A PRECAUTIONARY, PREVENTATIVE FRAMEWORK FOR OUTER SPACE RESOURCES: APPLYING THE ANTARCTIC TREATY SYSTEM'S MADRID PROTOCOL TO THE UNREGULATED FRONTIER OF "NEWSPACE"

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INTRODUCTION

Imagine you step out of the Martian research station at dawn and take in the view. The morning is bitter cold, as it always is, and the thin atmosphere is thick with smog. Nearby, mineral waste is piled in gigantic heaps next to deep craters – officials say the community's water may be polluted from leaching. Across the horizon, which is eerily flat, you can see into the expanse of space, and rising in the distance, the pale sun – its light barely reaching the Martian surface. As a SpaceCorp Cargo ship, ferrying precious minerals to Titan, readies for blastoff at the launch site, you ask yourself a question that has been on your mind lately – how did we, humanity, get here? How did we arrive at a point where the Martian atmosphere, surface, and resources are all polluted? You wonder if it was inevitable, or if it could have turned out differently.

We are at a pivotal point in our exploration and exploitation of outer space. Private space companies are proliferating, with states enacting unilateral legislation to encourage growth. This approach is leading to a regulatory "race to the bottom," with the effect of an unclear and under-regulated approach to space resource exploration and use. The lack of clarity and competition for space resources, in turn, could quickly spiral into conflict. Considering this trajectory, states must pivot to a multilateral approach to regulating space resource exploration and use. As a corollary to the Outer Space Treaty ("OST"), the Antarctic Treaty System's Madrid Protocol offers the best principles and framework for an approach to space resources that is precautionary, de-escalates potential conflict in space, and prevents damage to the extraterrestrial environment.

This paper is organized in a series of parts, each one building on the next, to arrive at a proposal for a precautionary, preventative approach to outer space resource exploration and use. Part I will provide the context of our current state, with a discussion of the emergence of NewSpace and the need for a "spatial fix" for capitalist growth, followed by relevant articles of the Outer Space Treaty, and concluding with potential extraterrestrial environmental impacts of space resource exploration and

use. Part II will discuss the international impact of unilateral space resource policymaking, the ensuing regulatory "race to the bottom," and the increasing potential for conflict. Part III will discuss an alternative, multilateral framework for space resource use based on the preventive and precautionary approach of the Antarctic Treaty's Madrid Protocol, including potential challenges to such a framework. The topics of sovereignty and resource-sharing between states are critical issues related to this topic but are beyond the scope of this paper and therefore will not be considered.

PART I – NEWSPACE AND THE IMPLICATIONS FOR EXTRATERRESTRIAL ENVIRONMENTAL IMPACTS

NEWSPACE AND THE "SPATIAL FIX"

Humankind has entered a new era in outer space exploration – "NewSpace." Also known as "New Space," these terms refer to the emergence of private entities directly operating in outer space and the increasing commercialization of the outer space sector.[1] In May of 2012, SpaceX launched its first rocket, Cargo Dragon, to ferry supplies to the International Space Station ("ISS") on behalf of NASA, ushering in the era of NewSpace.[2] Private firms in the space industry are nothing new, as Boeing, Lockheed Martin, and Airbus have acted as contractors for decades to build rocket components or satellites. But in the last decade, the role of private companies has shifted, as they are now directly operating in outer space with their own rockets and systems.

Since the first SpaceX launch, and the general success of reusable rocketry it exemplified, the private space sector is booming. According to news reports, the private space sector is a multi-billion-dollar industry.[3] Some articles claim the riches of outer space are significant enough that

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1. . *See* Steve Simon, *A cause for concern: Developing regulatory competitions in NewSpace*, 187 ACTA ASTRONAUTICA 212, 212-13 (2021).

2. . Elizabeth Howell, *SpaceX's Dragon: First Private Spacecraft to Reach Space Station*, SPACE.COM (Aug. 10, 2020), *available at* https://www.space.com/18852-spacex-dragon.html (last visited Mar. 25, 2022).

3. . *See* Michael Sheetz, *Investment in space companies put at record $8.9 Billion in 2020 despite Covid*, CNBC (Jan. 25, 2021), *available at* https://www.cnbc.com/2021/01/25/investing-in-space-companies-hits-record-8point9-billion-in-2020-report.html (last visited Mar. 25, 2022).

a single asteroid could make everyone on Earth a billionaire,[4] signaling the vast amounts of wealth in space resources, while grossly misunderstanding the realities of markets and wealth generation. Led most visibly by a trio of billionaires, Elon Musk (SpaceX), Jeff Bezos (Blue Origin), and Richard Branson (Virgin Galactic), NewSpace has exploded onto the scene with high-profile space tourism missions. Blue Origin launched Star Trek star William Shatner into orbit on one of its rockets,[5] and SpaceX sent four civilians into space and filmed a Netflix documentary.[6] Beyond space tourism, private companies are expanding into satellite constellations and space stations. SpaceX's "Starlink" constellation will eventually include 42,000 satellites,[7] and Blue Origin recently announced its plan to build a space business park in outer space called the "Orbital Reef," a private-sector equivalent of the ISS.[8]

Despite the recent growth in the space sector, private companies are still heavily reliant on state funding. A particularly noteworthy example is NASA's choice of SpaceX for a $2.9 billion contract to design and develop a lunar lander for the Artemis missions. Following the contract award, Blue Origin filed a lawsuit against NASA alleging the award was unfairly granted, an argument the federal court recently rejected.[9] NASA's Commercial Lunar Payload Services (CLPS) Program has provided a much-needed boost for several established companies and

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4. . *See* Joao Piexe, *The golden asteroid that could make everyone on Earth a billionaire*, MINING.COM (June 26, 2019), *available at* https://www.mining.com/web/the-golden-asteroid-that-could-make-everyone-on-earth-a-billionaire/ (last visited Mar. 25, 2022).

5. . Joe Hernandez, *William Shatner boldly went into space for real. Here's what he saw*, NPR (Oct. 13, 2021), *available at* https://www.npr.org/2021/10/13/1045377132/william-shatner-star-trek-captain-kirk-blue-origin-space-flight (last visited Mar. 25, 2022).

6. . Rebecca Heilweil, *Streaming space tourism is the new reality TV*, VOX MEDIA, LLC (Aug. 4, 2021), *available at* http://www.vox.com/recode/22610315/netflix-spacex-streaming-space-tourism (last visited Mar. 25, 2022).

7. . Keith Cooper, *Astronomers Raise Concerns over SpaceX's Starlink*, 33 PHYSICS WORLD 10, 10 (2020).

8. . *Blue Origin and Sierra Space Developing Commercial Space Station*, BLUE ORIGIN (Oct. 25, 2021), *available at* https://www.blueorigin.com/news/orbital-reef-commercial-space-station (last visited Mar. 25, 2022).

9. . Joey Roulette, *Blue Origin Loses Legal Fight Over SpaceX's NASA Moon Contract*, N.Y. TIMES (Nov. 4, 2021), *available at* https://www.nytimes.com/2021/11/04/science/blue-origin-nasa-spacex-moon-contract.html (last visited Mar. 22, 2022).

start-ups in the space mining sector.[10] NASA has selected 14 companies for contracts under CLPS, including Blue Origin and SpaceX, but also smaller startups like Moon Express, Deep Space Systems, and Firefly Aerospace. The goal is to develop technologies that will deliver payloads for NASA and land on the Moon's surface under the Artemis missions.[11]

The emergence of NewSpace, led by billionaires, is a predictable next step in capitalism's evolutionary development. Private companies launching into outer space are seeking what Marxist economic geographer David Harvey calls a "spatial fix" to capitalism.[12] Harvey defines the spatial fix "to describe capitalism's insatiable drive to resolve its inner crisis tendencies by geographical expansion and geographical restructuring."[13] The concept posits that capitalism reaches physical and geographic limits to growth, which require a "spatial fix" to capitalize on a new market and generate wealth.[14] The colonization of the Global South and the rise of the internet and social media are both examples of the "spatial fix." Now, as private companies have overexploited the resources of Earth in pursuit of ever-increasing profits, and the "externalities" of climate change – drought, heat waves, fires, and increasingly devastating storms – are coming home to roost, private

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10. . *See generally* Chabeli Carrazana, *Layoffs and Stalled Projects Plagued Space Start-up Moon Express, Then NASA Stepped In*, ORLANDO SENTINEL (Dec. 9, 2018), *available at* https://www.orlandosentinel.com/space/os-bz-moon-express-update-20181114-story.html (last visited Mar. 22, 2022); Brian Dunbar, *Commercial Lunar Payload Services Overview*, NASA (Nov. 18, 2019), *available at* http://www.nasa.gov/content/commercial-lunar-payload-services-overview (last visited Mar. 22, 2022) (noting that "NASA's Commercial Lunar Payload Services (CLPS) initiative allows rapid acquisition of lunar delivery services from American companies for payloads that advance capabilities for science, exploration or commercial development of the Moon.").

