

# SPACE, THE FINAL FRONTIER: NAVIGATING THE COMPLEXITIES OF COMMERCIAL SPACEFLIGHT, RESOURCE EXTRACTION, AND COLONIZATION

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## *Abstract*

*Space has long cultivated the human imagination. For eons, man has looked to it for guidance and inspiration. The earliest seafarers relied on the stars to navigate the Earth's oceans; the faithful of many a religion beseeched the heavens for guidance; and the philosopher, the artist, the writer, and the poet looked to the endless sky for inspiration. As early as the 1800, that fascination had morphed into something deeper and fantastical at the time. The idea of man embarking boldly into space, a devout confidence that our destiny as species was no longer exclusively tied to the Earth. The rapid development of spaceflight technology during the space race between the U.S. and U.S.S.R in the Cold War era made such earlier fantastical propositions now a plausible, if still distant reality. The national governments of states around the world scrambled to formulate new laws, regulations, and international treaties to deal with the rapidly changing reality of spaceflight. These laws and treaties, products of their time, acknowledged the possible assistance of non-state actors, but never truly accounted for the possibility of a mostly or wholly civilian space market; a market that has rapidly begun to grow and expand as state actors, like NASA, have started withdrawing from direct activity and ceding exclusive control of the field. The void left by this withdraw has created a "Gold Rush"-like market, and billionaires like Elon Musk, Jeff Bezos and Richard Branson have rushed in to capitalize on the opportunities now open those with the capital and means to take advantage of them. These investors (and prospective ones), however, are not only contemplating just trips into space. They are looking far-further, to the possible mining of resource-rich and plentiful space bodies, and even the colonization of other celestial bodies. The law, domestically and*

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\* J.D. Candidate, University of Illinois College of Law, 2023; B.A., Bowdoin College, 2018. This note is dedicated to my father, Robert; my mother, Marie; and my brother, RJ. Without their constant love and support, this Note, and many of my other achievements before and during law school, would not have been possible. I hope I can continue to make you proud! I would also like to thank my mentors and the many wonderful teachers I have had throughout my academic and professional life. Thank you all for taking an interest in me, in my goals and in my dreams! And thank you for helping me cultivate the talents and passions that led me to the legal profession. I hope I can pay forward that kindness one day!

*internationally, and whether it be treaty or regulatory, lags far behind in this field, and is woefully obsolete or even simply absent. This note examines the most important historical and current treaty and regulatory efforts in the field across several key areas of concern (including: health & safety, environment, property rights & wealth inequality, and international competition and government cooperation) and provides possible solutions to these concerns and a way forward that will allow mankind to continue to embark on its new destiny amongst the stars.*

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#### I. INTRODUCTION

You want to wake up in the morning and think the future is going to be great—and that’s what being a spacefaring civilization is all about. It’s about believing in the future and thinking that the future will be better than the past. And I can’t think of anything more exciting than going out there and being among the stars. — Elon Musk<sup>1</sup>

When Neil Armstrong took his first few strides on the moon in 1969, he inspired millions of American children, who began to dream of one day flying to space.<sup>2</sup> Space, however, was largely (there are some notable exceptions, including the work of telecoms companies and the United States EELV

1. SPACEX, *Mars & Beyond*, <https://www.spacex.com/human-spaceflight/mars/index.html> [perma.cc/Z2FT-4JLE] (last visited Mar. 15, 2023) (quoting Elon Musk, Founder and CEO of SpaceX).

2. See, e.g., News-Journal Editorial Board, *Private Space Flight Opens a Potential New Era for Dreams of Space – and Prosperity*, DAYTONA BEACH NEWS-J. (Sept. 22, 2021, 12:17 PM), <https://www.news-journalonline.com/story/opinion/editorials/2021/09/22/commercial-space-flight-could-game-changer-many-ways-nasa-spacex/5783678001/> [perma.cc/25WP-E5V2] (depicting a SpaceX crew speaking to pediatric St. Jude patients from space).

program) under the exclusive purview of the United States Federal Government, and it was governed and overseen by the National Aeronautics and Space Administration (NASA).<sup>3</sup> Through NASA, the United States continued to explore the stars, sending a privileged few astronauts into space.<sup>4</sup> NASA and the Federal Government's domination of all things space, however, ended when the agency largely withdrew from space travel in 2010 and switched to a more indirect partnership model with private enterprises.<sup>5</sup> Replacing this more direct role were dozens of private businesses and entities, who saw an opportunity to realize their own dream and turn a profit in what became a Gold-Rush-like market.<sup>6</sup> Billionaires like Jeff Bezos and Richard Branson have captured the popular imagination with their recent flights into space.<sup>7</sup> However, the opportunities open to those with the capital to take advantage of them extend far beyond joyrides into space: including resource mining and harvesting, and perhaps one day, even colonization of other celestial bodies—ideas that only a half-century ago would have been seen as fanciful imagination fit only for science-fiction novels.<sup>8</sup>

Over the course of the last decade, space, as a privatized industry, has grown significantly as more and more private companies begin to take an interest in what was once a government-only sphere.<sup>9</sup> However, even before this period of great interest and investment, space had already progressively started to become a private, corporate-dominated space with hundreds of satellites (and increasingly, debris from derelict or damaged older satellites) rotating Earth's orbit.<sup>10</sup> Increased human presence in space, though capable of delivering great good (such as space-based broadband internet, access to which is limited in broad swaths of the world, despite being identified by the United Nations as a key to economic growth and development), has also increasingly begun to cause problems.<sup>11</sup> Some of these problems are limited in severity or impact; however, others are more serious, like decreasing the ability of Earth-based astronomers

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3. Brandon Dillon, *Profitable Risk: The Dangers of Consumer Spaceflight and Space Tourism*, VITERBI CONVERSATIONS ETHICS (Dec. 12, 2020), <https://vce.usc.edu/volume-4-issue-2/profitable-risk-the-dangers-of-consumer-spaceflight-and-space-tourism/> [perma.cc/P9U8-EZHU].

4. *Id.*

5. *Id.*

6. *See id.* (“The wave of new companies entering the spaceflight industry in the 1990s and 2000s made leaps in space technology development, and their successes have encouraged them to pursue new opportunities beyond the bounds of conventional research-based space travel.”).

7. Jeffrey Kluger, *The Jeff Bezos-Richard Branson Space Race is About More than Two Billionaires' Egos*, TIME (July 9, 2021, 3:03 PM), <https://time.com/6079195/bezos-branson-space-race> [perma.cc/4NHL-4TTX].

8. *See* Gadget Lab: Weekly Tech News from Wired, *Bezos in Space*, WIRED (July 23, 2021, 8:00 AM), <https://www.wired.com/story/gadget-lab-podcast-513> [perma.cc/KR45-SD4A] (summarizing Jeff Bezos' dreams and plans for space exploration and colonization).

9. *See* Hope M. Babcock, *The Public Trust Doctrine, Outer Space, and the Global Commons: Time to Call Home ET*, 69 SYRACUSE L. REV. 191, 191–92 (2019) (recognizing private space travel and exploration is “rapidly filling up” near-space).

10. *See* Christopher Crockett, *New Fleets of Private Satellites are Clogging the Night Sky*, SCIENCE NEWS (Mar. 12, 2020, 6:00 AM), <https://www.sciencenews.org/article/starlink-spacex-satellites-amazon-oneweb-global-internet-astronomy> [perma.cc/8KXH-WUZJ] (“Artificial satellites have been getting in astronomers' way since the launch of Sputnik 1 in 1957.”).

11. *See id.* (recognizing that, though there are benefits of space exploration such greater internet access, there are problems, such as bright satellites interfering with astronomers' research).

to detect potential space-based threats to Earth, or ironically impeding ground-breaking research into space or space-related scientific concepts like dark matter and wormholes.<sup>12</sup> The larger issue that these smaller issues illuminate, however, is the lack of regulation over the increasing number of private actors in space.<sup>13</sup>

Unlike most other industries on Earth, spaceflight and the exploitation of space resources are relatively sparsely regulated (it should be noted that there is, however, a breadth of regulatory bodies in the United States that play a role and do regulate certain aspects).<sup>14</sup> This is true at both the national and international level.<sup>15</sup> The U.N. Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, is one of the few major treaties regulating the field at the international level (its near-universal acceptance and ratification among states has effectively caused it to become a *jus cogens* of international law).<sup>16</sup> The treaty—dealing primarily with government-directed space operations—provides little direct guidance or regulation for private businesses.<sup>17</sup> Even less regulation exists on possible settlement and private ownership rights of celestial bodies and man-made space objects such as habitable space stations.<sup>18</sup> Further, private actors lack the external limitations that governments must contend with, like geopolitical concerns that create an environment of self-regulation.<sup>19</sup> Without a universal regulatory scheme, the entire field is at risk of becoming the new “Wild West,” a pejorative connotation that other scholars have made with regards to the Space Industry.<sup>20</sup> It is important that we address these issues now before they spread beyond near space and into the galaxy at large as humanity increases its footprint.<sup>21</sup>

Spaceflight, resource extraction and mining, and colonization, each have their own unique regulatory challenges.<sup>22</sup> However, they share many of the same core concerns like property rights and liability schemes, pollution and environmental harm (both tangible and ethical), judicial, legal enforcement and punishment, socio-economic disparate impact, and geo-political implications

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12. *Id.*

13. *Id.* (“When it comes to rules on private companies, space is the Wild West. Negotiations to establish regulations would require cooperation among many countries, possibly mediated by the United Nations, and that could take many years to work out.”).

14. *Id.*

15. *See id.* (noting that space for private companies is like the “Wild West” and that there is “little international oversight”).

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

17. *See id.* (referring to the regulation of “States,” with no mention of private operations).

18. *See* Babcock, *supra* note 9, at 191–92 (explaining that parties to space treaties “left development of a system for managing non-military activities in outer space to another day”).

19. *See* Dillon, *supra* note 3 (explaining the lack of restrictions on private companies exploring space and how most lack incentives to self-regulate).

20. Babcock, *supra* note 9, at 192; *see also* Ezra J. Reinstein, *Owning Outer Space*, 20 NW. J. INT’L L. & BUS. 59, 72 (1999) (“Furthermore, space should not become the next Wild West.”).

21. Babcock, *supra* note 9, at 191–92.

22. *See id.* at 199–206 (discussing the various activities occurring and projected to occur in space, including flight, mining, and colonization, and the challenges that arise from conflicting interests, including scientific advancement and environmental impact).

(including national security, territorial war and expansion, and sovereignty).<sup>23</sup> Part II of this Note delves into the background of spaceflight and its transition from a largely government to a largely private commercial activity. It also introduces underlying theories and concepts underpinning space mining and resource extraction, and the colonization of celestial bodies. Part III will analyze the current and projected regulatory schemes that do or will, if left unchanged, govern commercial spaceflight, resource and mineral extraction, and colonization. Part IV recommends alternative regulatory schemes for each of these three areas and best addresses the leading areas of concern including the following: health and safety, law and legal liability, property rights, wealth and social inequality, and international political concerns and government cooperation. Finally, Part V concludes.

