 5, 7.

136 ViaSat, Inc. v. Fed. Commc'n Comm'n, 47 F.4th 769, 769 (D.C. Cir. 2022).

137 *See id.* at 779.

138 *In re* Space Expl. Holdings, LLC, Request for Modification of the Authorization for the SpaceX NGSO Satellite Sys., 36 FCC Rcd. 7995, 7997 (2021).

139 *Id.*

140 *Id.* at 7999, 8034.

141 *ViaSat, Inc.*, 47 F.4th at 779.

142 *In re* Space Expl. Holdings, LLC, 36 FCC Rcd. at 8035.

covered the outer space environment.[143] Under NEPA, the FCC then determined that SpaceX would not be required to prepare an EA, and subsequently, the FCC approved SpaceX's modifications.[144] ViaSat appealed the FCC's determination, and while the D.C. Circuit Court of Appeals upheld the FCC's license approval, it determined that ViaSat's claim was outside the scope of NEPA.[145]

B. International Law: The Outer Space Treaty

Over growing concerns of the rising tension between the United States and the Soviet Union during the Cold War and Space Race, the United Nations (UN) established the UN Committee on the Peaceful Uses of Outer Space (COPUOS) to encourage peace when engaging in space activities among the international community.[146] COPUOS was originally formed as an ad hoc committee in 1958, but the UN General Assembly quickly established the committee as a permanent body the next year.[147] Within COPUOS, two subcommittees are tasked with more complex issues: the Scientific and Technical Subcommittee and the Legal Subcommittee.[148]

Since 1967, COPUOS has implemented five main multilateral treaties to deal with various issues involving outer space.[149] These include: (1) the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty);[150] (2) Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space;[151] (3) Convention on International Liability for Damage Caused by

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143 *Id.*

144 *Id.* at 8038, 8045.

145 *ViaSat, Inc.*, 47 F.4th at 782.

146 United Nations Off. for Outer Space Affs., *COPUOS History*, https://www.unoosa.org/oosa/en/ourwork/copuos/history.html *[*https://perma.cc/X3DE-N4XJ*]*.

147 *Id.*

148 *Id.*

149 United Nations Off. for Outer Space Affs., *Space Law Treaties and Principles*, https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html *[*https://perma.cc/G626-FX38*]*.

150 Outer Space Treaty, *supra* note 94.

151 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 [hereinafter Rescue Agreement].

Space Objects (International Liability Convention);[152] (4) Convention on Registration of Objects Launched into Outer Space (Registration Convention);[153] and (5) Agreement Governing the Activities of States on the Moon and other Celestial Bodies (Moon Agreement).[154] Combined, these five treaties promote international cooperation and cover outer space issues such as preventing appropriation of outer space, establishing liability for damage caused by space objects, ensuring the safety of astronauts, and establishing proper notification and registration of outer space activities.[155] In addition to these five treaties, the UN General Assembly has put out five declarations establishing additional principles governing space activities, such as the use of nuclear power and satellites for television broadcasting in space.[156] While each of the treaties cover different issues related to space activities, none of them expressly provide for environmental protections.[157] Furthermore, as these treaties were formulated during the Cold War era, they did not reasonably anticipate more modern commercial space tourism activities.[158] Notably, the five treaties do not "specifically consider how nonstate actors such as commercial spaceflight companies fit into the regime they create."[159] Moreover, the Outer Space Treaty "fails to employ strict enforcement mechanisms and leaves commercial spaceflight regulations up to individual states."[160]

While none of the UN treaties expressly address the outer space environment or orbital space debris, the Inter-Agency Space Debris Coordination Committee (IADC) was specifically created for this reason.[161] Founded by NASA and three other space agencies,[162] the IADC is an "international governmental forum" created to

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152 Convention on International Liability for Damage Caused by Space Objects, Oct. 9, 1973, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Liability Convention].

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

154 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 18, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Agreement].

155 UNITED NATIONS OFF. FOR OUTER SPACE AFFS., *supra* note 150.

156 *See id.*

157 Mary Button, *Cleaning Up Space: The Madrid Protocol to the Antarctic Treaty as a Model for Regulating Orbital Debris*, 37 WM. & MARY ENV'T. L. & POL'Y REV. 539, 548–49 (2013).