11. . Carrazana, *supra* note 10; Dunbar, *supra* note 10.

12. . Victor L. Shammas & Tomas B. Holen, *One giant leap for capitalistkind: private enterprise in outer space*, 10 PALGRAVE COMM. 1, 1-9 (2019).

13. . DAVID HARVEY, GLOBALIZATION AND THE 'SPATIAL FIX, 24, (geographische revue ed., 2001) (using the term "fix" to refer to the way a person with a drug addiction requires a "fix," meaning any relief is temporary.).

14. . *Id.* at 25–26 ("The primary result of these enquiries was to show that (a) capitalism could not survive without being geographically expansionary (and perpetually seeking out 'spatial fixes' for its problems), (b) that major innovations in transport and communication technologies were necessary conditions for that expansion to occur (hence the emphasis in capitalism's evolution on technologies that facilitated speed up and the progressive diminution of spatial barriers to movement of commodities, people, information and ideas over space) . . . .").

companies must look elsewhere for profits, beyond our globe. Jeff Bezos, at the unveiling of Blue Origin's lunar lander concept, posited a future where people live on Earth and extract resources from other planets saying, "[t]he reason we go to space, in my view, is to save the Earth."[15] In other words, NewSpace companies are finding their "spatial fix" in outer space.

THE OUTER SPACE TREATY

The current legal framework for regulating private industry's expansion into outer space is the "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies," also known as the "Outer Space Treaty," or simply the "OST."[16] The OST is a constitutional treaty that articulates a series of principles for the governance of outer space. These principles are borrowed in large part from the Antarctic Treaty System, which was negotiated in 1959, shortly before parties met to begin drafting the OST.[17] The relationship between the two treaties will be discussed in more detail in Part III and will form the basis for a new proposal to regulate outer space resource exploration and use. Initiated shortly after the launch of the Soviet satellite Sputnik, the OST was negotiated during the Space Race between the USSR and the United States.[18]

The UN General Assembly adopted the OST in 1966 and it opened for signature in 1967, prior to the US landing astronauts on the Moon.[19] Following adoption of the OST, the UN General Assembly adopted four other clarifying agreements regarding the Moon,[20] liability,[21] astronaut

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15. . Eric Lutz, *Jeff Bezos Wants to Move Industry Offworld to 'Save the Earth,'* VANITY FAIR (June 7, 2019), *available at* https://www.vanityfair.com/news/2019/06/jeff-bezos-wants-to-move-industry-to-space-to-save-the-earth (last visited Mar. 22, 2022).

16. . Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, *opened for signature* Jan. 27, 1967, 18 U.S.T. 2410, 610 U.N.T.S. 205 [hereinafter Outer Space Treaty].

17. . Paul G. Dembling & Daniel M. Arons, *The Evolution of the Outer Space Treaty,* 33 J. AIR L. & COM. 419, 422–23 (1967).

18. . *See Space Race Timeline,* ROYAL MUSEUMS GREENWICH, *available at* https://www.rmg.co.uk/stories/topics/space-race-timeline (last visited Mar. 23, 2022).

19. . Outer Space Treaty, *supra* note 16.

20. . Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, *opened for signature* Dec. 18, 1979, 1363 U.N.T.S. 3 [hereinafter Moon Treaty].

21. . *See* Convention on the International Liability for Damage Caused by Space Objects, *opened for signature* Mar. 29, 1972, 24 U.S.T. 2389, 961 U.N.T.S. 187 [hereinafter Space Liability Treaty].

rescue,[22] and the registration of objects.[23] All four agreements, apart from the Moon Agreement, achieved widespread adoption. For the purposes of this analysis, however, we will focus solely on the OST. Several provisions of the OST are related to outer space resource use and exploration, as well as extraterrestrial environmental impacts.

Private companies seeking a spatial fix in outer space find both enabling and constraining language in the OST. Article I of the OST enables private companies and Articles II, VI, VII, and IX constrain them. Article I states that celestial bodies "shall be free for exploration and use by all states without discrimination of any kind."[24] Alternatively, Article II states 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."[25] Like most terms in the OST, "exploration" and "use" go undefined, leaving open a wide range of possible interpretations. Several states, in what some scholars consider contravention of Article II of the OST, are going beyond authorizing legislation and developing legal frameworks to allow for private company resource exploration and use under Article I of the OST. By employing the least restrictive reading of OST Article II, the United States is leading this regulatory "race to the bottom" through a series of unilateral domestic laws and executive orders. This concept will be further explored in Part II.

Articles VI and VII constrain private actors by placing them under the authority of the launching state and including liability provisions.[26] Article VI places the responsibility of non-governmental actors in outer space under the launching and authorizing state, including a requirement for authorization and supervision by a state party to the treaty.[27]

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22. . *See* Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space, *opened for signature* Apr. 22, 1968, 19 U.S.T. 7570, 672 U.N.T.S. 119 [hereinafter Rescue Treaty].

23. . *See* Convention on Registration of Objects Launched into Outer Space, *opened for signature* Jan. 14, 1975, 28 U.S.T. 695, 1023 U.N.T.S. 15 [hereinafter Registration of Objects Treaty].

24. . Outer Space Treaty, *supra* note 16, art. I.

25. . *Id.* at art. II.

26. . *Id.* at arts. VI, VII.

27. . *Id.* at art. VI ("State Parties to the Treaty shall bear international responsibility for national activities in outer space, . . . whether such activities are carried on by governmental agencies or by non-governmental entities, and for assuring that national activities are carried out in conformity with the provisions set forth in the present Treaty. The

Article VII expands upon the principle that states bear responsibility for private actors, providing that those states are liable for damage caused by space objects, while including a provision on space debris.[28]

The authorizing and launching state bears responsibility for non-governmental actors in outer space. The launching state is determined not by the location of a private company's headquarters (which would be challenging in our increasingly globalized world), but by the physical location, or territory, from which a rocket is launched.[29] Given the two constraining principles in Articles VI and VII, states have enacted authorizing laws for commercial entities to launch in their territories with some states including regulations regarding space debris and environmental impacts.[30]

A final relevant article regarding resource extraction and use is Article IX of the OST which is specific to contamination of the Earth and celestial objects.[31] While some consider this an entry point for the regulation of extraterrestrial environmental impacts, it is too narrowly

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activities of non-governmental entities in outer space, including the Moon and other celestial bodies, shall require authorizing and continuing supervision by the appropriate State Party to the Treaty.").

28. . *Id.* at Art. VII. ("Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the Moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the Moon and other celestial bodies.").

29. . *Id.* at Art. VII.

30. . *See* Annette Froehlich & Vincent Seffinga, *Comparative Analysis of National Space Legislation*, *in* NAT'L SPACE LEGIS.: A COMPAR. & EVALUATIVE ANALYSIS 173-77 (Annette Froehlich & Vincent Seffinga, eds., 2018). (Discussing differing approaches by states towards protection and mitigation of the Earth environment. For example, Australia, France and Belgium require licensees conduct environmental impact assessments or an adequate environmental plan. Several states also set out specific requirements related to space debris mitigation. Finally, states include requirements to limit contamination of celestial bodies. Other extraterrestrial environmental impacts – pollution, waste management, emissions, etc. have only been considered by France in their EIA process.).

31. . Outer Space Treaty, *supra* note 16, at Art. IX. (Article IX states that treaty signatories shall "pursue studies of [the Moon and other celestial bodies] . . . so as to avoid their harmful contamination and also adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter and, where necessary, shall adopt appropriate measures for this purpose.").

constructed on biological contamination, anthropocentric framing, and Earth-centric language to achieve this goal.[32]

The OST delineates a series of enabling and constraining articles for outer space resource exploration and use. Unfortunately, the articles are either silent or vague regarding extraterrestrial environmental impacts, leaving open a wide range of possible interpretations for states to exploit. In the next section, we will explore the current and potential impacts of NewSpace on the extraterrestrial environment.