## II. BACKGROUND

### A. *Commercial Spaceflight: A Long Road*

For over 60 years, mankind has continued to reach for the heavens, and the NASA space missions (along with the Soviet space programs) were only the first in a long line of successive endeavors to put objects, and more importantly people, into space.<sup>24</sup> The road to the stars, however, has a dark beginning.<sup>25</sup> Government interest in space arose during the closing years of World War II, as the victorious Allies took notice of Nazi Germany's successful and deadly rocketry programs and poached the best and brightest German scientists willing to surrender and cooperate in exchange for pardons.<sup>26</sup> The majority of these scientists would go on to work for either the United States or the USSR in the years following the war.<sup>27</sup> Their expertise and leadership would jumpstart the previously non-existent or stagnated rocketry programs of both countries, starting the beginnings of what would come to be known as The Space Race.<sup>28</sup> Over the course of the next two decades, this race rapidly heated up, driving technological innovation at breakneck speeds as the two nations competed

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23. See *id.* at 204–06 (discussing various negative impacts and concerns of space exploration, including environmental harm); Alex Gilbert, *Mining in Space is Coming*, MILKEN INST. REV. (Apr. 26, 2021), <https://www.milkenreview.org/articles/mining-in-space-is-coming> [perma.cc/8RBL-G8TQ] (“Potential economic, scientific and even security benefits underlie an emerging geopolitical competition to pursue space mining.”).

24. Babcock, *supra* note 9, at 196; Dillon, *supra* note 3; Gilbert, *supra* note 23.

25. Alejandro De La Garza, *How Historians Are Reckoning with the Former Nazi Who Launched America's Space Program*, TIME (July 18, 2019, 11:27 AM), <https://time.com/5627637/nasa-nazi-von-braun> [perma.cc/UYA6-MCX] (explaining one of the “chief architects” of the America space program was a former Nazi).

26. *Id.*; AEROSPACE, *A Brief History of Space Exploration*, <https://aerospace.org/article/brief-history-space-exploration> [perma.cc/G447-4WXX] (last visited Mar. 16, 2023).

27. De La Garza, *supra* note 25; Lance Kokonos & Ina Ona Johnson, *The Forgotten Rocketeers: German Scientists in the Soviet Union 1945–1959*, TEX. NAT'L SEC. REV. (Oct. 28, 2019), <https://warontherocks.com/2019/10/the-forgotten-rocketeers-german-scientists-in-the-soviet-union-1945-1959> [perma.cc/QNM3-6DM3].

28. Kokonos & Johnson, *supra* note 27.

through proxies, locked in a Cold War, vying for the crown jewel: space.<sup>29</sup> Arguably, it is against this backdrop that the most important international treaty on spaceflight was signed.<sup>30</sup>

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies (referred to as the “Outer Space Treaty”) was ratified in 1967, by a handful of states including the United States and former USSR (the current number of ratifications stands at 102).<sup>31</sup> The treaty’s acceptance by the leading space powers and more general acceptance by the majority of nations, yet to be matched by any other space-focused treaty, has arguably given it the effect of binding law, even on the few nations that have not signed, and thus its provisions are of no small importance.<sup>32</sup> The treaty and its provisions arose out of an earlier resolution by the United Nations, addressing the rising rivalry between the United States and USSR, and fears that tensions would spill over into outer space, given the increasing prominence of The Space Race between the two.<sup>33</sup> That resolution, passed in 1958, came just months after the USSR had launched Sputnik 1 and the United States had launched Explorer 1, the first satellites ever launched into orbit.<sup>34</sup> As a result, tensions were at a fever pitch, and both nations, along with their allies, were keen to prevent space from becoming a battleground, where victory meant unstoppable Earth-side military domination.<sup>35</sup> Since this was the driving motivation, the Outer Space Treaty took great pains to prohibit the claiming of celestial bodies by nation-states, creating a treaty framework that was actively hostile to the concepts of privatization and commercialization of space objects, at least by state actors.<sup>36</sup> In doing so, the treaty resolved the prevailing concerns of the day about nation-state imperialism in space and the use of celestial bodies as staging grounds for space-to-earth weaponry.<sup>37</sup> It also set out an aspirational mandate that “[t]he exploration and use of outer space, including the moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries . . . and shall be the province of all mankind.”<sup>38</sup> This mandate, along with the provisions in the proceeding articles of the treaty, answered the leading questions of the day but is incapable of addressing the issues that plague the industry today.<sup>39</sup> Chiefly,

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29. NASA, *Human Spaceflight*, <https://www.nasa.gov/specials/60counting/spaceflight.html> [perma.cc/QNM3-6DM3] (last visited Feb. 27, 2023) (“The Cold War between the United States and former Soviet Union gave birth to the space race and an unprecedented program of scientific exploration.”).

30. Babcock, *supra* note 9, at 206–09.

31. *Id.* at 206–07.

32. *Id.*

33. *Id.* at 207–09.

34. AEROSPACE, *supra* note 26 (“On Oct. 4, 1957, the Soviets launched the first artificial satellite, Sputnik 1, into space. . . . The first U.S. satellite, Explorer 1, went into orbit on Jan. 31, 1958.”).

35. Babcock, *supra* note 9, at 207–08.

36. *Id.* at 207–09.

37. *Id.* at 207–08; *see also* Outer Space Treaty, *supra* note 16, art. II (explaining that nations shall not claim sovereignty over “the moon and other celestial bodies”).

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

39. *See* Rajeswari Pillai Rajagopalan, *The Outer Space Treaty: Overcoming Space Security Governance Challenges*, COUNCIL ON FOREIGN RELS. (Feb. 23, 2021), <https://www.cfr.org/report/outer-space-treaty> [perma.cc/P93G-JSC2] (arguing current outer space agreements are “showing their age” and new agreements and regulations are needed for the present day).

while the treaty imputes responsibility on state parties to govern non-state actors, this responsibility is limited to “national activities,” phrasing that arguably suggests governmental responsibility only where the space activity has taken on a national character, such as a private launch that is sponsored and endorsed by a government agency, when there is collaboration between private enterprises and the government, or when said government agency is providing subsidies or funds.<sup>40</sup>

Of course, the significant absence of directed provisions relating to private space enterprise is unsurprising and for reasons beyond just the circumstances of spaceflight at the time.<sup>41</sup> The Outer Space Treaty drafters did not intend for the document to become a comprehensive and long-term governing document as it has.<sup>42</sup> The goal was to lay out basic principles and foundations, upon which later treaties would build, which is why the document itself is rather unsubstantial and contains little guidance on today’s issues. The drafters were simply in no position at the time to contemplate a future where spaceflight was largely or even exclusively a private commercial exercise.<sup>43</sup> Without the detailed follow-up treaties they envisioned, there exists a gap in regulation that has contributed to the issues facing the commercial spaceflight industry, as well as space mining and colonization enterprises.<sup>44</sup>

In the years between the 1958 resolution and the ratification of the treaty in 1967, the USSR and United States pushed forward with their space programs, the goal shifting with each success.<sup>45</sup> In 1961 and 1962, the Soviets and Americans successfully sent men into space and had them orbit the Earth before safely returning.<sup>46</sup> The defining moment of the bloodless conflict, however, would occur only two years after the ratification of the Outer Space Treaty, in 1969, when the United States successfully landed men on the Moon.<sup>47</sup> Fulfilling the bold proclamation of President Kennedy earlier in 1961 that the United States would land a man on the moon within the decade, The Space Race had come to an end.<sup>48</sup> But fascination with space and the stars only continued to grow.<sup>49</sup> Following the success of Apollo 11, the United States sent six more missions to the Moon, and the Soviets, bent but not broken, would continue to

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40. Outer Space Treaty, *supra* note 16, art. VI; *See* Babcock, *supra* note 9, at 208–09 (explaining that the drafters of the Outer Space Treaty did not anticipate the “push by private companies to engage in commercial activities in outer space,” thus implying that the treaty does not properly regulate private entities).

41. Babcock, *supra* note 9, at 208–09.

42. *Id.* at 208.

43. *Id.* at 208–09.

44. *See id.* at 211 (explaining the Outer Space Treaty was meant to pacify the Cold War between the USSR and United States, not establish property rights, and is thus “riddled with ambiguities”).

45. *See* AEROSPACE, *supra* note 26 (detailing various American and Soviet expeditions and goals involving space in the 50s and 60s, including President John F. Kennedy’s goal made in 1961 to “[l]and[] a man on the Moon and return[] him safely to Earth within a decade”); NASA, *supra* note 29 (chronicling the space race between the USSR and United States in the 60s and 70s).

46. AEROSPACE, *supra* note 26; NASA, *supra* note 29.

47. AEROSPACE, *supra* note 26.

48. *Id.*

49. *See id.* (detailing the continued exploration and efforts to explore space after the moon landing, including increased satellite use and the development of the International Space Station); NASA, *supra* note 29 (chronicling efforts after the moon landing to continue exploring space).

send astronauts and satellites into space in the succeeding years.<sup>50</sup> With the race concluded, however, competition between the superpowers transitioned into cooperation, and in the 1970's, the Apollo-Soyuz Test Project would lay the groundwork for the International Space Station nearly three decades later.<sup>51</sup> Continued successes opened the door to greater private citizen involvement, whether in the form of flights with civilian crew members, or increasingly more launches of private satellites.<sup>52</sup> In 1990, Congress passed a law requiring NASA to contract with private providers for launches, and as we entered the 2000's, more private companies and contractors entered the space left behind, as the government progressively pulled out of an area it had dominated for decades.<sup>53</sup> That withdrawal became more significant with the retirement of the Space Shuttle program in 2011 and a shift to using private contractors to send NASA astronauts into space.<sup>54</sup>

The years since have seen the emergence of a private, commercially focused space industry with big plans for the future of human spaceflight.<sup>55</sup> However, most of their endeavors, until recently, had been sponsored or administered by governmental agencies and actors.<sup>56</sup> As noted, while there has been some civilian involvement previously, it has never been on the scale that is currently being planned, with private actors taking the lead and operating without any government involvement at all.<sup>57</sup> This shift from quasi-governmental to fully private/commercially driven spaceflight opens the door to tremendous opportunities, some financial, some technological, and some social.<sup>58</sup> It also creates immense risks that need to be properly mitigated and accounted for, particularly as the industry continues to grow and expand.<sup>59</sup>

Despite the enthusiasm and growing development of the industry, there is still relatively little in the way of regulations, across all nations, that are specially tailored to private/commercial spaceflight.<sup>60</sup> A vestige of strong government involvement and domination in the field, the majority of current regulations that govern space activities, both nationally and internationally, are tailored to government agencies and actors; this is true, regardless of whether we are talking

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50. AEROSPACE, *supra* note 26; NASA, *supra* note 29; Sarah Pruitt, *The 5 Deadliest Disasters of the Space Race*, HISTORY (Mar. 29, 2019), <https://www.history.com/news/the-5-deadliest-disasters-of-the-space-race> [perma.cc/4UZU-VXWK].