158 Freeland, *supra* note 41, at 4–5.

159 McCue, *supra* note 92, at 1091.

160 *Id.* at 1093.

161 INTER-AGENCY SPACE DEBRIS COORDINATION COMM., *What's IADC*, https://iadc-home.org/what_iadc [https://perma.cc/6FEP-MPBN].

162 Nicholas Johnson, *Origin of the Inter-Agency Space Debris Coordination Committee*, NASA Technical Reports Server (Jan. 1, 2014).

coordinate and encourage cooperation amongst space agencies and governmental entities to develop space debris research and mitigation procedures.[163] This committee was founded in 1993 and is currently composed of thirteen member agencies.[164] The IADC has published space debris mitigation guidelines which focus on: (1) limiting debris released during normal operations; (2) minimizing the potential for debris breaking in orbit; (3) disposing procedures post-mission; and (4) preventing orbital debris collisions.[165] However, within the context of space tourism, the IADC is only composed of space agencies and thus does not directly address space debris produced by private space companies.[166] Instead, private space companies are merely "encouraged to apply these guidelines to the greatest extent possible."[167] Moreover, COPUOS's Scientific and Technical Subcommittee published their space debris mitigation guidelines in 2007,[168] which were largely modeled after the IADC's guidelines.[169] However, COPUOS's mitigation guidelines "are non-binding and thus essentially unenforced."[170] Furthermore, to the extent that private space companies follow either of these guidelines, scholars point out that the guidelines only propose methods for the reduction of orbital debris and do not address the removal of existing orbital debris.[171]

In addition to the treaties and principles set forth by the UN, customary international law should be examined as a part of the international legal framework for space regulations.[172] The International Court of Justice defines customary international law as "evidence of a general practice accepted as law."[173] This evidence requires both actual practice by states that is "extensive and

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163 *What's IADC*, *supra* note 162.

164 *Id.*; Johnson, *supra* note 163, at 71.

165 Inter-Agency Space Debris Coordination Comm., *IADC Space Debris Mitigation Guidelines* 1 (Mar. 1, 2020).

166 Button, *supra* note 158, at 556.

167 *IADC Space Debris Mitigation Guidelines*, *supra* note 166, at 6.

168 United Nations Off. for Outer Space Affs., *Space Debris Mitigation Guidelines of the Committee on the Peaceful Uses of Outer Space*, U.N. Doc. A/Res/62/217 (Feb. 1, 2008).

169 Button, *supra* note 158, at 555.

170 *Id.* at 549.

171 *Id.* at 556.

172 Ram Jakhu & Steven Freeland, *The Relationship Between the Outer Space Treaty and Customary International Law*, 59th IISL Colloquium on L. Outer Space 1, 3 (2016).

173 U.N. Charter & Statute of the International Court of Justice art. 38, ¶ 1.

virtually uniform" and the "*opinio juris* of [s]tates."[174] It is important to consider customary international law because it "is recognized as a binding form of law and in the hierarchy of international law, falls immediately below treaties."[175] Indeed, "customary international law bind[s] *all* states," regardless of the treaties that they are bound to.[176] Thus, because the UN's space treaties have not codified all "rules of custom" and not all of the players within the space industry are parties to the treaties, the "soft law" of customary international law could apply to considerations of space debris regulation.[177] However, as customary international law is not codified in specific agreements, many commentators contend that solely relying on customary international law raises the concern over "inherent risks" of "greater 'non-compliance.'"[178] Nevertheless, "it is generally recognized that as a matter of legal policy the reliance on international custom is advisable primarily in situations where treaty regulation is inadequate."[179] Furthermore, customary international law is especially significant as COPUOS has not established a new space treaty since the Moon Agreement of 1979.[180] However, there is likely no customary international law that qualifies with specific respect to space debris.[181] This is because space debris mitigation guidelines "have not existed long enough to qualify as a consistent State practice," and states are not obligated to follow such practices as these mitigation guidelines are non-binding international law.[182]

Nevertheless, despite lacking a specific customary international law for orbital space debris, the "rules of general international law still apply in space."[183] Indeed, regarding space tourism and the space debris that it produces, commentators have argued that the customary international law that was "originally developed in the context of environmental law" may apply because "space debris is treated by space preservationists as a form of outer

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174 Michael W. Taylor, Orbital Debris: Technical and Legal Issues and Solutions 46–47 (Aug. 1, 2006) (L.L.M. thesis, McGill University) (on file with McGill University).