EXTRATERRESTRIAL ENVIRONMENTAL IMPACTS

The expansion of NewSpace into outer space brings new challenges and new externalities.[33] The exploration and use of outer space will result in increasing amounts of space debris in orbit and the potential for contamination of celestial bodies – two space environment impacts the OST and consequent agreements attempt to address with limited success.[34] Regarding space debris, the concern is the "Kessler Syndrome"; debris colliding in orbit, causing a chain reaction of collision and debris, until the orbit is no longer usable.[35] The potential for

32. . *See* William R. Kramer, *Extraterrestrial environmental impact assessments - A foreseeable prerequisite for wise decisions regarding outer space exploration, research and development*, 30 SPACE POL'Y 215, 217 (2014). *See also* PHILLIPE SANDS, PRINCIPLES OF INT'L ENV'T LAW 383 (1995). ("Moreover, studies and exploration of outer space must avoid 'the harmful contamination and adverse changes in the environment of the earth resulting from the introduction of extraterritorial matter.' Parties are also under an obligation to undertake 'appropriate international consultations' before proceeding with activities or experiments which may cause 'potentially harmful interference' with activities of other state parties. It is evident that the approach of Article IX is directed towards the protection of human beings, rather than the protection of the environment as an end in itself.").

33. . Kramer *supra* note 32, at 218. ("While the environmental effects of our extraterrestrial actions may still be relatively insignificant, their cumulative impact will predictably increase with the number and scope of future missions."); *see also* Cheney, et. al., *Planetary Protection in the NewSpace Era: Science and Governance*, 7 FRONT. ASTRON. SPACE SCI. 1, 1 (Nov. 3, 2020).

34. . Cheney *supra* note 33, at 2. (Regarding planetary protection, "Planetary protection is perhaps more important as ever as the number of actors and the diversity of their activities increase (sic). Private and non-governmental space activities present a particular challenge given the status of the COSPAR Planetary Protection Policy in international law and the motivations and intentions of some of these new actors."). *Id.* at 6. (regarding debris "Increased lunar activities could replicate Earth's "space debris problem" around the Moon (and later Mars)").

35. . Judy Corbett, *Micrometeoroids and Orbital Debris (MMOD)*, NASA (Sep. 17, 2015), *available at* http://www.nasa.gov/centers/wstf/site_tour/remote_hypervelocity_test_laboratory/micromet

contamination of celestial bodies, or the introduction of extraterrestrial contaminants to Earth, is also a concern. Introducing organisms from Earth to celestial bodies could damage any potential life already existing there, irrevocably undermining the search for life.[36] These concerns have resulted in the creation of planetary protection principles through the Committee on Space Research (COSPAR).[37] Beyond space debris and contamination of celestial bodies is another space environment concern that is not widely discussed in the literature – extraterrestrial environmental impacts.[38]

The speculative scenario in the introduction attempts to imagine what a future person on Mars may experience in terms of extraterrestrial environmental impacts. Eventually, private companies will have developed the technology to mine minerals and resources (such as helium and water) on asteroids, the Moon, and Mars.[39] Some companies

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eoroid_and_orbital_debris.html (last visited Mar. 27, 2022); *see also* Shannon Bugos, *Russian ASAT Test Creates Massive Debris*, ARMS CONTROL ASS'N (Dec. 2021), *available at* https://www.armscontrol.org/act/2021-12/news/russian-asat-test-creates-massive-debris (last visited Mar. 27, 2022). (On November 15, 2021, Russia conducted an anti-satellite missile test that succeeded in destroying one of its satellites. The test created a field of over 1,500 pieces of trackable space debris and resulted in the astronauts on the ISS sheltering in escape pods.).

36. . *See generally* Kramer, *supra* note 32; *see also* Cheney, *supra* note 33.

37. . COSPAR Panel on Planetary Protection, *COSPAR Policy on Planetary Protection,* COMM. ON SPACE RSCH. (Jun. 3, 2021), *available at* https://cosparhq.cnes.fr/assets/uploads/2021/07/PPPolicy_2021_3-June.pdf (last visited Mar. 28, 2022); *see also* Gerhard Kminek ET. AL., *COSPAR's Planetary Protection Policy,* A CONSENSUS STUDY REP. OF THE NAT'L ACAD. OF SCI., ENG'G, MED. (2017) *available at* https://cosparhq.cnes.fr/assets/uploads/2019/12/PPPolicyDecember-2017.pdf (last visited Mar. 28, 2022); J.D. Rummel, et al., *Ethical Considerations for Planetary Protection in Space Exploration: A Workshop*, 12 ASTROBIOLOGY 1017, 1017-23 (2012).

38. . Stephen Eric Mustow, *Environmental Impact Assessment (EIA) Screening and Scoping of Extraterrestrial Exploration and Development Projects*, 36 IMPACT ASSESSMENT AND PROJECT APPRAISAL 467, 467-78 (2018) ("Other environmental issues have been given far less attention, including for example potential contamination by radioactive material which is often used within spacecraft and landers, atmospheric emissions and protection of environmental landscape features and historical/scientific or other resources of interest to humans." (internal citations omitted)).

39. . *See* Elliott Reavan, *The United States Commercial Space Launch Competitiveness Act: The Creation of Private Space Property Rights and the Omission of the Right to Freedom from Harmful Interference*, 94 WASH. U. L. REV. 238 (2016); *see also* Sarah Coffey, *Establishing a Legal Framework for Property Rights to Natural Resources in Outer Space*, 41 CASE W. RES. J. INT'L L. 119, 120 (2009) ("The moon, Mars, and other celestial bodies contain resources that are scarce or non-existent on Earth and which could have immense value. One example is helium-3, a substance common on the moon but exceedingly

envision this as *in situ* use to support human outposts on celestial objects, others foresee using the Moon and Mars as fuel stations to further explore the solar system, while others imagine exporting minerals back to Earth from celestial objects.[40] Inevitably, the prospecting, mining, and use of these resources will have an impact on the extraterrestrial environment. Some of the impact will be found in the form of pollution of water sources, soil, and the atmosphere, physical disturbance of the land, geologic features, cultural heritage sites, and human health and biodiversity impacts to extraterrestrial life.[41] A common response to these impacts is that celestial bodies – including the Moon and Mars – are "just rocks."[42] The "just rocks" argument posits that since there is currently no life on these objects, we should not artificially limit the exploration or exploitation of them. This argument seems to misunderstand two crucial pieces of information; first, there is no life *that we know of,* [43] and, second, there may be (and likely will be) human life on these celestial objects at some point in the future.

It is critical and necessary that we consider all the potential environmental impacts of space exploration and use. Impacts include space debris, pollution of orbits, contamination of celestial bodies, and other extraterrestrial environmental impacts. When considering extraterrestrial environmental impacts, it is important to bear in mind that the ecosystems of celestial objects are incredibly fragile, the resources on celestial objects are finite, there are currently more unknowns than knowns regarding resource extraction, and that resource extraction will impact future human use of celestial bodies as well as the resources contained therein.[44] It is also important to keep in mind the current state

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scarce on Earth. Helium-3 has better potential for providing clean, efficient energy than any other source currently known on Earth.").

40. . Reavan, *supra* note 39, at 233; *see generally* Kramer, *supra* note 32.

41. . *See* Mustow, *supra* note 38, at 471 (includes a table of potential extraterrestrial environmental impacts by topic area).

42. . *See generally* Leigh Phillips, *We Don't Need Elon Musk to Explore the Solar System*, JACOBIN MAGAZINE (May 8, 2021), *available at* https://jacobinmag.com/2021/05/elon-musk-space-exploration-mars-colonization (last visited Mar. 27, 2022).

43. . *See generally* Kramer, *supra* note 32; *see also* Cheney, *supra* note 32; Rummel, *supra* note 37, at 1019 ("both subgroups responded in the affirmative to the question of whether we should conduct solar system exploration in ways that minimize or eliminate other possible negative effects on celestial bodies (beyond prevention of biological contamination.").

44. . *See* Kramer, *supra* note 32, at 216; *see also* Mustow, *supra* note 38, at 471.

of outer space resource regulation and use as we turn to the next section: unilateral lawmaking and the regulatory "race to the bottom." NewSpace is bringing forth a new era of space exploration and exploitation with only the OST's ambiguous principles to constrain potential extraterrestrial impacts. As we will see in the next section, states are taking advantage of this approach but to their own detriment in the long run.