51. AEROSPACE, *supra* note 26; NASA, *supra* note 29.

52. NASA, *supra* note 29; Dillon, *supra* note 3.

53. Dillon, *supra* note 3.

54. *Id.*; Rahul Rao, *NASA Wants to Buy More Astronaut Rides on Private Spaceships*, SPACE.COM (Oct. 22, 2021), <https://www.space.com/nasa-commercial-crew-more-private-spaceships> [perma.cc/5ZVB-C5KH].

55. See Dillon, *supra* note 3 (“The wave of new companies entering the spaceflight industry in the 1990s and 2000s made leaps in space technology development, and their successes have encouraged them to pursue new opportunities beyond the bounds of conventional research-based space travel.”).

56. *Id.* (“Until now, all spaceflight has been some sort of ‘mission,’ typically carried out by a government program to conduct scientific research. Instead, commercial space companies are now looking to expand into the private sector by offering recreational space flights to civilian consumers.”).

57. *Id.*

58. See *id.* (finding the privatization of space exploration “could catapult space technology forward to reach incredible new heights”).

59. *Id.*

60. See *id.* (explaining “a glaring issue with the burgeoning private space industry: the lack of regulation”).



about NASA and FAA regulations or prohibitions in the Outer Space Treaty (there has been some shift, at least in the United States, to expand and update regulations).<sup>61</sup> The U.N. treaty addresses space issues in only the broadest concepts and devotes only one article to “non-governmental” space activity, which is subject to some interpretation.<sup>62</sup> NASA regulations, as well as other similar government agency regulations, apply only to actions taken by the agency at issue and private actors fulfilling contracts with them, and have no applicability on their independent, non-government counterparts.<sup>63</sup>

Problematically, this means that private actors are not beholden to the same external concerns as national actors.<sup>64</sup> While there are licensing schemes and other such rules that parties may be beholden to depending on the jurisdiction, there is no international regulatory body overseeing national regimes, and as such, most requests coming from actors of other nations or other non-state actors are just that, requests, regardless of their importance.<sup>65</sup> This holds true despite whether these requests come from scientists who want changes to private satellites that are causing light pollution and impeding astronomical studies, or royals asking that these companies focus on earth-bound socio-environmental concerns rather than “escapes” into space.<sup>66</sup> One can imagine how severe the problems that may arise as companies expand beyond satellites and trips into near-space.

### B. *Resource and Mineral Extraction: Diamonds in the Sky*

Along with space tourism, the extraction and harvesting of extraterrestrial resources is a rapidly growing industry, with plenty of wealthy investors financing both start-ups and companies developing plans to harvest and sell these resources raw or after been manufactured.<sup>67</sup> However, unlike spaceflight, the possibility of space mining is a much newer area of interest, bolstered by rapid technological development and the emergence of a wholly private space-focused industry in the last decade which make mining space objects definitively

61. *See id.* (“There is some law regarding human spaceflight from the US, but this applies only to space crew and is surprisingly hands-off regarding civilian non-crew members and space tourists.”).

62. Outer Space Treaty, *supra* note 16, art. VI.

63. *See* Dillon, *supra* note 3 (“There are currently no legal criteria for civilian spacefarers. The FAA has released a report entitled ‘FAA Recommended Practices’ regarding commercial spaceflight, but, as the title states, these are recommendations, not requirements.”).

64. *See* Crockett, *supra* note 10 (“And that’s the rub: When it comes to rules on private companies, space is the Wild West.”).

65. *Id.* (“Private companies face little international oversight on their activity in space . . .”); Loren Grush, *FCC Slams Spaceflight Company with \$900,000 Fine Over Illegal Satellite Launch*, THE VERGE (Dec. 20, 2018, 4:53 PM), <https://www.theverge.com/2018/12/20/18150684/swarm-technologies-illegal-satellite-launch-fcc-settlement-fine> [perma.cc/952E-X3MV] (detailing the repercussions that a private spaceflight company had to face because it violated various FCC procedures).

66. Crockett, *supra* note 10 (“[A]stronomers can only hope that private companies are receptive to their concerns.”); Michael Holden, *UK’s Prince William Says Great Minds Should Focus on Saving Earth Not Space Travel*, THOMSON REUTERS (Oct. 14, 2021, 7:17 PM), <https://www.reuters.com/world/uk/uks-prince-william-says-great-minds-should-focus-saving-earth-not-space-travel-2021-10-14> [perma.cc/W7PN-WSS4].

67. Jayshree Pandya, *The Race to Mine Space*, FORBES (May 13, 2019, 10:37 AM), <https://www.forbes.com/sites/cognitiveworld/2019/05/13/the-race-to-mine-space> [perma.cc/A4SV-UAMS]; Babcock, *supra* note 9, at 202–03; David Johnson, *Limits on the Giant Leap for Mankind: Legal Ambiguities of Extraterrestrial Resource Extraction*, 26 AM. U. INT’L L. REV. 1477, 1480–81 (2011).

more feasible than was once thought only a few decades ago.<sup>68</sup> As such, until all but recently, space “mining” has been a purely scientific endeavor, done by government space agencies like NASA or the Japanese Aerospace Exploration Agency (JAXA).<sup>69</sup>

This landscape has started to change.<sup>70</sup> In 2015, The United States passed the Commercial Space Launch Competitiveness Act, which has laid the foundations for large-scale mining operations by private companies in the coming decade.<sup>71</sup> The law encourages private actors to enter the space mining industry by extending the period under which said companies may explore before reporting to governmental authorities and also recognizes said companies’ claims to the resources they find.<sup>72</sup> Commenters have noted that the provisions of the Act are in strong tension with the Outer Space Treaty, particularly, its provisions prohibiting the claiming of celestial bodies, though others have countered that the ambiguities of the Outer Space Treaty and the exact language of the Act, which still prohibits claiming property ownership, mean that the Act is still in concert with the treaty.<sup>73</sup> The United States has not been the only nation active in this area either.<sup>74</sup> Luxembourg, perhaps a surprising front-runner to those unfamiliar with the space field, given its lack of widely-known space history, has been increasingly proactive in the field.<sup>75</sup> In 2016, it launched its SpaceResources Initiative, bringing together space mining companies from around the world in an attempt to establish broad international standards, and establish itself as an economic focus point for the industry moving forward.<sup>76</sup> Not content, in 2017, Luxembourg passed its own version of the United States’ 2015 Act, and began establishing co-operation agreements with other nations in Europe as well as across the globe, including Japan, Portugal, and the United Arab Emirates.<sup>77</sup> Even Russia was brought to the negotiation table in 2019.<sup>78</sup> In 2020, the United States, along with several of its long time partners, including Luxembourg, but also the United Kingdom, Japan and others, signed the Artemis Accords: a non-binding arrangement governing lunar exploration in the near-future and furthering international cooperation in the spirit of the Outer Space Treaty.<sup>79</sup> While a positive step, the accords did not

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68. Gilbert, *supra* note 23.

69. JP Casey, *The History of Space Mining: Five Key Events for Mineral Exploration in Space*, MINING TECH. (Mar. 18, 2019), <https://www.mining-technology.com/features/history-of-space-mining> [perma.cc/RKJ8-FMA6].

70. *See id.* (explaining the shift from government agencies being the sole actors in space mining to the United States “encourage[ing] private companies to undertake mining work beyond Earth”).

71. *Id.*

72. *Id.*

73. *See generally* P.J. Blount & Christian J. Robinson, *One Small Step: The Impact of the U.S. Commercial Space Launch Competitiveness Act of 2015 on the Exploitation of Resources in Outer Space*, 18 N.C. J.L. & TECH. 160, 160–63 (2016) (providing background on the critics’ argument of the passage of the Commercial Space Launch Competitiveness Act and an argument in rebuttle that the Act bolsters interpretations of the Outer Space Treaty).

74. Casey, *supra* note 69.

75. *Id.*

76. *Id.*

77. *Id.*

78. *Id.*

79. Gilbert, *supra* note 23.

include Russia, China, or India, all major space-faring countries, whose long-term cooperation is crucial to establishing any universal regulatory scheme or standard in the future.<sup>80</sup> Given the astronomical financial and strategic stakes involved, however, cooperation will likely be hard to come by as smaller countries like Luxembourg along with the larger space-faring nations like the United States, China, and Russia are likely to continue to maneuver themselves into poll position to benefit from the opening of this new industry.<sup>81</sup>

There is a massive benefit to be reaped.<sup>82</sup> Previous scientific expeditions have already shown that celestial bodies from the Moon to Mars, and the asteroids of the asteroid belt to the planets at the edge of our solar system, are rich in economically crucial and previously rare liquids, gases, and metals.<sup>83</sup> Gold, platinum, palladium, iridium, nickel, and cobalt, among others, which are extremely rare and in danger of being exhausted here on Earth, can be found in abundant quantities on thousands of near-Earth asteroids.<sup>84</sup> These metals are crucial elements in the manufacture of electronics, batteries and renewable fuel cells, surgical tools and medical implants, and other critical technology, and they lack a synthetic or man-made alternative.<sup>85</sup> As such, the value of a single asteroid could be in the trillions of dollars, based on its mineral wealth.<sup>86</sup> In addition to metals, isotope gases like Helium-3, can be found in large quantities on the Moon and H<sub>2</sub>O, found in both solid and liquid form, is minable on our Moon, Mars, and the moons of other planets in the solar system.<sup>87</sup> Helium-3 is incredibly valuable as a future clean and powerful energy source, capable with the right fusion reactor, of producing ten times the energy of all recoverable fossil fuels on Earth combined.<sup>88</sup> Water likewise is incredibly valuable, as a fission reactor can turn water molecules into fuel propellant, making space-based re-fueling feasible and significantly cheaper than it might otherwise be.<sup>89</sup> Additionally, the water can be used to support habitation systems and further afield exploration and someday colonization.<sup>90</sup> In the near-term, shifting mining and heavy industry into space would alleviate, and possibly eliminate, the environmental damage that harvesting these same resources on Earth causes.<sup>91</sup> Additionally, at least on asteroids, the lack of gravity, lack of corrosive elements due to non-existent atmospheres, and the presence of a continual energy source

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80. *Id.* (“[Russia, China, and India] provide for ‘safety zones’ around mining sites, which raises fears about exclusion of other countries from prime locations and de facto national appropriation.”).

81. *Id.*

82. See Babcock, *supra* note 9, at 200–01 (detailing the “attractiveness” of space mining); Gilbert, *supra* note 23 (“Potential economic, scientific and even security benefits underlie an emerging geopolitical competition to pursue space mining.”).