175 *Id.* at 46.

176 Jakhu & Freeland, *supra* note 173, at 3; Taylor, *supra* note 175, at 48.

177 Jakhu & Freeland, *supra* note 173, at 3; Taylor, *supra* note 175, at 48.

178 Jakhu & Freeland, *supra* note 173, at 4.

179 Gennady M. Danilenko, *Space Activities and Customary Law of Environmental Protection, in* ENVT. ASPECTS ACTIVITIES OUTER SPACE 169, 169 (Karl-Heinz Böckstiegel ed., 1990).

180 *Id.*

181 Taylor, *supra* note 175, at 48.

182 *Id.* at 47.

183 *Id.* at 48.

space pollution."[184] Specifically, the customary international law principles that have been applied to "marine pollution, air pollution, and other types of pollution on Earth" may be relevant for outer space pollution.[185] For example, the precautionary principle, which has been contended as customary international law,[186] states that "[w]here there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."[187] The UN has recommended "that all Governments adopt the 'principle of precautionary action' as the basis of their policy with regard to the prevention and elimination of marine pollution."[188] Similarly, this customary international law principle could also apply to the outer space environment to combat space debris.[189]

IV. UPDATING THE INTERNATIONAL LEGAL FRAMEWORK

As discussed in Part II, the current domestic and international legal regulatory regimes governing space tourism are inadequate for preventing and removing space debris produced by space tourism companies. While the United States' regulatory policies show that steps are being taken toward a promising direction, NEPA's conflicting scope suggests that this legal framework is still too ambiguous to sufficiently address the growing space debris produced by private companies.[190] Furthermore, despite the international community taking steps to address space debris, such as through mitigation guidelines, there are three main reasons for why the current international regulatory scheme is lacking: (1) the multilateral outer space treaties currently in force are not environmentally minded; (2) the treaties' liability system is severely lacking towards addressing damage caused by space debris; and (3) the international community has largely focused solely on mitigation procedures and does not

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184 Sraavya Poonuganti, *It's Raining Rockets: Heightening State Liability for Space Pollution*, 23 CHI. J. INT.'L L. 490, 512 (2023).

185 *Id.*

186 Taylor, *supra* note 175, at 51.

187 U.N. Conference on Environment and Development, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26/Rev.1 (Vol. I), Principle 15 (*adopted* June 14, 1992).

188 *Id.*

189 *See* Taylor, *supra* note 175, at 51–52.

190 *See* Ellis, *supra* note 101, at 1.

consider active removal of space debris.[191] In order to propose an adequate and updated international legal regulatory framework, this comment will briefly analyze each of these points before suggesting a new framework based on environmental principles and treaties governing the protection of the marine environment.

A. Identifying the Issues: The Lack of Consideration for Space Debris

A principal barrier to the effective regulation of space debris produced by space tourism is that none of the current international treaties address the protection of the outer space environment.[192] As the five main UN outer space treaties have not been updated since they were enacted, they fail to address commercial space activities, including space tourism and its environmental effects.[193] Indeed, the five UN treaties and the five UN declarations governing the international use and exploration of space all lack an explicit provision calling for the environmental protection of the outer space environment.[194] The Outer Space Treaty only requires state parties to "avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter."[195] There are no provisions addressing environmental harm done to the outer space environment.[196] However, adequately addressing space debris caused by space tourism activities requires an international agreement that is environmentally-minded from its inception.