PART II - UNILATERAL US SPACE RESOURCES LAW AND POLICY

THE US SPACE ACT

On November 25, 2015, Congress passed, and President Barack Obama signed, the "US Commercial Space Launch Competitiveness Act" ("US Space Act").[45] On November 25, 2015 Congress passed, and President Barack Obama signed, the "US Commercial Space Launch Competitiveness Act" ("US Space Act").[46] The preamble of the law provides insight into Congress's considerations for the need of such legislation, stating that the act is necessary to "facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating more stable and predictable regulatory conditions, and for other purposes."[47]

Most importantly for this Article, the US Space Act unilaterally grants access to space resources for US citizens and companies in Title IV "Space Resource Exploration and Utilization."[48] Through the addition of this Section, the US provides a domestic legal framework for US citizens and private companies to explore, use, and sell outer space resources. This text exploits the ambiguities of Articles I and II of the OST and is an attempt by the US to thread the needle of space law by allowing the use of space resources by private companies, while attempting to not contravene the principles of the OST.[49]

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45. . U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704 (2015) [hereinafter USCSLC].

46. . U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704 (2015) [hereinafter USCSLC].

47. . *Id.*

48. . *Id.* at §51302.

49. . *Id.* at §51303. (A United States Citizen engaged in commercial recovery of an asteroid resource or a space resource under this chapter shall be entitled to any asteroid resource or space resource obtained, including to possess, own, transport, use, and sell the

The US doubled-down on its deregulated approach to outer space resource use through the signing of Executive Order 13914 ("EO 13914"), entitled: "Encouraging International Support for the Recovery and Use of Space Resources."[50] Issued by President Donald Trump on April 6, 2020, and still in force under President Joe Biden's administration, EO 13914 states that "Americans should have the right to engage in commercial exploration, recovery, and use of resources in outer space, consistent with applicable law."[51] This language in EO 13914 can be seen as further supporting and justifying the US Space Act.

While scholars and states differ in their interpretations of whether or how much the US Space Act and EO 13914 align with or depart from the OST,[52] the greater concern is the forum in which it was established, and the precedence it sets internationally.[53] In its condemnation of this approach, Russia has been particularly vocal, calling the US Space Act "manifestations of total disrespect for international law and order,"[54] referring to the trend in unilateral space resources policy - making as "fraught with serious risks for international cooperation and understanding," and calling upon the international community "to make a collective effort to prevent outer space, including the Moon and other celestial bodies, from becoming an arena for international discord and

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asteroid resource or space resource obtained in accordance with applicable law, including the international obligations of the United States.).

50. . *See* Exec. Order No. 13914, 85 Fed. Reg. 70,20381 (Apr. 6, 2020).

51. . *Id.* at § 1.

52. . *See generally* Fabio Tronchetti & Hao Liu, *The White House Executive Order on the Recovery and Use of Space Resources: Pushing the Boundaries of International Space Law?*, 57 SPACE POL'Y 1 (Sept. 13, 2021); *see also* Steven Freeland & Annie Handmer, *Giant leap for corporations? The Trump administration wants to mine resources in space, but is it legal?*, CONVERSATION (Apr. 20, 2020), *available at* https://theconversation.com/giant-leap-for-corporations-the-trump-administration-wants-to-mine-resources-in-space-but-is-it-legal-136395 (last visited Mar. 28, 2022).

53. . *See* Reavan, *supra* note 39. ("Some commentators suggest that the impact of passing the US Commercial Space Launch Competitiveness Act (USCSLC) will not be on international law, but rather on international politics. It is also reasonable to suggest that the USCSLC could trigger mirroring legislation in other space-faring nations, which could create heated competition, controversy, and possibly chaos.").

54. . Almudena Azcárate Ortega, *Artemis Accords: A Step Toward International Cooperation or Further Competition?*, LAWFARE (Dec. 15, 2020), *available at* https://www.lawfareblog.com/artemis-accords-step-toward-international-cooperation-or-further-competition (last visited Mar. 28, 2022).

conflict."[55] The US Space Act was the first domestic law to carve out specific outer space resource exploration and use allowances for private companies, but it was not the last Since its passage, Luxembourg (2017),[56] the United Arab Emirates (2019),[57] and Japan (2021)[58] have all established domestic law allowing private companies to exploit outer space resources. This trend is a regulatory "race to the bottom" with countries competing to establish the most permissive frameworks for outer space resource use to encourage private companies to authorize under their domestic frameworks and launch from their soil.[59] In this way, states may capitalize on the NewSpace era and the desire for a spatial fix to capitalism. Additionally, states are positioning themselves to be greater players in the space domain, strengthening themselves economically and militarily, while ignoring potential extraterrestrial environmental impacts.

THE REGULATORY "RACE TO THE BOTTOM": SHORT-TERM GAINS, LONG-TERM CONFLICT

The regulatory "race to the bottom" will provide short-term benefits to states like the US, Luxembourg, the UAE, and Japan, as they realize financial gains from their relationships with private companies and

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55. . *Comment by the Information and Press Department on the US President's Executive Order on Encouraging International Support for the Recovery and Use of Space Resources*, MINISTRY FOREIGN AFFS. RUSS. FED'N (Apr. 7, 2020), *available at* https://www.mid.ru/en/foreign_policy/news/-/asset_publisher/cKNonkJE02Bw/content/id/4096701 (last visited Feb. 1, 2022).

56. . Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace [Law of 20 July 2017 on the Exploration and Use of Space Resources], JOURNAL OFFICIEL DU GRAND-DUCE DE LUXEMBOURG [OFFICIAL GAZZETTE OF THE GRAND DUCHY OF LUXEMBOURG], No. 674, July 28, 2017 (Lux.); *See also* Froehlich & Seffinga, *Alternative Law: Luxembourg's National Space Law*, in NATIONAL SPACE LEGISLATION, STUDIES IN SPACE POLICY, (Vol. 15) (Feb. 17, 2018).

57. . Federal Law No. 12 of 2019, On the Regulation of the Space Sector, 669 – 2019 (Dec. 19, 2019), at 111 (UAE).

58. . Act on Promotion of Business Activities Related to the Exploration and Development of Space Resources, Act No. 83, (Dec. 23, 2021) (Jpn.)

59. . Simon, *supra* note 1, at 213. ("Instead of promoting variations in regulations that create efficiencies to attract different market participants, a race to the bottom ideology believes regulatory competition pressures regulators to lower their standards to attract and keep market participants in their jurisdiction. As a result, a back-and-forth swing of lowering regulatory standards is created between jurisdictions, keeping governments captive to a cycle of continual regulatory softening. In the end, the entire market is left in a worse position — a macro net-loss.").

bolster their positions in outer space.[60] As this race continues, other states may adopt exploration and use policies that further diverge from the OST, eventually establishing a new regime of customary international law. In the short run, states adopting permissive regulatory regimes will reap the benefits of private company exploration and use of outer space, but the repercussions for long-term governance of outer space are potentially dire.[61] Short-sighted approaches to outer space resource use through domestic law will likely lead to over-exploitation of outer space resources and conflict in outer space. Outer space resources are not infinite, and their unregulated or under-regulated use will result in competition between states.[62] Competition between states, without clear rules or guidelines for resource exploration and use, will increase opportunities for conflict in space, which would be catastrophic both for states active in outer space and fledgling private companies.[63] Geopolitical conflicts on Earth may also exacerbate or contribute to conflicts in space.

Conflict in outer space will emerge from competition over space resources and unclear regulatory policies. While space is infinite, with billions upon billions of stars, galaxies, and other celestial objects, the potentially exploitable resources near the Earth are not.[64] The Moon, Mars, and near-Earth asteroids are finite objects with finite resources. Currently, outer space resource exploration and use is constrained by technology, scientific knowledge, and distance. This will not be the case for much longer, as technology improves and scientific knowledge advances, shrinking the distances. Given this finitude of resources, there

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60. . *Id.* ("Regulatory competition occurs when states compete with one another in their capacity as regulators to attract people, resources, and entities into their jurisdictional authority. Through securing a diverse pool of talent and interests, states realize increased economic activity. This in turn decreases unemployment, lowers social welfare costs, and raises tax revenues. Given the economic and technological potency the NewSpace industry could input into an economy, there is considerable appeal in attracting NewSpace entrepreneurs for states." (Internal footnote citations omitted).