83. Babcock, *supra* note 9, at 200–01; Gilbert, *supra* note 23.

84. Babcock, *supra* note 9, at 199–201; Elizabeth Steyn, *Space Mining is Not Science Fiction, and Canada Could Figure Prominently*, CONVERSATION (Apr. 4, 2021, 8:00 AM), <https://theconversation.com/space-mining-is-not-science-fiction-and-canada-could-figure-prominently-155855> [perma.cc/FGB4-WLVA]; Gilbert, *supra* note 23.

85. Babcock, *supra* note 9, at 200–01; Steyn, *supra* note 84; Gilbert, *supra* note 23.

86. Babcock, *supra* note 9, at 199–200.

87. *Id.* at 200–01; Gilbert, *supra* note 23.

88. Babcock, *supra* note 9, at 199–01; Gilbert, *supra* note 23.

89. Babcock, *supra* note 9, at 200–01; Gilbert, *supra* note 23.

90. Babcock, *supra* note 9, at 200–01.

91. *Id.*

in the form of the sun, mean that the energy required to harvest these resources is also significantly lower than on Earth.<sup>92</sup>

The sheer amount of rare and valuable resources available, including heavy metals, water, ice, and gases, that have no substitute and are critically important to various industries makes space mining crucial to the continued success of mankind not only on Earth, but among the stars, an ever increasing necessity and perhaps inevitable future given overpopulation and environmental concerns on Earth.<sup>93</sup> Given this vast mineral wealth, and its implications on mankind's present and future, it is crucial that regulatory mechanisms be established, and a new property regime be established that allows commercial endeavors to grow, but also staves off what is effectively economic hostage taking by private enterprises and prevent political conflicts that are assured as competition terrestrially for limited resources grows fiercer.<sup>94</sup>

Historically, property rights to new land, and land not yet claimed, are subject to one of two Roman-derived concepts of property.<sup>95</sup> The first is *Res Nullius*, under which the land sought belongs to no one, and it can be claimed by anyone.<sup>96</sup> The second is *Res Communis Omnium*, under which the land sought is open to any and all but may not be claimed by any one person or entity.<sup>97</sup> It is the second concept of property into which space currently falls, at least as far as the Outer Space Treaty and its related derivatives attempt to make clear.<sup>98</sup> The idea of treating space and space objects as a commons pervades most of the treaty's provisions and it is expressly outlined in Article I, that "[t]he exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries . . . and shall be the province of all mankind."<sup>99</sup> The treaty, however, is riddled with ambiguities and half-answers in response to questions of private use and ownership, and there exists widespread disagreement as to how binding the language "shall be the province of all mankind" is.<sup>100</sup> Much of the treaty's issues are inherently tied to its de-facto, and unintended, longevity and supremacy in international law.<sup>101</sup> The treaty, as previously noted, was never intended to do anything more than lay a framework for the future, by extolling general principles, and stave off Cold War era tensions.<sup>102</sup> The result is a legal document that lays out a principle,

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92. *Id.*

93. *See id.* at 202–03 (arguing that space colonization may help with over-population); Johnson, *supra* note 67, at 1480–81 (arguing the importance of mining resources in space for the preservation of future generations).

94. *See* Babcock, *supra* note 9, at 204–06 (acknowledging that the main reason space exploration is not advancing is the uncertainty in the law and regulations); Johnson, *supra* note 67, at 1480–81 (acknowledging the important of space exploration and how uncertainty in the law hinders such exploration); Pandya, *supra* note 67 ("If private companies and select nations are funding space exploration, who will these valuable space resources belong to? In other words, who are we enabling to wield massive economic power in the next chapter of our species' history?").

95. Johnson, *supra* note 67, at 1483.

96. *Id.*

97. *Id.*

98. Babcock, *supra* note 9, at 233 ("[E]arly space treaties treated space as though it was a commons.").

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

100. *Id.*; Babcock, *supra* note 9, at 209–11.

101. Babcock, *supra* note 9, at 208–09.

102. *Id.*

but never defines it, and never dives deeper than surface level, thus creating an issue of which property regime really applies.<sup>103</sup> A later treaty, known as the Moon Treaty, attempts to further expand upon the commons theory, which articulates what some have referred to as a third concept of property, or the Common Heritage of Mankind.<sup>104</sup> A newer scheme of property originating in the 20th century, during similar property-based discussions concerning sea resources and Antarctica, the Common Heritage of Mankind doctrine is a stricter version of the Res Communis or commons theory.<sup>105</sup> It focuses on five core elements: (1) the designated area cannot be controlled or owned; (2) the use of the area (and resources within) are to be managed by an international authority; (3) all benefits derived from the area and its resources are to be distributed equitably to all stakeholders; (4) the area must be used peacefully and non-militarily; and (5) the benefit of the area and its resources are to be directed to the common good of mankind collectively.<sup>106</sup> While this theory and interpretation are often favored by traditionally non-space-faring nations and developing countries, they create a problematic free-rider issue that discourages nations with the means from actively exploring and developing space because rewards are equally distributed without regard to contribution.<sup>107</sup> On the other side of the spectrum, treating space as a commons results in the phenomena known as the tragedy of the commons.<sup>108</sup> Nations, lacking any right to exclude, have no incentive to protect the commons because costs are externalized rather than internalized on each user or the group.<sup>109</sup> As a result, every user maximally exploits the resources to the point of unsustainability and collapse.<sup>110</sup> Beyond the destruction of the resource, there is the resulting widespread economic harm that naturally results from oversaturated markets.<sup>111</sup> As supply increases, demand plummets, driving prices and subsequently return on investment down.<sup>112</sup> In the best case, industries that are largely stable and have adequate cash reserves can weather the bear market and reemerge on the other side of a revived market.<sup>113</sup> At worse, a bear market may lead to a depression or recessions of modern times, and the resulting loss is likely to be catastrophic for a nascent industry like space

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103. *Id.* at 209–11.

104. Johnson, *supra* note 67, at 1483; Babcock, *supra* note 9, at 211–15.

105. Johnson, *supra* note 67, at 1483–84.

106. *Id.*

107. Babcock, *supra* note 9, at 214–16.

108. *Id.* at 237–40.

109. *Id.*

110. *Id.*

111. See Bill Conerly, *Commodities Prices: Why Do They Shoot Up and Then Collapse?*, FORBES (June 26, 2014, 5:40 PM), <https://www.forbes.com/sites/billconerly/2014/06/26/commodities-prices-why-do-they-shoot-up-and-then-collapse/?sh=106c4bea2a18> [perma.cc/4FDE-T2MG] (explaining the negative effects in an economy flowing from high supply).

112. *Id.*

113. See Alana Benson, *What is a Bear Market? Definition and How to Invest During One*, NERDWALLET (Mar. 8, 2023), <https://www.nerdwallet.com/article/investing/how-to-invest-during-a-bear-market#:~:text=Think%20about%20the%20things%20consumers,bear%20markets%20better%20than%20others> [perma.cc/L5LW-GEZX] (“[T]hings such as consumer staples and utilities usually weather bear markets better than others.”).

mining.<sup>114</sup> There is also risk of conflict and ruinous competition that has the potential to engender all the ills that the current space treaties have tried to prevent.<sup>115</sup> A commonly proposed solution to the tragedy of the commons is often privatization. However, that approach is not perfect either, for it results most often in the concentration of resources and commodities, in the hands of the few, a perverse and unfair outcome, when many of these resources have values that extend far beyond their market price.<sup>116</sup> It is clear that a new property regime is needed, one that protects and encourages investment but also protects against unlimited exploitation and further socio-economic harm.<sup>117</sup>

### C. *Colonization: Life Among the Stars*

Colonization is still a distant prospect but one that is becoming increasingly more realistic as technology advances, and many might call it inevitable given the nature of man and the crises we face and will continue to face on Earth.<sup>118</sup> Yet, it also poses serious legal and ethical issues that require significant thought as we move forward into the Final Frontier.<sup>119</sup> Who can start colonies? Who can control them (countries, corporations, no one)? What laws apply? And who will enforce those laws?<sup>120</sup> These and many other questions must be resolved before man can truly begin to claim the stars as their own.<sup>121</sup>

The drive to explore and subsequently colonize space has long roots, but only recently has technology made the prospect a plausible reality rather than a science-fiction dream.<sup>122</sup> Leading scholars, experts, and philosophers have sparred over these developments, particularly as colonization has grown in the public consciousness.<sup>123</sup> For some, the prospect of humanity's colonization of space is morally and socially perverse at this moment in time.<sup>124</sup> Humanity, they argue, lacks the social and ethical development necessary to colonize without

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114. *See id.* (explaining that markets providing necessary goods “weather bear markets better” than other, non-necessity markets).

115. Babcock, *supra* note 9, at 240.

116. *Id.* at 240–41.

117. *Id.* at 241–42.

118. Marko Kovic, *Political, Moral, and Security Challenges of Space Colonization*, in ZIPAR DISCUSSION PAPER SERIES 5–8 (2018).

119. *See generally* Igor Levchenko et al., *Mars Colonization: Beyond Getting There*, 3 GLOB. CHALLENGES, Jan. 2019, at 3–11 (discussing the ethical, legal, social, and technological challenges of colonizing Mars and beyond).

120. *Id.* at 4.

121. *Id.* at 3.

122. *Id.* at 1; *see generally* HERMANN POTOČNIK NOORDUNG, *THE PROBLEM OF SPACE TRAVEL: THE ROCKET MOTOR 140* (Ernst Stuhlinger et al. eds., 1929) (putting forth the mathematical and scientific advancements necessary to allow for spaceflight “to show that travelling into outer space should no longer be viewed as something impossible”); DANDRIDGE M. COLE & DONALD W. COX, *ISLANDS IN SPACE: THE CHALLENGE OF THE PLANETIODS* (1964) (putting forth predictions of and the importance of space exploration); GERARD K. O’NEILL, *THE HIGH FRONTIER: HUMAN COLONIES IN SPACE* 211 (1977); T. A. HEPPENHEIMER, *COLONIES IN SPACE*, 178–79 (1977) (discussing the predicted future of space colonization for the next 100 years).