Despite lacking explicit environmental protection provisions, the liability system created by these overarching UN treaties could, in theory, address the space debris issue.[197] Out of the five UN treaties, three form the basis of this liability system: the Outer Space Treaty, the International Liability Convention, and the Registration Convention.[198] These three treaties contain provisions that attempt to establish liability caused by space objects,

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191 *See* Button, *supra* note 158, at 549–56; McCue, *supra* note 92, 1096–99.

192 *See* McCue, *supra* note 92, at 1096–98.

193 *See id.* at 1099.

194 *See* Button, *supra* note 158, at 549–55.

195 Outer Space Treaty, *supra* note 94, at art. IX.

196 *See id.*

197 *Id.* at 552–55. *See* McCue, *supra* note 92, at 1093–95.

198 Button, *supra* note 158, at 548–55; Outer Space Treaty, *supra* note 94, at art. VII; Liability Convention, *supra* note 153, at art. I–IV; Registration Convention, *supra* note 154, at art. VI.

which likely includes damage caused by space debris.[199] The Outer Space Treaty first "creates the basis for each subsequent treaty on outer space activity by establishing liability . . . requirements."[200] Article VI requires state parties to the Outer Space Treaty to "bear international responsibility for national activities in outer space . . . whether such activities are carried on by governmental agencies or by non-governmental entities."[201] Additionally, as part of COPUOS's principle of peaceful use, the Outer Space Treaty requires state parties to "undertake appropriate international consultations before proceeding" with any space activity that "would cause potentially harmful interference with activities of other States Parties."[202]

While the Outer Space Treaty begins to create a liability system for damage caused by space objects, it has been criticized for not adequately addressing the introduction of private space companies in the space industry, as it does not recognize non-governmental organizations as parties under the Treaty.[203] Therefore, the Outer Space Treaty only regulates these private companies indirectly through the state parties from which they launch from.[204] Given the Outer Space Treaty's inapplicability, COPUOS drafted the Liability Convention and the Registration Convention to expand on the liability regime initiated by the Outer Space Treaty.[205] Unlike the Outer Space Treaty, the liability system created by these two Conventions recognizes non-governmental organizations as parties.[206] Furthermore, these two Conventions work in tandem to establish liability for damage caused by space objects.[207] To explain, the Liability Convention establishes either absolute liability or fault-based liability, depending on where the damage is caused.[208] For damage caused in outer space, a state party would be subject to fault-based liability.[209] As required under a fault-based liability system, it is necessary to identify the

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199 Outer Space Treaty, *supra* note 94, at art. VII; Liability Convention, *supra* note 153, at art. I–IV; Registration Convention, *supra* note 154, at art. VI.

200 McCue, *supra* note 92, at 1092–93.

201 Outer Space Treaty, *supra* note 94, at art. VI.

202 *Id.* at art. IX.

203 *See id.* at art. VI.

204 McCue, *supra* note 92, at 1102; Button, *supra* note 158, at 549.

205 *See* James P. Lampertius, *The Need for an Effective Liability Regime for Damage Caused by Debris in Outer Space*, 13 MICH. J. INT'L L. 447, 452–53 (1992).

206 Button, *supra* note 158, at 552.

207 McCue, *supra* note 92, at 1093–95.

208 The Liability Convention, *supra* note 153, at art. I–IV.

209 *Id.* at art. III–IV.

responsible party.[210] Since the Registration Convention requires party members to register any space object launched into outer space with the UN, this registration would provide a method of identification to establish fault.[211] Thus, in theory, these three UN treaties provide a liability system that could establish fault for damage caused by space debris and thus encourage private space companies to reduce the orbital debris they produce.[212]