61. . *Id.*

62. . Hope M Babcock, *The Public Trust Doctrine, Outer Space, and the Global Commons: Time to Call Home ET*, 69(2) SYRACUSE L. REV. 191, 240 (2019). ("Unless the development of outer space resources is regulated, too many entities vying for the same resource could lead not only to congestion and rivalrous behavior, but also to accidents and serious conflict—the conditions the space treaties are intended to avoid.")

63. . Simon, *supra* note 1, at 220. ("Military action in the face of conflicting interests over a vital and limited resource is a familiar scenario as is further destruction of the environment as collateral damage in such a confrontation.").

64. . *See generally* Mustow, *supra* note 38.

will be competition on celestial bodies for energy from sunlight, water, and minerals.[65] Since private companies and states are investing significant sums in resource extraction, they will jockey for the best sites on celestial bodies to exploit resources.

The conflicts that arise between actors in a commons like outer space, and the governance of the commons, is an oft-debated subject in the literature.[66] The most widely-cited theory in this domain is Garrett Hardin's "Tragedy of the Commons," which assumes actors will overexploit a common resource if left to their own devices.[67] Hardin recommends enclosure and privatization of the commons as a policy solution to ensure this tragedy does not occur.[68] In response, Nobel prize-winning economist Elinor Ostrom's theory on collective action and common pool resources, provides a more nuanced framework. Dispensing with the one-size-fits-all approaches of centralization or privatization, Ostrom theorizes an approach focused on collective action of the group to address the specific needs of the common pool resource.[69] While Hardin and Ostrom fundamentally disagree about the best mechanism to govern resources within a commons, they both agree that without some governance, conflicts would necessarily arise.[70] Examples of conflicts over under-regulated common pool resources on Earth can be found in fisheries, grazing, and water management.[71] Furthermore, research shows that after conflicts have developed, cooperative management of a resource can serve to reduce natural resources conflicts through "environmental peacebuilding."[72] Finally, research shows that competition for natural resources can drive conflict and that the conflict

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65. . Babcock, *supra* note 61, at 240.

66. . *See generally id.*

67. . Garrett Hardin, *The Tragedy of the Commons: The Population Problem Has No Technical Solution; It Requires a Fundamental Extension in Morality*, 162 SCI. 1243, 1243–8 (1968).

68. . *Id.*

69. . Elinor Ostrom, Governing the Commons: The Evolution of Institutions for Collective Action (James E. Alt, et al. eds, 1990).

70. . *Id.* at 90 (For example, Ostrom includes conflict-resolution as one of her eight design principles for long-enduring common pool resource (CPR) institutions); *see also* Hardin, *supra* note 66, at 1244 ("[r]uin is the destination toward which all men rush, each pursuing his own best interest in a society that believes in the freedom of the commons").

71. . *See* Ostrom, *supra* note 68 (exploring each CPR in detail).

72. . Blake Ratner et al., *Addressing Conflict through Collective Action in Natural Resource Management*, 11(2) INT'L J. OF THE COMMONS, 877 (2017); INTERNATIONAL UNION FOR CONSERVATION OF NATURE, CONFLICT AND CONSERVATION (1st ed, 2021).

causes follow-on impacts to the environment.[73] In an under-regulated environment like outer space, with private companies operating under different exploitation frameworks and regimes, and competing with one another for finite sites to exploit resources, the opportunities for dispute and conflict increase significantly.

Additionally, the geopolitical situation on Earth is likely to increase the chances of conflict in outer space. Powerful space actors, such as Russia and China, are bolstering their state and private space programs. China is building its own space station – Tiangong – as the ISS is set to be decommissioned.[74] Russia recently demonstrated anti-satellite rocket capabilities, which created a debris field endangering astronauts on the ISS.[75] Together, Russia and China have entered into a memorandum of understanding to build a lunar base, a direct challenge to the US's Artemis program.[76] Relations between Russia, China, and the US are fraught on Earth, where the regulations around resource extraction and conflict are clearer. As these countries expand into space resource use, and geopolitical tensions are projected into the arena of space, the chances and potential for conflict continues to grow.

Since the rules of engagement for such conflicts in outer space are unclear, the outcomes could be catastrophic (see discussions regarding the Woomera and Milamos manuals).[77] States that are the most active in outer space, such as the US, China, and Russia, will have the most to lose

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73. . INTERNATIONAL UNION FOR CONSERVATION OF NATURE, *supra* note 71.

74. . Eleanor Lutz, *A Tour of China's Tiangong Space Station*, N.Y. TIMES (Sept. 22, 2021), *available at* https://www.nytimes.com/interactive/2021/science/tiangong-space-station.html (last visited Mar. 24, 2022); Stephen McDonell, *China Launches First Module of New Space Station*, BBC NEWS (Apr. 29, 2021) *available at* https://www.bbc.com/news/world-asia-china-56924370 (last visited Mar. 24, 2022).

75. . *See* Bugos, *supra* note 35.

76. . Nathaniel Rome, *A Chinese-Russian Moon Base? Not So Fast.*, FOREIGN POLICY, *available at* https://foreignpolicy.com/2021/10/17/moon-base-china-russia-lunar-space-nasa/ (last visited Mar. 24, 2022). (The two countries have released a road map, which includes a total of 14 missions, culminating with a manned lunar base. Rome debates whether that is in fact achievable, or mere posturing).

77. . *See generally* Cassandra Steer, *The Woomera Manual: Legitimising or Limiting Space Warfare?*, in MILITARY SPACE ETHICS, Howgate Publishing (2021)(forthcoming); *The Woomera Manual, available at* https://law.adelaide.edu.au/woomera/about (last visited Mar. 24, 2022); *Manual on International Law Applicable to Military Uses of Outer Space*, *available at* https://www.mcgill.ca/milamos/ (last visited Mar. 24, 2022).

from such a conflict.[78] These states could find their space programs and private industries devastated by a conflict, while other countries with small space programs or space industries will be relatively unaffected — except for the geopolitical outfall as the conflict extends onto Earth. Similarly, private companies in outer space will have the most to lose from conflicts that arise. Private companies rely on stability and predictability to maintain the investments of their shareholders. Conflicts in space between states would create chaos and significantly impact a nascent industry.

Put another way, private companies and the current hegemonic space powers also have the most to gain from clear regulations and a conflict-free operating environment in outer space. As described above, the current unilateral, state-by-state approach to exploration and use of space resources will not effectively achieve this environment. Rather, it will likely lead to a scramble for finite resources and conflict, destabilizing industry, and research in outer space. Bearing this in mind, it is imperative that States shift from the status quo, unilateral regulatory "race to the bottom" and towards a precautionary, preventative approach to space resources use, developed in a multilateral setting.

PART III – A PRECAUTIONARY, PREVENTATIVE APPROACH

THE ANTARCTIC TREATY SYSTEM'S MADRID PROTOCOL

In order to avoid extraterrestrial environmental impacts and prevent conflicts arising from the regulatory "race to the bottom," which is symptomatic of unilateral policy and lawmaking, states must shift to a precautionary, preventative approach to space resource exploration and use developed in a multilateral forum. A regulatory framework that fits this approach is the Antarctic Treaty System's Madrid Protocol.

The Antarctic Treaty[79] and the OST are close corollaries as the Antarctic Treaty was used as one of the foundational texts for the OST.[80] On September 22, 1960 President Eisenhower proposed to the UN

78. . Presentation by Steven Freeland, November 3, 2021 (on file with author).

79. . Antarctic Treaty, Dec. 1, 1959, 12 U.S.T. 794, 402 U.N.T.S. 71.

80. . *Outer Space Treaty*, U.S. DEPT. OF STATE, *available at* https://2009-2017.state.gov/t/isn/5181.htm#:~:text=of%20all%20mankind.-,Outer%20space%2C%20including%20the%20moon%20and%20other%20celestial%20bodies%2C%20shall,all%20areas%20of%20celestial%20bodies (last visited Mar. 24, 2022).