123. Levchenko et al., *supra* note 119, at 1–2.

124. *See generally* Linda Billings, *Should Humans Colonize Other Planets? No*, 15 THEOLOGY & SCI. 321, 321–30 (June 25, 2017) [hereinafter THEOLOGY AND SCI.] (discussing the moral and ethical problems with human colonization of space).

repeating the same mistakes of the past.<sup>125</sup> For others, space colonization is immoral and unethical, pointing to the current environmental and social state of the Earth, questioning how one can justify the expense when funds could be better used to fix problems on Earth, or that such an enterprise is elitist and racially-coded, given the treatment of the poor and marginalized in most societies.<sup>126</sup> Arguments on the other side are long-standing and have formed the core of current thought for most government and private space enterprises.<sup>127</sup> Chief among them is that mankind must colonize other planets to protect its own survival as a species.<sup>128</sup> Beyond mere survival of our species, space colonization, they argue, will drive tremendous positive technological, social, and economic change for mankind, improving the quality of life for all and pushing man into the next age.<sup>129</sup> For others, man's expansion into the stars is only its natural evolution as a species, with famed Russian Cosmist, Konstantin E. Tsiolkovsky once saying that "Earth is the cradle of humanity, but one cannot remain in the cradle forever."<sup>130</sup>

Moving beyond the philosophical hurdles, there are many technological hurdles that must be overcome, starting from simply getting to space (quickly and safely), to helping humans, and likely other creatures such as livestock, survive there.<sup>131</sup> Despite great advances, the necessary technology for such a colony is still some decades away.<sup>132</sup> While some might bemoan, and others cheer, it provides the much-needed time for us to reevaluate the current rules and lay the groundwork for a new set of rules to govern mankind's inevitable future in space, reigning in the unchecked exuberance and address many of the concerns of those against space colonization.<sup>133</sup>

As previously discussed, the prevailing international law is that of the Outer Space Treaty (OST), whose core principle is that space is a commons,

125. *Id.*; see generally Lori Marino, *Humanity is Not Prepared to Colonize Mars*, 110 FUTURES 15, 15–18 (2019) (discussing humanity's arguably poor track record with colonization and maintenance of environments, and current unpreparedness for space colonization).

126. Linda Billings, *Colonizing Other Planets Is a Bad Idea*, 110 FUTURES 44, 44–46 (2019) [hereinafter FUTURES].

127. See Avery Hartmans, *Jeff Bezos Predicts That People Will One Day Be Born in Space and Will 'Visit Earth the Way You Visit, You Know, Yellowstone National Park'*, BUS. INSIDER (Nov. 12, 2021, 9:13 AM), <https://www.businessinsider.com/jeff-bezos-humans-born-in-space-eventually-space-colonies-2021-11> [perma.cc/BL3B-TNZR] (putting forth generally Jeff Bezos' ideas and rationales for colonizing space).

128. Levchenko et al., *supra* note 119, at 2.

129. *Id.* at 2–3.

130. NASA, *Konstantin E. Tsiolkovsky* (Sept. 22, 2010), <https://www.nasa.gov/audience/foreducators/rocketry/home/konstantin-tsiolkovsky.html> [perma.cc/N8XP-Y7X8].

131. Jessica Orwig, *These Are the 2 Big Hurdles to Setting Up a Mars Colony*, BUS. INSIDER (Jan. 16, 2015, 4:07 PM), <https://www.businessinsider.in/tech/These-Are-The-2-Big-Hurdles-To-Setting-Up-A-Mars-Colony/articleshow/45905176.cms> [perma.cc/B59V-YHTG]; see Matt Williams, *The Future of Space Colonization — Terraforming or Space Habitats?*, UNIVERSE TODAY (Mar. 10, 2017), <https://phys.org/news/2017-03-future-space-colonization-terraforming-habitats.html> [perma.cc/Q29G-VD87] (outlining the various hurdles that must be overcome in order for organisms to survive on Mars).

132. See Levchenko et al., *supra* note 119, at 1–2 (stating that Mars colonization is likely possible "within our lifetime").

133. See THEOLOGY & SCI., *supra* note 124, at 321 (putting forth reasons why humans should not colonize other planets); Hartmans, *supra* note 127 (putting forth Jeff Bezos' reasons why humans should colonize Mars); Babcock, *supra* note 9, at 206–16 (detailing the various gaps in the current legal framework regulating space activities).

open and accessible to all, and unable to be claimed with exclusivity by any entity.<sup>134</sup> The language of the treaty reads, “[t]he exploration and use of outer space, including the Moon and other celestial bodies, shall be carried out for the benefit and in the interests of all countries . . . and shall be the province of all mankind.”<sup>135</sup> Yet despite this language, the exact definition and meaning is subject to some discussion, with some parties arguing that the language is purely aspirational, and others arguing that it is more binding and together with the later Moon Treaty, clearly prohibiting ownership which is not for and in the benefit of all of man.<sup>136</sup> But such prohibitions, as noted earlier, are targeted at state, not private entities, leaving open the possibility that a corporation has the legal right to colonize and claim ownership of celestial bodies, though some commenters have stated that the treaty provisions do in fact prevent private parties from doing so.<sup>137</sup> Regardless of one’s interpretation, it’s clear that a new treaty framework is needed.<sup>138</sup>

### III. ANALYSIS

#### A. *Commercial Spaceflight: The Dangers of No Regulations*

NASA—and similar non-United States governmental space agencies—have rigorous health and safety requirements for astronauts and passengers, and adhere to strict environmental and ethical policies.<sup>139</sup> Private enterprises are not bound to these regulations and policies, and while the FAA nominally has policies in place, these are far weaker than those formally adhered to, and are practically non-existent for non-crew passengers.<sup>140</sup> Environmental protections, as they pertain to activity in space and the upper atmosphere, are similarly quite low and existing property regimes applicable to space actually encourage rather than discourage blanket disregard for environmental impact of spaceflight activities once off the Earth’s surface.<sup>141</sup>

Safety and related implications are not distant concerns, as even with rigorous standards under the previous government-focused regime, tragedies have occurred.<sup>142</sup> The Soviet Union, during the course of the Space Race and in

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134. Babcock, *supra* note 9, at 233–34.

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

136. Babcock, *supra* note 9, at 210–11.

137. Kovic, *supra* note 118, at 5–8 (noting the ambiguity in the OST and open question of how private entities are regulated under the OST, if at all); Johnson, *supra* note 67, at 1486–87 (“[T]he OST applies to both private and state space activities.”).

138. See FUTURES, *supra* note 126, at 44 (highlighting the deficiencies of the current treaty frameworks and how humanity could benefit from a new framework).

139. See Dillon, *supra* note 3 (putting forth the standards that NASA adheres to, including screening, training, and preparation, and potential issues that may arise with the privatization of space exploration without regulations, like environment and ethical ramifications).

140. *Id.*

141. Babcock, *supra* note 9, at 204–05.

142. See, e.g., AEROSPACE, *supra* note 26 (detailing “the launch of the space shuttle Columbia” that resulted in the death of all seven crew members).



its immediate aftermath, had several tragedies strike its space program.<sup>143</sup> In 1967, under pressure to beat the United States, the Soviet Union pushed ahead with the launch of Soyuz 1, its answer to the United States' Apollo Program.<sup>144</sup> Manned by an experienced Soviet cosmonaut, the launch proceeded according to plan, but disaster struck after the craft reached orbit. Malfunctioning systems forced an early return of the craft, and further system failures required the cosmonaut on-board to attempt to manually re-enter and land the craft.<sup>145</sup> Despite extraordinary efforts by the pilot, one last system failure caused the parachute system to not deploy, resulting in a crash landing and death of the cosmonaut.<sup>146</sup> In 1971, Soyuz 11, returning from its mission, suffered a tragedy in course of atmospheric re-entry and landing.<sup>147</sup> During re-entry, the valves on the ventilation system improperly opened, resulting in depression of the cabin and loss of oxygen.<sup>148</sup> The rapid decompression and asphyxiation caused the death of three Soviet cosmonauts.<sup>149</sup> Lastly, in 1980, the Soviet Union suffered its worst space tragedy during the planned launch of a Vostok series rocket at the Plesek Cosmodrome.<sup>150</sup> Despite the Vostok rocket's safe reputation, a fuel fire infernoed during its refueling, killing forty-eight people, a toll which could have been much higher but for quick thinking by the ground crew.<sup>151</sup>

The Soviets were not the only side to suffer such tragedies.<sup>152</sup> In 1967, during a simulated launch in preparation for the Apollo missions, a flash fire occurred in the training shuttle capsule.<sup>153</sup> Due to a faulty hatch on the module, three astronauts were trapped inside and died before they could be saved.<sup>154</sup> The United States would thankfully suffer no further tragedy until nearly twenty years, when in January of 1986, the Challenger exploded during launch.<sup>155</sup> Dangerously cold weather conditions and faulty parts caused the shuttle to explode only minutes after takeoff, killing all seven of the astronauts on board.<sup>156</sup> Following the Challenger Disaster, the United States managed to avoid another tragedy until 2003, when the Columbia Space Shuttle exploded during re-entry

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143. See Alexey Timofeychev, *The Dark Side of the Soviet Space Program: 3 Tragic Disasters*, RUSS. BEYOND (Jan. 29, 2018), <https://www.rbth.com/science-and-tech/327410-dark-side-of-space-program> [perma.cc/3LYR-VPYA] (detailing several Russian tragedies during the space race, including Soyuz 1 and Soyuz 11, two missions that resulted in deaths).

144. *Id.*

145. *Id.*

146. *Id.*

147. *Id.*

148. *Id.*

149. *Id.*

150. *Id.*

151. *Id.*

152. See Sarah Pruitt, *The 5 Deadliest Disasters of the Space Race*, HIST. (Mar. 29, 2019), <https://www.history.com/news/the-5-deadliest-disasters-of-the-space-race> [perma.cc/DU32-NZNY] (detailing space race tragedies suffered by both the USSR and the United States); Jonathan Hogeback, *7 Accidents and Disasters in Spaceflight History*, ENCYCLOPEDIA BRITANNICA, <https://www.britannica.com/list/7-accidents-and-disasters-in-spaceflight-history> [perma.cc/M9LD-X57V] (last visited Mar. 17, 2023) (detailing American, European, and Soviet space disasters).

153. Pruitt, *supra* note 152.

154. *Id.*

155. *Id.*

156. *Id.*

and landing.<sup>157</sup> A faulty piece of insulation had broken free earlier and caused a hole in one of the shuttle wings, allowing smoke and gases to enter and cause the explosion of the wing and then spacecraft, during re-entry, killing all seven astronauts aboard.<sup>158</sup> All of these disasters occurred while under the strict rules and oversight of their respective government space agencies, but in each case, oversight and management failures, financial worries and faulty equipment, and time pressures resulted in mistakes that proved lethal and destructive.<sup>159</sup> Given the failure of governmental actors to fully protect its crews, are lower and less coherent regulations truly the best way for private actors to ensure the safety of future crews and passengers?<sup>160</sup>

Safety is not just a past concern but a present cognizable reality, as Richard Branson's recent famed Virgin Galactic Space Flight, though concluded safely, had its own brush with potential disaster, which might have imperiled the lives of crew, passengers, other crafts, and potentially those on the surface.<sup>161</sup> Spaceflight is a dangerous business that requires strict governance and policies to ensure success, but also to protect lives.<sup>162</sup> All of this is not to write off the benefits that private companies have brought to the industry, but it is a recognition that for private companies, profit is the greatest metric, and all others, including health and safety, along with the environment, are secondary metrics.<sup>163</sup>

To this point, given the current state of regulations, there is nothing forbidding a company from sending ill-equipped, wealthy patrons into space, disregarding concerns of their inadequacy in exchange for greater sums of money, or monetarily-impactful prestige.<sup>164</sup> Jeff Bezos's Blue Origin Company did just that recently, completing a trip with 90-year-old actor, William Shatner, aboard as a passenger, capitalizing on Shatner's famous role as Captain Kirk in SpaceTrek.<sup>165</sup> This is exactly the sort of scenario we need to regulate and prevent in the future. While NASA regulations by their very nature are exclusionary to some degree, they are also effective at protecting the health and safety of their astronauts and passengers, by ensuring that not only is every individual physically and mentally qualified but that they are also fully aware and cognizant

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157. *Id.*

158. *Id.*

159. See Timofeychev, *supra* note 143 ("While by 1967 the new spaceship was still not entirely ready, the [USSR's] leadership didn't want to wait any longer."); Pruitt, *supra* note 152 ("An investigation later found that NASA had known[, with respect to the Challenger explosion,] that extreme cold temperatures could result in damage to the spacecraft's rubber O-rings . . . but elected to go ahead with the launch anyway . . .").