Despite establishing a potential method to address space debris produced by space tourism companies, these three treaties are inadequate for a number of reasons.[213] First, when space objects collide, the collision itself often creates thousands of individual orbital space debris pieces that can clutter the orbit and cause damage to other existing space objects.[214] Once these thousands of debris pieces are created, it would be almost impossible to determine which piece originated from which state.[215] In other words, "debris cannot always be traced back to a specific launched object."[216] However, since orbital space debris from space tourism is produced by several different countries, "to have any noticeable effect on the quantity of debris, a group of States undertaking such an endeavor would need to be able to remove any debris, not just debris for which that group of States was a launching State."[217] Additionally, under the Registration Convention, the removal of space debris is only allowed after determining the ownership of every individual piece of debris.[218] Moreover, this liability regime is not environmentally minded as it "only applies to space objects damaged in space and not to the space environment itself."[219] The drafters of these three treaties were mainly concerned with the potential damage done on Earth and thus "recognized that the need for a treaty would arise when activities in space became more 'frequent and numerous.'"[220] Thus, for these reasons, the current liability regime imposed by the five UN outer space treaties is inadequate for regulating space debris caused by space tourism.

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210 Lampertius, *supra* note 207, at 454–55.
211 *Id.* at 455.
212 Button, *supra* note 158, at 552.
213 *Id.*
214 *Id.* at 550.
215 *Id.*
216 *Id.*
217 Taylor, *supra* note 175, at 79–80.
218 *Id.* at 77
219 *Id.* at 76.
220 Lampertius, *supra* note 207, at 454.

A final critique on the current international legal regime targets the IADC's and COPUOS's published space debris mitigation guidelines.[221] Taken together with the FAA's recent proposed rule concerning the mitigation of space debris,[222] this suggests that both international and domestic regulations will focus on mitigation procedures, rather than on researching and developing remediation technologies.[223] While mitigation guidelines are necessary and a step in the right direction, the potential "cascade-effect" of colliding orbital debris has led commentators to "[call] for increased research efforts into technologies for remediation."[224] Thus, a proposed solution will implement mitigation procedures and encourage scientific research and development of remediation measures.

B. The London Protocol and UNCLOS: A Model For Outer Space

In order to establish a lasting solution, international cooperation is necessary to create a unified regime to protect the outer space environment.[225] When considering the outer space environment, scholars draw similarities between the marine environment and the space environment.[226] For example, in the context of liability, maritime law, which is "the international body of law governing transport by sea, shares some similarities with space law."[227] This comment will focus on the Protocol to the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (London Protocol) and the United Nations Convention on the Law of the SEA (UNCLOS). Specifically, this comment will address the three main issues of the current international legal framework regulating space debris by applying certain provisions of these two international agreements in the context of the outer space environment and orbital space debris.

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[221] Taylor, *supra* note 175, at 79.

[222] *See* Mitigation Methods for Launch Vehicle Upper Stages on the Creation of Orbital Debris, 88 Fed. Reg. 65835 (proposed Sept. 26, 2023) (to be codified at 14 C.F.R. pt. 401, 404, 415, 417, 431, 435, 437, 450, 453).

[223] *See* Button, *supra* note 158, at 555–56; Taylor, *supra* note 175, at 79–80.

[224] Taylor, *supra* note 175, at 28–29.

[225] *See* Lampertius, *supra* note 207, at 466.

[226] *See* Rachel Rogers, *The Sea of the Universe: How Maritime Law's Limitation on Liability Gets it Right, and Why Space Law Should Follow By Example*, 26 Ind. J. Glob. Legal Stud. 741, 743–44 (2019); Poonuganti, *supra* note 185, at 516; McCue, *supra* note 92, at 1109–10.

[227] Rogers, *supra* note 228, at 743.

As discussed above, the first issue of the current international regulatory framework is that all five of the UN treaties fail to consider the environmental effects of space travel and thus contain no explicit provision for the outer space environment.[228] However, to successfully regulate space tourism's production of space debris, the international regulatory framework must require this consideration.[229] An adequate solution can be found by turning to both the London Protocol and UNCLOS as they are both environmentally focused and contain explicit provisions protecting the marine environment.[230] Indeed, the London Protocol updated the 1972 London Convention, whose objective was to "promote the effective control of all sources of pollution of the marine environment" and to "take all practicable steps to prevent the pollution of the sea by the dumping of waste and other matter."[231] In 1996, the London Protocol expanded the protection of the marine environment by "expressly prohibit[ing] incineration at sea and the export of wastes and other matter for the purpose of ocean dumping" and is intended to eventually replace the London Convention.[232] Moreover, the London Protocol requires a special permit "from a designated national authority under strict control" before certain items can be dumped.[233]

On the other hand, UNCLOS applies more broadly, as it "established a legal framework for all maritime activity."[234] UNCLOS's comprehensive legal regime is similar to that established by the Outer Space Treaty, with both treaties stating that their respective environment "shall be open to use exclusively for peaceful purposes by all States."[235] However, unlike the Outer Space Treaty, UNCLOS specifically "creates a regime for protecting the marine

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228 *See* McCue, *supra* note 92, at 1096–98.