General Assembly that the principles of the Antarctic Treaty be applied to outer space.[81] According to Dembling and Arons' contemporary account, the OST was clearly based on the Antarctic Treaty: "An obvious precedent for an international convention governing activities in outer space and on celestial bodies is the Treaty concerning Antarctica."[82]

According to Dembling and Arons' contemporary account, the OST was clearly based on the Antarctic Treaty: "An obvious precedent for an international convention governing activities in outer space and on celestial bodies is the Treaty concerning Antarctica."[83] Articles I through IV of the Antarctic Treaty provide that the Antarctic shall be used for peaceful purposes, allowing freedom of scientific investigation and cooperation, enabling the exchange of scientific information and personnel, and the prohibition of additional claims of sovereignty.[84] These articles in the Antarctic Treaty are the basis for Articles I, II, IV, XI, and XII in the Outer Space Treaty.[85] At the height of the Cold War, the adoption of the two treaties deescalated tensions in their respective domains by centering peaceful, scientific uses and prohibiting new sovereign claims.[86] Considering their histories and similarities, and considering the need to update the OST with a framework to regulate space resource exploration and use, perhaps it is time to again look to the Antarctic Treaty for guidance in outer space. Since its adoption, the Antarctic Treaty has been augmented by a protocol – the Protocol on Environmental Protection to the Antarctic Treaty ("the Madrid Protocol").[87] By applying the Madrid Protocol to outer space, we will arrive at a precautionary, preventative approach to outer space resource exploration and use.

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81. . *Id.*

82. . Dembling & Arons, *supra* note 17, at 423.

83. . Dembling & Arons, *supra* note 17 at 423.

84. . *Id.*

85. . *Id.*

86. . Jeffrey D. Myhre, *Origins of the Antarctic Treaty, 1948-1959*, in THE ANTARCTIC TREATY SYSTEM: POLITICS, LAW, AND DIPLOMACY, at 23 (1986); Steven Freeland and Anja Nakarada Pecujlic, *How Do You Like Your Regulation - Hard or Soft? The Antarctic Treaty and the Outer Space Treaty Compared*, 30(1) NAT'L L. SCH. OF INDIA REV. 1, 16 (2017).

87. . . Protocol on Environmental Protection to the Antarctic Treaty, Special Consultative Meeting, 27th Sess., ATSCM/2/3/2, 30 I.L.M. 1455 (1991) [hereinafter Protocol].

It is important to note that the Madrid Protocol was not developed in a vacuum and did not emerge on the international stage without a catalyzing event. To fully understand the Madrid Protocol, some historical context is required. The Antarctic Treaty System (ATS), as originally drafted in 1959, was more concerned with de-escalation and demilitarization of the region than with environmental protection (an oversight also replicated in the OST).[88] However, the ATS did include a provision in Article IX(f) for consultative parties to meet and discuss issues relating to "the preservation and the conservation of living resources" of the Antarctic.[89] Within this framework, consultative parties met and adopted three increasingly protective measures for the Antarctic treaty area from 1964 to 1982.[90] Then, in 1988, the consultative parties developed the "Convention for the Regulation of Antarctic Mineral Resource Activities."[91] At the time, there were no known mineral deposits in the Antarctic, let alone cost-effective means of accessing potential minerals.[92] Nevertheless, consultative parties established a robust regime to govern the prospecting and mining of resources in the Antarctic, which at the time was "the most comprehensive environmental protection for the continent."[93] After six years of painstaking deliberation, the Convention opened for signature on November 25, 1988, but it was never signed or ratified due to an environmental catastrophe.[94] Four minutes after midnight on March 24, 1989, the *Exxon Valdez* struck Bligh Reef in Alaska's Prince William Sound with 53 million gallons of

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88. . Evan Bloom, *The History, Vision Behind and Impact of the Protocol on Environmental Protection to the Antarctic Treaty*, U.S. DEPARTMENT OF STATE (May 30, 2016), *available at* https://2009-2017.state.gov/e/oes/rls/remarks/2016/258286.htm (last visited January 22, 2022).

89. . S.K.N. Blay, *New Trends in the Protection of the Antarctic Environment: The 1991 Madrid Protocol*, 86 AM. J. OF INT'L LAW 2, 379 (1992).

90. . *Id.* (The three measures include one agreement and two conventions: "The Agreed measures for the Conservation of Antarctic Fauna and Flora," "The Convention for the Conservation of Antarctic Seals," and "The Convention for the Conservation of Antarctic Marine Living Resources.").

91. . CHRISTOPHER A. CAREY, THE ANTARCTIC TREATY SYSTEM IN WORLD POLITICS 161 (Arnfinn Jørgensen-Dahl & Willy Østreng, eds., 1st ed. 1991).

92. . Bloom, *supra* note 88.

93. . Blay, *supra* note 89, at 382. (CRAMR included: a Commission for oversight of mineral operations and to review proposals, a required Environmental Impact Statement for operators, liability provisions, the ability to restrict and/or prohibit mining in certain areas, and more.).

94. . *Id.* at 378.

crude oil on board.[95] The ATS consultative parties pivoted and, under the leadership of Australia and France, developed the Protocol on Environmental Protection to the Antarctic Treaty, which would eventually become known as the Madrid Protocol.[96]

The Madrid Protocol was drafted in relatively short order and adopted at the 1991 consultative meeting in Madrid.[97] The Protocol entered into force in 1998[98] and established a comprehensive approach to environmental protection of the Antarctic, by creating an "'environmental code,' covering all human activities on the continent."[99] The Madrid Protocol requires state parties "commit themselves to the comprehensive protection of the Antarctic environment and dependent and associated ecosystems, and designates Antarctica as a natural reserve devoted to peace and science."[100] The keystone of the preservation of the Antarctic is a ban on all mineral exploration and use, found in Article 7 of the Protocol.[101] However, the Protocol does provide a mechanism and

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95. . *Exxon Valdez Oil Spill*, HISTORY (Mar. 23, 2021), *available at* https://www.history.com/topics/1980s/exxon-valdez-oil-spill (last visited Mar. 20, 2022). ("The oil spill was the worst in US history (until the Deepwater Horizon spill in 2010), resulting in the contamination of 1,300 miles of coastline and the deaths of an estimated 250,000 sea birds, 3,000 otters, 300 seals, 250 bald eagles, and 22 killer whales.).

96. . Bloom, *supra* note 88. (Bloom, the Director of the Bureau of Oceans and International Environmental Scientific Affairs at the US Office of Polar Affairs, had the following remarks regarding the Madrid Protocol at a 25th anniversary event for the protocol in 2016:

"The Antarctic Treaty Parties made a wise decision when they decided to negotiate and ultimately adopt the Environmental Protocol. This took an act of political courage, requiring the abandonment of an approach that had been under negotiation for years, namely the establishment of a regulatory regime related to mining, in favor of taking a quite different direction. My government had initially supported the prior approach under the Convention on the Regulation of Antarctic Mineral Resource Activities (CRAMRA). But the daring – perhaps heroic – decision by leaders of countries like Australia and France, we must admit, led to something better. With the benefit of hindsight, the wisdom of that change of course is now quite evident.").

97. . Blay, *supra* note 89, at 387.

98. . *Summary Information*, CENTRE FOR INT'L LAW AT NAT'L UNIV. OF SINGAPORE, *available at* https://cil.nus.edu.sg/databasecil/1991-protocol-on-environmental-protection-to-the-antarctic-treaty/ (last visited Mar. 20, 2022). (Under a similar timeline, the OST should have been augmented with a space resources exploration and use framework in 1999, with ratification taking place by 2006. It is long overdue.).

99. . Blay, *supra* note 89, at 385.

100. . Protocol, *supra* note 87, at Art. 2.

101. . Protocol, *supra* note 87, at Art. 7 ("Any activity relating to mineral resources, other than scientific research, shall be prohibited.).

pathway to begin mineral exploration and use at a future date. The Madrid Protocol includes a provision allowing for amendment based on unanimous agreement by parties, and in 2048 (fifty years after the treaty entered into force) any state party to the treaty may request review or modification of the Protocol.[102] If a state party intends to modify Article 7 of the protocol related to the prohibition on Antarctic mineral resource activities, a legal regime for Antarctic mineral resource extraction and use must be adopted.[103] Through these mechanisms, state parties to the Antarctic Treaty System have established the Antarctic as a natural preserve for a minimum of 50 years. Additionally, state parties have banned mineral resource extraction in the Antarctic for a minimum of 50 years and until there is an agreed-upon legal regime in place.