160. See Dillon, *supra* note 3 (arguing that "it is imperative that a governing body be put in place to deal with the inherent risks of space flight").

161. Nicholas Schmidle, *The Red Warning Light on Richard Branson's Space Flight*, NEW YORKER (Sept. 1, 2021), <https://www.newyorker.com/news/news-desk/the-red-warning-light-on-richard-bransons-space-flight> [perma.cc/39KQ-JCJY].

162. Dillon, *supra* note 3.

163. See *id.* (putting forth various potential harms that may ensue if private spaceflight companies are not regulated, including safety and environmental concerns).

164. See *id.* ("Nothing is legally stopping a company from putting a 65-year-old man with a high risk for heart attacks on a rocket and launching him into space.")

165. Marcia Dunn & Rick Taber, *William Shatner, TV's Capt. Kirk, Blasts Into Space*, AP NEWS (Oct. 13, 2021), <https://apnews.com/article/shatner-blue-origin-launch-09705724072c0ecad2674c8511f0fcab> [perma.cc/UB8K-6FQB].

of the risks—something that is only “recommended,” not required for private carriers to follow.<sup>166</sup> While FAA regulations and United States statutes require that a disclaimer and list of risks be presented to all passengers, this often takes the form of a standard boiler plate waiver, that most of us rarely even skim, let alone actually read and critically evaluate.<sup>167</sup> Further, specialty medical screenings and medical evaluations that filter out individuals with potentially dangerous conditions that spaceflight may make worse, are only “recommended.”<sup>168</sup> Without more stringent regulation, there is little if any incentive for companies to do more than this.<sup>169</sup>

This lack of regulation extends to environmental concerns as well.<sup>170</sup> With frequent launches in the offing and plans to send even more satellites into orbit (despite the fact that there are already dozens times more private satellites than government/public satellites in orbit), pollution of the atmosphere and near space is a present and real concern.<sup>171</sup> However, research into this area is still new, and the long-term impact of commercial spaceflight on the atmosphere and broader space environment is not fully clear given that the quantity of launches has rapidly increased only recently.<sup>172</sup> Studies already show that space launches contribute to and cause Ozone damage and pollution, and emit polluting particles and gases at a significantly higher rate than airplanes.<sup>173</sup> Some companies, like Blue Origin or SpaceX, employ more environmentally-friendly fuel than traditional combustion rocket fuel, but it still pollutes the atmosphere and causes negative effects; and further, their choice to use “cleaner” fuel is purely their own strategic choice and is not driven by regulatory requirements (i.e., Virgin Galactic uses more traditional, and as such, “dirtier” fuel).<sup>174</sup> While the pollution contribution of space travel is still relatively minor in comparison to other pollution causes, with the expected growth of the industry in the near future, this is unlikely to be the case, even according to conservative

166. Dillon, *supra* note 3.

167. *See id.* (“The FAA ‘Recommended Practices’ makes some bare-minimum and rather mediocre suggestions for safety . . .”).

168. *See id.* (“Nothing is legally stopping a company from putting a 65-year-old man with a high risk for heart attacks on a rocket and launching him into space.”).

169. *Id.*

170. *Id.*; Babcock, *supra* note 9, at 204–05.

171. Dillon, *supra* note 3 (“[R]esearch indicates that a thousand private launches per year could significantly disrupt the distribution and circulation of ozone.”); Babcock, *supra* note 9, at 204–05 (discussing various environmental concerns with private space travel, including space debris and contamination); Crockett, *supra* note 10.

172. Charlie Wood, *How Blue Origin, SpaceX, Virgin Galactic Space Race Could Impact the Atmosphere*, CNBC (Aug. 27, 2021, 2:30 P.M.), <https://www.cnbc.com/2021/08/27/how-blue-origin-spacex-virgin-galactic-space-race-could-impact-the-atmosphere.html> [perma.cc/U4AA-M79Z]; Tereza Pultarova, *The Rise of Space Tourism Could Affect Earth’s Climate in Unforeseen Ways, Scientists Worry*, SPACE.COM (July 26, 2021), <https://www.space.com/environmental-impact-space-tourism-flights> [perma.cc/TP89-SDWB].

173. Wood, *supra* note 172; Pultarova, *supra* note 172.

174. Wood, *supra* note 172 (“A spokesperson for Virgin Galactic said the company ‘is examining opportunities to offset the carbon emissions for future customer flights.’ While SpaceX has not commented directly on carbon emissions, Musk has supported a carbon tax policy. Blue Origin has said its New Shepard rocket uses carbon-free fuels like hydrogen and oxygen.”); Pultarova, *supra* note 172 (“In the case of SpaceShipTwo, the vehicle operated by Branson’s Virgin Galactic, these flights are powered by a hybrid engine that burns rubber and leaves behind a cloud of soot.”).

estimates.<sup>175</sup> It is of critical importance that we begin to formulate regulations and support research into the long-term effects of this pollution while the industry is still small and manageable, and the effects are limited, rather than later when the industry has grown and become unmanageable, and the effects are more significant and perhaps irreversible.<sup>176</sup>

Looking to existing international treaties again provides little guidance for dealing with private actors.<sup>177</sup> The main treaties in this area with any level of significant international agreement are the OST, and to a lesser extent, the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies [“Moon Treaty”] (1979).<sup>178</sup> Both treaties have little in the way of provisions with any effect on private actors, and indeed private actors dominating the Aerospace sphere was a negligible concern at the time the treaties were drafted.<sup>179</sup> Drawn up and agreed to during the height of the Cold War and the Space Race between the United States and the Soviet Union, the treaties were designed to assuage fears of a conflict spreading to space and creating a situation of grave threat to either nation’s security.<sup>180</sup> As such, the focus of the Treaties’ articles are nation-states, and not private-actors, and beyond that, the treaties themselves are largely outline-like in nature, carving broad swaths but often leaving out the specifics.<sup>181</sup> This includes not establishing a universally applicable governance/legal enforcement regime, using broad, undefined language, and neglecting consideration of property rights outside of the state-context.<sup>182</sup> Most of these considerations concern themselves with the OST, and for good reason, because the Moon Treaty, despite its position as an important international agreement on space given the scarcity of treaties in this area, lacks the broad international agreement to make it binding on the majority of countries, and there is even ambiguity from some scholars on whether the current signatories of the agreement are still bound to it themselves.<sup>183</sup>

Given the varied and significant concerns implicated by a growing commercialized spaceflight industry<sup>184</sup> and the lack of existing effective international law,<sup>185</sup> there is need for all nations to come together and formulate a new universal legal and regulatory scheme so that the issues we face today do not become the catastrophes of tomorrow.

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175. Wood, *supra* note 172; Pultarova, *supra* note 172.

176. See Wood, *supra* note 172 (pointing out that many environmental researches would like to prevent harm that space tourism could cause before it happens so that “the space industry can move forward in a sustainable manner”); Pultarova, *supra* note 172 (“[I]t is critical that scientific work starts now to evaluate the future risks.”).

177. Babcock, *supra* note 9, at 191–92.

178. *Id.* at 206–07.

179. *Id.* at 207–09.

180. *Id.*

181. *Id.* at 208–09.

182. *Id.* at 206–11.

183. *Id.* at 211–12.

184. See, e.g., Dillon, *supra* note 3 (pointing out various environmental and moral concerns with the commercialization of spaceflight).

185. Babcock, *supra* note 9, at 206–08, 211–12.

*B. Mining and Resource Extraction: The Tragedy of Treating Space as a Commons*

Mining and property rights in space are currently governed by the OST.<sup>186</sup> These regulations, however, have limited and contested application to private actors.<sup>187</sup> While other treaties exist, such as the Moon Treaty, none are as universally signed as the OST.<sup>188</sup> That said, both treaties conceive of space as a shared “commons” available for use by all of mankind.<sup>189</sup> This “Common Heritage” property scheme, which is de-facto the applicable property scheme for space, creates significant practical, theoretical, and ideological conflicts and issues.<sup>190</sup> One of the largest issues with this conception of property rights is that it encourages the “tragedy of the commons,” whereby the costs in terms of damage environmentally, ethically, and commercially are not internalized by any one country or company.<sup>191</sup> Further, it encourages the propagation of a “wild west/gold rush” environment where rules and regulations are disregarded in favor of hedonistic and capitalistic overconsumption.<sup>192</sup> Lastly, without a clear framework, businesses, particularly those not backed by those with the financial might of a Bezos or Branson, will struggle to get off the ground, limiting not only the potential investors, but the commercial and technological growth, development, and innovation that is sure to emerge from the mining of these resources.<sup>193</sup> The lack of formalized rules and property rights protections for business will not only lead to the inevitable monopolization of resources by a handful of companies, it will also contribute to the collapse of the industry in the long-term and risk the loss of all of the benefits that space mining can provide.<sup>194</sup>

In order to determine to the most appropriate property scheme, it is necessary to analyze the cost and benefits of the various types of ownership.<sup>195</sup> We begin firstly with types of private ownership. Privatization and individual ownership lie at the heart of American (and other nations’) ideals.<sup>196</sup> Driven by capitalism and individualism, private property is conceptualized as driving economic progress and development by providing a means by which individuals are incentivized to care for, protect, and invest in property.<sup>197</sup> Private ownership ties or internalizes the value and future value of property to the owner, and in doing so encourages economic efficiency, as only those most able to bear these

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186. Outer Space Treaty, *supra* note 16; Johnson, *supra* note 67, at 1480–81; Steyn, *supra* note 84.

187. Johnson, *supra* note 67, at 1503; Steyn, *supra* note 85.

188. Babcock, *supra* note 9, at 210–11.

189. *Id.* at 208–09, 211–12.

190. *Id.* at 214–16.

191. *Id.* at 214 n.190.

192. *Id.* at 191–92, 205.