229 *See id.* at 1096; Button, *supra* note 158, at 555.

230 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, art. I, Dec. 29, 1972, 1046 U.N.T.S. 120 [hereinafter London Convention]; United Nations Convention on the Law of the Sea, art. 145, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

231 London Convention, *supra* note 232, at art. I.

232 Int'l Maritime Org., *Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter*, https://www.imo.org/en/OurWork/Environment/Pages/London-Convention-Protocol.aspx [https://perma.cc/3CP6-R3ND]; Environmental Protection Agency, *Ocean Dumping: International Treaties*, https://www.epa.gov/ocean-dumping/ocean-dumping-international-treaties [https://perma.cc/4KF9-ATGY].

233 Int'l Maritime Org., *supra* note 233.

234 McCue, *supra* note 92, at 1109; UNCLOS, *supra* note 231, at art. 145, 147.

235 UNCLOS, *supra* note 231, at art. 141.

environment."[236] Specifically, UNCLOS states that when contracting parties partake in activities within the marine environment, they must take necessary measures "to ensure effective protection for the marine environment from harmful effects which may arise from such activities."[237] Indeed, UNCLOS emphasizes that contracting parties should take appropriate measures to "prevent, reduce, and control pollution of the marine environment."[238] Finally, UNCLOS "encourages states to promote scientific research on pollution and other damage to marine ecosystems and exchange information with other states and international organizations."[239] Therefore, like the London Convention, London Protocol, and UNCLOS, an updated international legal regime for space debris should first begin by defining space debris and other space activities that are considered pollution in order to clarify that the treaty is environmentally minded at the outset. Additionally, this agreement should also specify that it is intended to protect the outer space environment, and contracting parties must take necessary measures to do so. Finally, this agreement should contain provisions promoting scientific research on space debris and other forms of pollution affecting the outer space environment.

After establishing an environmentally-focused framework with explicit environmental protection provisions, the next issue concerns liability for damage caused by space debris. While the current international framework already contains a liability system, this should be updated in accordance with the London Convention, which calls for liability to be established "for damage to the environment of other States or to any other area of the [marine] environment."[240] Similarly, the new liability system should be updated to include liability for damage done by space debris to the outer space environment itself. Given the cascading effect of space debris, this change alone is likely to be an inadequate means to control orbital space debris.[241] Therefore, the proposed solution also follows the London Protocol, which essentially incorporates two customary international law principles—the precautionary principle and the polluter pays principle.[242]

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[236] McCue, *supra* note 92, at 1109.

[237] UNCLOS, *supra* note 232, at art. 145.

[238] *Id.* at art. 194.

[239] *Id.* at art. 200; McCue, *supra* note 92, at 1109.

[240] London Convention, *supra* note 232, at art. X.

[241] *See* Taylor, *supra* note 175, at 76–78.

[242] 1996 Protocol to the 1972 Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter, art. 3, July 11, 1996, A.T.S. 11 [hereinafter London Protocol].