One should not reduce the Madrid Protocol to a simple ban on Antarctic mining – it is far more comprehensive. The Protocol also includes environmental principles, creates a Committee of Environmental Protection to advise consultative parties of environmental impacts, and requires prior environmental assessment of all proposed activities that take place in the treaty area.[104] Article 3 of the Madrid Protocol lays out a series of environmental principles.[105] In support of the principles, Article 8 of the Madrid Protocol requires an environmental impact assessment of any activities in the Antarctic Treaty area.[106] Through these principles and mechanisms, we find a framework in the Madrid Protocol that centers environmental protection, takes a preventative and precautionary approach to environmental impacts, and still provides a mechanism for future resource exploration and use.

Since the ATS served as a basis for the drafting of the OST, might the Madrid Protocol also serve as a basis for a space resources exploration

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102. . *Id.* at Art. 25, Sec. 2 (a request for review or modification after 50 years must be approved by three quarters of the consultative parties).

103. . *Id.* at Art. 25, Sec. 5(a) ("With respect to Article 7, the prohibition on Antarctic mineral resource activities contained therein shall continue unless there is in force a binding legal regime on Antarctic mineral resource activities that includes an agreed means for determining whether, and, if so, under which conditions, any such activities would be acceptable.").

104. . Blay, *supra* note 87 at 382.

105. . Protocol, *supra* note 85 at Art. 3, Sec. 2(a) ("activities in the Antarctic Treaty area shall be planned and conducted so as to limit adverse impacts on the Antarctic environment and dependent on associated ecosystems").

106. . *Id.* at Art. 8 (The EIA includes "scientific research programmes, tourism and all other governmental and non-governmental activities in the Antarctic Treaty area . . . including associated logistic support activities.").

and use framework? If we were to apply the principles and building blocks of the Madrid Protocol to space, what would be lost and what would be gained? A Madrid Protocol in space would permit a pathway for eventual resource exploration and use. In the meantime, a Madrid Protocol for the OST would allow for scientific exploration, space tourism, satellite launches, and visits to the Moon and celestial bodies, with the added layer of protection of an environmental impact assessment. A Madrid Protocol in space would take a preventative and precautionary approach to extraterrestrial environmental impacts. Relatedly, it would help deescalate outer space with a framework that centers protection, rather than competition. Finally, a Madrid Protocol for the OST would allow states with fledgling space sectors the time and opportunity to grow their space industries to compete with established space powers. The benefits of adopting a space resources framework that mirrors the Madrid Protocol are many.

Applying the Madrid Protocol to outer space is not the only option for a space resources framework, although it is likely the most precautionary and protective of the extraterrestrial environment. States may instead prefer an approach that is more permissive of space resource extraction. Since we have not had an equivalent *Exxon Valdez* disaster in space, it may be more palatable to adopt an approach more aligned with the Madrid Protocol's predecessor –CRAMRA. One such space resources framework under consideration has been proposed by the Hague Space Resources Working Group ("the Hague Working Group"). The Hague Working Group, which was established in 2016, defines its objective as follows: "to assess the need for a governance framework on space resources and to lay the groundwork for such framework (sic)."[107] In order to achieve its mission, the Working Group met over the course of two years and, using a consensus-based approach, developed a set of "building blocks" related to space resource exploration and use to inform a future governance framework for states and international organizations.[108] Accordingly, the Hague Working Group has submitted the Building Blocks to the UNCOPUOS space resources working group

107. . *The Hague International Space Resources Governance Working Group*, UNIVERSITEIT LEIDEN, *available at* https://www.universiteitleiden.nl/en/law/institute-of-public-law/institute-of-air-space-law/the-hague-space-resources-governance-working-group (last visited Mar. 26, 2022) [hereinafter Hague Working Group].

108. . Chelsey Davis & Mark J. Sundahl, *The Hague Working Group on Space Resources: Creating the Legal Building Blocks for a New Industry*, 30 THE AIR & SPACE LAW. (2017).

for consideration and incorporation into the eventual space resources exploration and use framework.[109] Ultimately, the Hague Building Blocks fall short in several respects. First, the language in the Building Blocks regarding risk and damage to the environment, while potentially useful upon close reading, is too vague a formulation for a future framework and relies, perhaps to its detriment, on the Moon Agreement.[110] Second, in removing the language of the "precautionary approach" the Building Blocks rely on the less effective and more reactive environmental framework of "avoidance and mitigation."[111] In this way, the Building Blocks represent a CRAMRA-like approach to outer space resource exploration and use. Ultimately, the UNCOPUOS working group will decide upon a final framework and in terms of extraterrestrial environmental protection, the Hague Building Blocks do not go far enough.

UNCOPUOS – THE APPROPRIATE FORUM FOR A FRAMEWORK

A multilateral forum is required to develop a space resources framework. As discussed in Part II, the unilateral approach leads to a regulatory "race to the bottom" and the eventual formation of customary international law that benefits some countries above others. The multilateral forum must also be international for all states to participate. Additionally, the forum must include and consider the widest range of possible interests. Otherwise, it would be possible to reach an agreement on a framework while ignoring the concerns of less powerful states. Finally, the multilateral forum should have significant experience drafting similar frameworks. Considering these requirements, there is only one body with the experience, mission, and membership to effectively draft a multilateral framework for space resources to include extraterrestrial environmental impacts: the United Nations Committee on Peaceful Uses of Space (UNCOPUOS). UNCOPUOS is an international

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109. . Hague Int'l Space Res. Governance Working Grp., *Building Blocks for the Development of an International Framework on Space Resource Use* (Nov. 12, 2019), *available at* https://www.universiteitleiden.nl/binaries/content/assets/rechtsgeleerdheid/instituut-voor-publiekrecht/lucht—en-ruimterecht/space-resources/bb-thissrwg—cover.pdf (last visited Mar. 28, 2022).

110. . BUILDING BLOCKS FOR THE DEVELOPMENT OF AN INTERNATIONAL FRAMEWORK FOR THE GOVERNANCE OF SPACE RESOURCE ACTIVITIES – A COMMENTARY 63 (Bittencourt Neto et al., eds., 2020).

111. . *Id.* at 64.

body and one of the UN's largest committees, including 95 member states and 43 observer organizations.[112] Furthermore, UNCOPUOS is a consensus-based organization, relying on member states to arrive at agreed-upon language for an agreement to be adopted (but not requiring a vote).[113] UNCOPUOS is also the original drafting body of the OST, as well as the other four follow on agreements.[114] Finally, UNCOPUOS drafted the non-binding Long-Term Sustainability Guidelines, which were adopted in June 2019 and serve as a natural precursor to the drafting of a space resources framework.[115]

UNCOPUOS has already taken the first steps towards drafting a space resources framework. In 2021, UNCOPUOS established a space resources working group under the Legal Subcommittee.[116] Chaired by Ambassador Andrzej Misztal of Poland and Vice-Chaired by Professor Steven Freeland of Australia, the space resources working group has established a mandate, scope of work, and is currently developing a 5-year plan.[117] The mandate of the working group is fivefold: to collect information regarding exploration and use of space resources; to develop recommended principles and practices (if appropriate) for space exploration and use activities; to study existing legal frameworks, taking into consideration the OST and other UN treaties; to assess benefits of additional governance instruments; and to identify areas for further work of the committee, including "models, rules and/or norms, for activities in the exploration, exploitation, and utilization of space resources."[118] Furthermore, the working group mandate states that it shall take "into

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112. . *Committee on the Peaceful Uses of Outer Space*, U.N. OFF. FOR OUTER SPACE AFFAIRS, *available at* https://www.unoosa.org/oosa/en/ourwork/copuos/index.html (last visited Jan. 29, 2022) [hereinafter COPUOS].

113. . Freeland & Pecujlic, *supra* note 84 at 21.

114. . COPUOS, *supra* note 110.

115. . *Long-Term Sustainability of Outer Space Activities*, U.N. OFF. FOR OUTER SPACE AFFAIRS, *available at* https://www.unoosa.org/oosa/en/ourwork/topics/long-term-sustainability-of-outer-space-activities.html (last visited Mar. 28, 2022).

116. . COPUOS, *Working Group on Space Resources*, UNITED NATIONS, *available at* https://www.unoosa.org/oosa/en/ourwork/copuos/lsc/space-resources/index.html (last visited Mar. 25, 2022).

117. . Antonio Salmeri, *#SpaceWatchGL Interviews: Ambassador Misztal and Professor Freeland on UNCOPUOS Working Group on Space Resources*, SPACEWATCH GLOBAL, *available at* https://spacewatch.global/2021/09/spacewatchgl-interviews-ambassador-misztal-and-professor-freeland-on-uncopuos-working-group-on-space-resources/ (last visited Mar. 25, 2022).