193. See Babcock, *supra* note 9, at 224–25 (arguing innovation will be stifled if companies do not have the proper monetary incentives to invest in space exploration); Dillon, *supra* note 3 (“If the industry can move forward practically, sustainably, and ethically, the possibilities for human advancement are thrilling.”).

194. See Babcock, *supra* note 9, at 261 (“[T]here is an urgency to figure out how to control what happens in outer space before its resources are irreparably damaged or permanently monopolized by powerful countries and individuals.”).

195. See *id.* at 217 (analyzing the costs and benefits of different property systems to determine which is more appropriate for space).

196. *Id.* at 221–22.

197. *Id.*

cost participate, and those able to bear the costs are also those most able to utilize its resources productively.<sup>198</sup> Private ownership also provides protections and some assurances of efficient but judicious use.<sup>199</sup> Space mining is a risky and incredibly expensive proposition, and private ownership provides the necessary rewards to inspire investor confidence and business activity.<sup>200</sup> It also engenders a manner of stewardship, as owners, because of their vested value interest in the property (as well as its future value), are far less likely to exploit resources to the point of exhaustion.<sup>201</sup> Of course, there are negatives as well.<sup>202</sup> Private ownership can lead to rising economic disparity between the haves and have-nots, overconcentration of resources in the hands of the few, and potentially dangerous socio-economic tensions across society.<sup>203</sup> There is also the practical matter of the OST, and its common ownership provisions.<sup>204</sup> While there is likely to be wiggle room for some scaled-back versions of private ownership (property ownership types less than a fee simple absolute or ownership with all rights), the more sticks of rights removed from the ownership bundle, the less of a benefit private ownership provides.<sup>205</sup>

In opposition to private property is the commons or communal property.<sup>206</sup> Under communal ownership, resources are collectively shared amongst all, and no one possess the right of exclusion, which is the right to prevent all others but themselves from accessing the property.<sup>207</sup> While addressing some of the concerns of private ownership, it creates other problems of its own.<sup>208</sup> These problems coalesce into something commonly known as the “tragedy of the commons.”<sup>209</sup> The lack of certain property rights, like the right of exclusion, means that members have none of the incentives of private ownership to manage resources, and so instead exploit the property’s resources to the point of depletion, because if they do not, others will.<sup>210</sup> This cycle of rivalry and competitive exploitation is difficult to stop or manage because it requires a measure of cooperation and swallowing of economic loss that runs counter to self-interest.<sup>211</sup> In addition to the resource loss, the uncontrolled competition itself is a worry, because it enflames aggressive behavior of the type that the space treaties were designed to protect against.<sup>212</sup> Even now, ideological and economic blocs are forming around the leading players, like the United States

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198. *Id.* at 221–22, 221 n.246.

199. *Id.* at 223–25.

200. *Id.*

201. *Id.*

202. *Id.* at 222.

203. *Id.*

204. *Id.* at 233–34.

205. *Id.* at 226–27 n.282, 229–33.

206. *Id.* at 192–93.

207. *Id.*

208. *Id.* at 236–37.

209. *Id.* at 239 n.379.

210. *Id.* at 237–38.

211. *See id.* (explaining that exiting a commons can be difficult, at least in part due problems with cooperation within the commons).

212. *Id.* at 240.

and China, in near mimicry of the earlier space race of the 20<sup>th</sup> century.<sup>213</sup> The United State's Artemis Accords and China's Earth-Moon Special Economic Zone are functioning as space's version of NATO and the Warsaw Pact, with China already eliciting the support of Russia and targeting other countries through its investment programs, and the United States courting the support of countries like Luxembourg, Australia, and the United Arab Emirates in addition to traditional allies.<sup>214</sup>

Neither a fully private nor a fully communal property scheme is the best approach to space, and there is a need for a new, hybrid regime that can combine the best attributes of both sets of schemes, while minimizing their drawbacks.<sup>215</sup> Some scholars have proposed looking to the Law of the Sea Treaty or Antarctic Treaty to assist in conceptualizing what laws and property rights should apply in space.<sup>216</sup> But doing so is also problematic and does little to clarify some of the most outstanding issues given dissimilarities and the lack of consensus even there.<sup>217</sup> Space will require novel and outside of the box solutions.

### C. *Colonization: A Problematic Dream*

Colonization, much like mining, presents legal, political, and philosophical issues that are partially addressed, at least in the state context, by U.N. treaties but are ill-addressed in the individual context.<sup>218</sup> Indeed, given the legal ambiguity and conflict over the treaties' exact prohibitions and requirements, it can be fairly argued that it is fully within the current legal regime for private companies to found colonies or long-term space habitats or that such a practice is wholly illegal.<sup>219</sup> Of course, beyond the question of simple legality of the practice exists the problem of how to govern these hypothetical colonies, what laws would apply, and how to enforce and delegate authorities and rights, particularly if states lack the authority to directly oversee settlements.<sup>220</sup>

Article II of the OST lays out the principle of non-appropriation by sovereign states of celestial or space bodies.<sup>221</sup> This principle essentially prohibits countries from colonizing, in the historic sense of the word, and expanding their territory through occupation of objects like the Moon or Mars.<sup>222</sup>

213. Chaitanya Giri, *As Geopolitical Blocs Vie for Primacy in Space, the History of Colonization Looms Large*, CTR. FOR INT'L GOVERNANCE INNOVATION (Feb. 7, 2022), <https://www.cigionline.org/articles/as-geopolitical-blocs-vie-for-primacy-in-space-the-history-of-colonization-looms-large> [perma.cc/XW42-GRXZ].

214. *Id.*; Gilbert, *supra* note 23.

215. Babcock, *supra* note 9, at 242.

216. Johnson, *supra* note 67, at 1510–13.

217. *Id.*

218. Kovic, *supra* note 118, at 5–8; see Babcock, *supra* note 9, at 207–18 (explaining the framework of the Outer Space Treaty and the governance it has over states with no mention of governance over individuals).

219. Kovic, *supra* note 118, at 7–8 (“[I]t is not clear whether the hypothetical [private] mining company would be engaging in a form of appropriation or in a permissible activity [when mining in space].”); Babcock, *supra* note 8, at 207 (“For example, while the OST clearly bars the appropriation of ‘celestial bodies’ by countries, it does not address private entities appropriating them.”); Johnson, *supra* note 67, at 1486–87 (“[T]he OST applies to both private and state space activities.”).

220. Joshua Fitzmaurice & Stacey Henderson, *On the Legality of Mars Colonisation*, 40 ADEL. L. REV. 849–50 (2019); Kovic, *supra* note 118, at 6–9.

221. Fitzmaurice & Henderson, *supra* note 220, at 848.

222. *Id.* at 848–49.

This prohibition and understanding of the prohibition is widely accepted by the international community.<sup>223</sup> Given this prohibition, the question then becomes, if not countries, then who can colonize, and if done, who will govern, protect, and maintain these colonies?<sup>224</sup> Much like with mining, the answer largely depends upon the adoption of a new scheme of property and international cooperation between state actors.<sup>225</sup> Given the costs, legal considerations, and reality that colonies, unlike mining enterprises, are not intrinsically economic endeavors (and likely early on will be economic consumers rather than producers), companies and private enterprises are poorly placed and lack the incentives to drive such a process, even if their cooperation is vital to its success.<sup>226</sup> As such, unlike mining, colonization needs to be a state-driven enterprise, borne of cooperation and collaboration among many states (in conjunction with private companies and corporations).<sup>227</sup> The International Space Station (ISS) provides a particularly relevant example of the success of such a proposition in space and an example to follow.<sup>228</sup> The ISS only functions as a result of the political will of participating states to cooperate and craft hybrid legal regimes to address the unique issues of life in space.<sup>229</sup>

In addition to the issues of founding and governance, there are ethical and moral considerations that must be resolved as well, particularly those dealing with the environmental impact of mankind colonizing celestial bodies.<sup>230</sup> How does humanity interact with the existing geographical and atmospheric makeup of the places it colonizes?<sup>231</sup> How much change is acceptable?<sup>232</sup> Is any change acceptable?<sup>233</sup> What about life-forms on these bodies?<sup>234</sup> What level of zoological contamination are we prepared to accept?<sup>235</sup>

The reality of man settling on planets and space objects beyond Earth, is that by necessity these environments will have to be changed in order to be more hospitable for long-term human habitation.<sup>236</sup> Mars as an example would require large scale terraforming, causing foundational changes to the composition of its atmosphere, and major changes to its topography.<sup>237</sup> Human settlement will also cause changes as land is cleared for buildings, food production, and resources

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223. *Id.*

224. *Id.* at 849.

225. *Id.* at 849–50.

226. *See id.* (arguing that private companies will have insufficient incentives to drive space colonization in the absence of property rights, at least in part due to high costs).

227. *See id.* at 851–52 (suggesting that colonization should be a cooperation between states and private companies, pointing to the International Space Station as a successful analogy).

228. *Id.*

229. *Id.*

230. *See* Levchenko et al., *supra* note 119, at 8 (discussing the potential environmental ramifications of colonizing Mars, including damage to its native environment).

231. *See id.* (discussing problems that would arise should humans contact life on Mars and how humans could and should preserve the Martian environment).

232. *Id.* at 8–9.

233. *Id.*

234. *Id.* at 8.

235. *Id.*

236. *Id.*; *see* Williams, *supra* note 131 (discussing the various investigations and changes needed to be made to Mars to successfully terraform it, including searching for water and warming the planet).

237. Levchenko et al., *supra* note 119, at 8–9; Williams, *supra* note 131.



harvesting to sustain settlements.<sup>238</sup> Though change is to some degree inevitable, many would and have argued that we have a moral duty to try to preserve the environments of the places we settle, and the OST, in fact, imposes a legal obligation to try to limit harmful and adverse damage.<sup>239</sup> Keeping this obligation in mind, along with the practical requirements and effects of colonizing new celestial bodies, we need a formalized set of guidelines for what is and is not permitted, something governmental bodies like the Committee on Space Research (COSPAR) have attempted to formulate for existing space exploration missions.<sup>240</sup>

#### IV. RECOMMENDATIONS

Complex and novel problems require equally complex and novel solutions. Space, perhaps more so than any other area of the universe currently contemplated by man, presents the trickiest challenge.<sup>241</sup> But it is a challenge we must overcome, not only for our own sakes, but for the sake of those who will follow. By embarking on a new path today, we will hopefully be able to create a better tomorrow. To that end, I make the proposed recommendations below:

##### A. *Commercial Spaceflight*

Under the auspices of the U.N., the leading space nations need to create and agree upon a universal, formalized set of rules and regulations governing launches and landings, the health and safety of pilots and crew, legal liability, and environmental impact. Likewise, they need to work to encourage the full denationalization of space programs and establish rules and regulations that address international security, sovereignty, and international defense concerns. This is likely to take the form of a replacement treaty for OST. Though, given the slow and at times disunified nature of the U.N.,<sup>242</sup> reform is likely to start with working groups and less formal or non-binding conferences. One such recent example in the broader space context is the Open-Ended Working Group on Reducing Space Threats (OEWG), which is a U.N. working group, open to all U.N. Member and Observer States, who will meet bi-yearly to discuss and make recommendations on new rules and principles for responsible conduct in space, and the possible creation of a new treaty dealing with national security concerns as it relates to space.<sup>243</sup> While an exemplar of the sort of initial step commercial space reform will need at the international level, it also illustrates

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238. See Levchenko et al., *supra* note 119, at 8 (describing how “it would not be possible to transport all the raw materials required for sustained growth and operation of a colony from Earth,” thus at least some resources would need to be taken from Mars).