Regarding the precautionary principle, the London Protocol takes a precautionary approach to environmental protection from dumping of wastes . . . when there is reason to believe that wastes or other matter introduced into the marine environment are likely to cause harm even when there is no conclusive evidence to prove a causal relation between inputs and their effects.[243]

Additionally, the polluter pays principle states that "nations engaging in polluting activities shall be held fully liable for the environmental costs of such activities."[244] With respect to the polluter pays principle, the London Protocol states that "the polluter should, in principle, bear the cost of pollution," such that "each Contracting Party shall endeavor to promote practices whereby those it has authorized to engage in dumping or incineration at sea bear the cost of meeting the pollution prevention and control requirements for the authorized activities, having due regard to the public interest."[245] Notably, this principle can encourage nations engaged in the space industry to be "particularly careful when engaging in outer space pollution and launching space objects that may be more prone to breaking off into smaller, more dangerous and non-trackable pieces of debris."[246] Thus, in the context of outer space and orbital space debris, incorporating these customary international law principles can encourage private space companies to be more careful in producing space debris.[247] Moreover, the London Protocol's special permit system could be implemented to help track space debris.[248] Therefore, rather than maintain the current liability system that would not adequately track and establish liability for space debris, this updated liability regime is not only environmentally focused, but it would encourage private space companies to manage the risks associated with space debris upfront.[249]

Finally, this solution also considers active remediation procedures, rather than just mitigation guidelines. First, the updated liability regime based on customary international law principles described above would encourage both mitigation and remediation.[250] This is because the polluter pays principle provides

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[243] *Id.*
[244] Poonuganti, *supra* note 185, at 512–13.
[245] London Protocol, *supra* note 243, at art. 3.
[246] Poonuganti, *supra* note 185, at 514.
[247] *Id.* at 512–13.
[248] *See* London Protocol, *supra* note 243, at art. 9.
[249] *See* Poonuganti, *supra* note 185, at 512–13.
[250] *Id.*

"a strong legal basis for mandating active debris removal programs in outer space jurisprudence."[251] Essentially, following the London Protocol's permit system could help reduce the orbital debris produced at the outset, while the liability regime would incentivize the removal of existing debris to prevent further liability.[252] Additionally, an updated legal regime benefits from the London Protocol's call for contracting parties to "enhance regional co-operation, including the conclusion of regional agreements consistent with this Protocol for the prevention, reduction, and where practicable elimination of pollution caused by dumping or incineration at sea of wastes or other matter."[253] Indeed, some commentators argue that a solution for the prevention of orbital space debris should operate using a bilateral approach rather than a multilateral approach, while others maintain that a multilateral approach is preferable.[254] While this comment's solution emphasizes that a multilateral agreement is necessary to avoid "numerous, inconsistent approaches,"[255] given the cascade effect and the problem of identification with space debris, a regional approach could prevent nations from becoming locked into inaction because of a lack of consent to remove orbital debris.[256]

Additionally, this approach of utilizing both multilateral and regional agreements is especially beneficial in the context of space tourism as more nations become involved in the space tourism industry.[257] Furthermore, UNCLOS also promotes scientific research and development, and since the removal of space debris is currently scientifically infeasible,[258] this provision would prioritize the development of remediation procedures.[259] Thus, the guiding environmental principles of the London Convention, London Protocol, and UNCLOS provide a framework on which to update the international legal regulatory framework for the protection of the outer space environment against space debris. While this solution is not comprehensive, it establishes an environmentally-minded framework at the outset that considers

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[251] *Id.* at 514.
[252] *See id.*
[253] London Protocol, *supra* note 244, at art. 12.
[254] Lampertius, *supra* note 207, at 467–68.
[255] *Id.* at 468.
[256] *See id.* at 466–68.
[257] *See id.* at 467–68.
[258] Taylor, *supra* note 175, at 79–80.
[259] *See* UNCLOS, *supra* note 232, at art. 239.

liability in the context of space debris' cascade effect and adequate mitigation and removal procedures.

V. CONCLUSION

Outer space has captivated humankind since antiquity and will continue to capture the public's attention as the mystery of space slowly unravels with the rise of space tourism. However, as space tourism companies continue to advance and increase technologies available for private flights into Earth's orbit, the current domestic and international regulatory frameworks remain inadequate to address the environmental implications of such travel. Notably, as space tourism flights increase, space debris will become a growing problem as these pieces collide into each other. Nevertheless, given the similarity between the international laws governing the marine environment and the outer space environment, a solution to this problem can be found in the principles underlying the London Protocol and UNCLOS. These changes include enacting specific outer space environment protection provisions and implementing customary international law principles.