118. . COPUOS Working Group, *supra* note 114.

account inputs from permanent observers and non-governmental stakeholders such as academia, civil society, technical experts . . ." [119] The aforementioned Madrid Protocol and the Hague Building Blocks represent two such inputs.

CHALLENGES AND CONCLUSION

The UNCOPUOS space resources working group faces a difficult path to arrive at a space resources exploration and use framework. As stated above, the group requires consensus to agree on a framework and state parties will enter the negotiations with drastically different perspectives. A resource framework as precautionary as the Madrid Protocol will face a particularly difficult path to adoption. The challenges arrayed against the Madrid Protocol applied to outer space are many but can be summarized as follows: the existence of an alternative body of practice, perceived stifling of enterprise, lack of a catalyst, and global geopolitics. Some bright spots, or opportunities for a precautionary, preventative approach in outer space, include the following: a subtle shift towards multilateralism in outer space, a body of international environmental law, and general agreement about the benefits of the Madrid Protocol for the Antarctic.

A proposal for space resource exploration and use that would apply the Madrid Protocol to outer space will meet several challenges. First, there is a body of practice and domestic law which runs counter to the Protocol. As mentioned in Part II, a few states have adopted measures to explore and use space resources. It is important to note that this can in no way be considered customary international law at this point. The number of states with such frameworks can still be counted on one hand and all the laws were adopted within the last six years. However, it is likely more states will adopt similar approaches in the near future and overcoming an established body of practice can be difficult.[120] Second, the Madrid Protocol will be perceived as stifling enterprise. If the Protocol is applied to outer space, it is sure to negatively impact the value of space mining and space tourism companies. Some will argue that, since these are young, burgeoning companies, they need cultivation and should not be hampered by such stringent regulations. But are these companies truly so small, or are they primarily projects for billionaires to expand into space, or opportunities for venture capitalists to place big

119. . *Id.*

120. . *See* Simon, *supra* note 1.

bets? And, for the small companies, as they grow will they be more willing to accept regulation, or will they instead lobby against it? I presume the latter. Additionally, today's space companies rely heavily on state investment and so cannot pretend to be at the whim of market forces. And finally, if a company is permitted to mine a planet and causes some extraterrestrial harm, to whom will they be held accountable? The potential for catastrophe brings me to my third challenge for the Madrid Protocol – the lack of a catalyst. Fortunately, we have not had a disaster akin to the *Exxon Valdez* in outer space. The absence of a disaster is due to our limited activities in space up to this point, and luck. On the issue of space debris, we are getting increasingly close to the Kessler Syndrome, which is visible as astronauts on the ISS are required to shelter in escape capsules with increasing frequency.[121] For contamination, we have had several near misses[122] – imagine if we polluted a planet's life with our own?– imagine if we polluted a planet's life with our own? And it is not hard to imagine a hypothetical, like that described in the introduction or above, by Reinstein: a company polluting a very limited water source on a celestial object, making the entire planet unfit for humans. The final challenge is one that all potential space resource frameworks face – global geopolitics. In order to arrive at consensus, the United States, Russia, and China will have to agree, along with other spacefaring and developing countries. Considering the relational challenges between these states on Earth this will be no simple feat.

Despite these challenges, there are also reasons to be optimistic that UNCOPUOS could adopt a precautionary, preventative approach to space resource exploration and use. First, despite the unilateral lawmaking by states, there is also a recent trend towards multilateralism. The Artemis Accords, spearheaded by the United States (and furthering US hegemony in space), may be viewed as one example of this

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121. . Rebecca Heilweil, *The Space Debris Problem is Getting Dangerous,* VOX (Nov. 16, 2021, 2:45 PM), *available at* https://www.vox.com/recode/2021/11/16/22785425/international-space-station-russia-missle-test-debris (last visited Mar. 25, 2022).

122. . *See* Cheney, *supra* note 33 at 5. (In February 2019, an Israeli spacecraft crashed into the Moon's surface. In August 2019, the mission commander revealed the payload included tardigrades, which are some of the most resilient known life forms. "The lack of disclosure of the existence of the tardigrades casts doubt upon the compliance of the Beresheet mission to the planetary protection guidelines.").

multilateralism.[123] The Accords state, "The Signatories intend to use their experience under the Accords to contribute to multilateral efforts to further develop international practices and rules applicable to the extraction and utilization of space resources, including through ongoing efforts at the COPUOS."[124] This sentiment is an effective entry point into international collaboration on the topic of space resources and use. The second cause for optimism is the increasing international awareness regarding environmental issues, accompanied by a growing body of international environmental law.[125] The OST and ATS were developed prior to scientific findings regarding impacts from DDT, ozone-depleting chemicals, carbon and methane emissions, and acid mine drainage. Since then, the international community has adopted the Stockholm Convention to ban DDT, the Vienna Convention for the protection of the ozone layer, the Madrid Protocol itself, the Rio Declaration on Environment and Development, the Convention on Biological Diversity, the UN Framework Convention on Climate Change, the Kyoto Protocol, Paris Agreement, and follow-on accords to address carbon and methane emissions.[126] The international trend towards sustainability and environmental preservation bodes well for applying the Madrid Protocol to outer space. A final cause for optimism is the fact that the Madrid Protocol is widely heralded as a success.[127] Since its adoption over 25 years ago, it has achieved the goals of preserving the Antarctic environment while encouraging scientific investigation.[128] Additionally, it has served a secondary goal of continuing to de-escalate Antarctic tensions by removing any incentive towards competition via resource extraction.[129]

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123. . *See Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of The Moon, Mars, Comets, and Asteroids for Peaceful Purposes*, (Oct. 13, 2020), *available at* https://www.nasa.gov/specials/artemis-accords/img/Artemis-Accords-signed-13Oct2020.pdf (last visited Jan. 31, 2022). (The Artemis Accords were opened for signature with international partners on October 13, 2020. Currently, 11 countries are signatories to the Accords, including: New Zealand, Republic of Korea, Australia, Canada, Italy, Japan, Luxembourg, the United Kingdom, the United Arab Emirates, Ukraine, and the United States.).

124. . *Id.* at § 10.

125. . PHILLIPE SANDS ET. AL., PRINCIPLES OF INTERNATIONAL ENVIRONMENTAL LAW xxi (2d ed. 2003)

126. . *Id.* at 1.

127. . *See* Bloom, *supra* note 86.

128. . *Id.*

129. . *Id.*

The challenges facing the application of the Madrid Protocol to outer space are many: a growing body of practice, the perception of stifled enterprise, the lack of a catalyst, and global geopolitics. Gaining the acceptance of this framework through UNCOPUOS' consensus-based process will not be easy. And yet the challenges all have sound rebuttals and there is also cause for optimism: trends towards multilateralism, increasing environmental awareness and international action, and the success of the Madrid Protocol for the ATS.

Now is the time to adopt a preventative, precautionary approach to outer space resource exploration and use. Private companies are proliferating in outer space through a NewSpace regime in order to achieve a "spatial fix" to capitalism. In response, states are adopting unilateral legislation and policy positions. This approach is leading to a regulatory "race to the bottom," with the effect of an unclear and under-regulated approach to space resources exploration and use. The lack of clarity and competition for space resources, in turn, could quickly spiral into conflict. Considering this trajectory, states must pivot to a multilateral approach to regulating space resource exploration and use. The UNCOPUOS space resources working group provides the ideal venue to create a framework for outer space resources. As a corollary to the OST, the Madrid Protocol offers the best principles and framework for an approach to space resources that is precautionary, deescalates potential conflict in space, and prevents damage to the extraterrestrial environment.

It is a new day on Mars. Imagine you step out of the research station at dawn and take in the view. Across the horizon, which is eerily flat, you can see into the expanse of space and, rising in the distance, the pale sun – its light barely reaching the Martian surface. The morning is still bitter cold, that will never change, but this time the thin Martian atmosphere is crystal clear. The community mining site is carefully managed with minimal disturbance to the surface and no leachate. At the transport depot, a SpaceCorp Cargo ship, ferrying precious minerals to Titan, is cleared for blastoff after rigorous inspection and compliance protocols. As it hurtles into space, you cannot help but find yourself wondering – how did we, humanity, get here?