239. *Id.* at 8–9.

240. *Id.*

241. See *id.* at 6 (explaining that “[t]hese issues, both psychological and physiological, are difficult if not impossible to address, and are independent of cultural, religious or educational background”).

242. See, e.g., Michelle L.D. Hanlon & Greg Autry, *The Rules of Space Haven't Been Updated in 50 Years, and the UN Says It's Time*, CNN (Jan. 3, 2022, 1:05 PM), <https://www.cnn.com/2022/01/03/world/space-law-united-nations-partner-scn/index.html> [perma.cc/M7EB-YE79] (acknowledging that the U.N. first “formally recognized the vital role that space and space assets play in international efforts” in 2021).

243. *Id.*

the problems of using U.N. processes, such that it can be extremely slow, and mandates are often limited.<sup>244</sup> COPUOS is the specific U.N. body with the mandate to regulate peaceful exploration and use of outer space.<sup>245</sup> Its working parties and subcommittees have identified many of the same issues as I have, and reaffirmed its members, and the U.N.'s commitment to attempting to resolve them through global cooperation and agreement.<sup>246</sup> They have also recognized the benefits and how group cooperation is necessary for those benefits to accrue to the entirety of mankind.<sup>247</sup> While COPUOS has done tremendous work through its efforts in fostering greater international cooperation and engagement, it is important that this be leveraged in a meaningful and permanently impactful way, and not just as a non-binding U.N. resolution or conversation between members.<sup>248</sup> I can only hope that consistent broader engagement with COPUOS signals a growing recognition of the inadequacies of the current space regulatory system and will lead to further changes and broader long-term international cooperation on rules and enforcement of international regulations through a unified global regulator or court-like body.

### B. Resource and Mineral Extraction

In addition to commercial space travel, any working group or treaty-making body will need to reach an agreement on a common and universal regime of property rights and ownership.<sup>249</sup> This regime must be one that encourages development, ingenuity, and entrepreneurialism, while protecting against the unchecked exploitation of valuable and rare resources that can be used for larger society's benefit.<sup>250</sup> These rules and regulations additionally need to protect against pollution and environmental destruction.<sup>251</sup> In order to achieve these goals, we need the institution of a hybrid or mixed property scheme that combines the best aspects of private and community-based ownership.<sup>252</sup> The

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244. See Hanlon & Autry, *supra* note 242 (acknowledging the OEWG will meet only twice a year and that the U.N. "lacks any ability to enforce the principles and guidelines set forth in the 1967 Outer Space Treaty or even to compel actors into negotiations").

245. U.N. OFF. FOR OUTER SPACE AFFS., *COPUOS History*, <https://www.unoosa.org/oosa/en/ourwork/copuos/history.html> [perma.cc/PML4-RDNQ] (last visited Mar. 19, 2023).

246. U.N. OFF. FOR OUTER SPACE AFFS., *Working Groups of the Committee and Its Subcommittees*, <https://www.unoosa.org/oosa/en/ourwork/copuos/working-groups.html#COPUOSWG2030> [perma.cc/HWY2-L8W6] (last visited Mar. 19, 2023); G.A. Res. 77/121, *International Cooperation in the Peaceful Uses of Outer Space* (Dec. 12, 2022).

247. G.A. Res. 77/121, *supra* note 246, at 2.

248. See U.N. OFF. FOR OUTER SPACE AFFS., *Space Law: Resolutions*, <https://www.unoosa.org/oosa/en/ourwork/spacelaw/resolutions.html> [perma.cc/S9Y8-8MTQ] (last visited Mar. 19, 2023) ("While resolutions adopted by the United Nations General Assembly are not legally binding, many resolutions dealing with issues related to outer space offer valuable guidance to States on the conduct of space activities.").

249. See Babcock, *supra* note 9, at 206 (explaining the importance of developing a coherent legal regime governing space in order to bolster innovation and exploration).

250. See *id.* at 221–23 (explaining the benefits and downsides or private property regimes and how they must be balanced for property rights in space).

251. *Id.* at 204–06.

252. See *id.* at 242–44 (suggesting space be governed under a "hybrid property" regime, that operates in a way "that is sometimes private and sometimes common").

exact shape and nature of this regime must account for the special complexities of an environment that has no hard geographical boundaries.<sup>253</sup> This can lead into two approaches: (1) a layered, non-geographical approach in which property schemes are intertwined and overlap (one readily observable example of this is privately owned property within a U.S. National Park); or (2) a bounded, quasi-geographical approach whereby all property in certain areas are subject to one scheme (like community ownership) and all properties in another are subject to another scheme (like private ownership) (a readily observable example of this would be most modern condo communities, where you have privately owned homes, but community shared facilities like a pool or clubhouse).<sup>254</sup> Both approaches can be effective, and ultimately it comes down to how the regime is governed and instituted (effectively how will ownership be distributed or awarded in the first instance).<sup>255</sup> Of all the proposed suggestions, I believe some form of a lottery or bid-based system, in conjunction with a modified exclusive economic zone approach is the right path forward.<sup>256</sup> A lottery or bid-based system removes the inherent unfairness of a first-possessor approach by opening market access to developing participants, while still protecting the successful bidder's investment and ownership rights, thus encouraging active economic participation and growth, along with more judicious and efficient use of resources.<sup>257</sup> This approach would be best for already-identified objects and space closest to human settlement.<sup>258</sup> For more distant resources and space bodies, a modified exclusive economic zone (EEZ) approach, similar to that which applies to Earth's seas, would be the best approach because it provides greater spacial awards (exclusive economic rights to everything within an area, not just a singular piece of property), thus rewarding the greater economic investment and risk-taking inherent in exploring and attempting to exploit new regions of space.<sup>259</sup> Adopting a system that combines these two approaches, allows nations to collectively come together to determine what property will be public and what will be private, and then allow them to award property determined to be private in the fairest and most economically efficient manner possible.

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253. *Id.* at 244–45.

254. *See, e.g., id.* at 243–45 (describing a regime where property may sometimes act as private property and sometimes act as commons, but acknowledging “[t]he problem with establishing a spatially hybrid property regime (or any property regime) in outer space is the lack of definable boundaries where one type of approach might be possible in one area, and another in a different area, or even overlapping regimes in the same area,” but that this hybrid regime may still be possible); BOONDOCKER’S BIBLE, *Can I Buy Land in a National Forest?* (Mar. 26, 2022), <https://www.boondockersbible.com/knowledgebase/can-i-buy-land-in-a-national-forest> [perma.cc/LFL2-ZF8V] (explaining, under certain regimes, it is possible to privately own property in national parks).

255. *See* Babcock, *supra* note 9, at 249–55 (discussing the benefits and downsides of various initial ownership possibilities, including ownership based on a first-come-first-served basis, developing economic exclusion zones, and lotteries).

256. *See id.* at 251–55 (discussing the benefits of an economic exclusion zone, but acknowledging the issues that approach has with respect to exclusion problems, and how lotteries may be able to rectify exclusion issues).

257. *Id.* at 253–54.

258. *See id.* at 253 (giving an example of allocating mining credits to mine resources on the moon).

259. *See id.* at 251–53 (explaining the rights an EEZ confers on an entity, which has been implemented successfully in Euclidian zoning, which “might be a useful approach in outer space”).

### C. *Colonization of Space Objects and Interstellar Space Habitats*

Extra-earth colonization and settlement will require the cooperation of all nations in order to be effective and successful.<sup>260</sup> The ISS exists as a model success story of how good will and positive cooperation can achieve great results in space.<sup>261</sup> Fundamentally, cooperation is also necessary because it will head-off growing geopolitical tensions here on Earth and hopefully prevent them from reaching space, a core concern of OST when it was first drafted decades ago.<sup>262</sup> Given the growing ideological and economic blocs forming around the United States, China, and Russia, this is particularly important.<sup>263</sup> How best to achieve this cooperation is the question, however, and as colonization moves closer to reality it will be necessary to determine the exact shape and structure cooperation will take. In large part, this will depend on the sort of agreements that will be reached on property rights, and broader regulatory issues, particularly if there is a new treaty agreed upon.

## V. CONCLUSION

The future of space is bright and promising. Commercial spaceflight is blooming, resource mining is only a few years behind, and colonization a decade or so behind that.<sup>264</sup> But as we begin heading into the final frontier, we must confront the challenging legal, ethical, and moral complications that emerge in our wake. As this Note has discussed, commercial spaceflight, the exploitation of space resources, and colonization are currently sparsely regulated, both at the national and international level.<sup>265</sup> Indeed, the applicable international treaties are outdated and unclear.<sup>266</sup> Given the concerns and implications of spaceflight, resource extraction and mining, and colonization analyzed throughout this piece, there is a need for a formalized and universally agreed upon approach to resolve each area's own unique regulatory challenges.<sup>267</sup> Through international cooperation (*vis-a-vis* the U.N.) and the adoption of an appropriate hybrid property scheme (including the right implementation process), these challenges

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260. Fitzmaurice & Handerson, *supra* note 220, at 851–52.

261. *Id.*

262. Babcock, *supra* note 9, at 207–09.

263. See Giri, *supra* note 213 (“Today, China and the United States both possess mechanisms to exert themselves as principal partners of the space blocs they are respectively assembling.”).

264. Dillon, *supra* note 3 (“The wave of new companies entering the spaceflight industry in the 1990s and 2000s made leaps in space technology development, and their successes have encouraged them to pursue new opportunities beyond the bounds of conventional research-based space travel. This is where the concept of space tourism begins.”); Pandya, *supra* note 67 (“Serious plans are being made for the mining of the moon and nearby asteroids using smart autonomous robots and humans.”); Levchenko et al., *supra* note 119, at 6 (acknowledging it will take decades until humans are able to colonize Mars).

265. Dillon, *supra* note 3.

266. Babcock, *supra* note 9, at 209–12.

267. *Id.* at 199–206.

can be tackled head-on and resolved, allowing mankind to benefit from the wonders and magic of space.<sup>268</sup>

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268. See Fitzmaurice & Handerson, *supra* note 220, at 851–56 (setting forth the importance of cooperation for the colonization of space, which can be accomplished through the U.N.); Babcock, *supra* note 9, at 242–44, 247–55 (arguing for a hybrid property regime for the governance of space that balances private and commons regimes).