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# Celestial Water Law: Creating a Framework Governing Water Resources in Space

## Cover Page Footnote

J.D. Candidate, 2023, University of Georgia School of Law; B.A., 2015, University of Georgia. The author would like to extend a special thank you to Juliana Neelbauer (Partner at Fox Rothschild, LLP) for providing her expertise and professional guidance throughout this project, Dean Melissa J. Durkee (University of Georgia School of Law) for providing academic supervision, and Riley K. Gardner (J.D. Candidate, 2023, University School of Law) for helping to edit and proofread this stellar project.

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# CELESTIAL WATER LAW: CREATING A FRAMEWORK GOVERNING WATER RESOURCES IN SPACE

*Elias Walker*[*]

*Water has always been the most valuable resource on our little blue planet. Since the dawn of civilization, water has been at the center of human economic, military, and technological advancement. It has long been known that whoever controls access to water holds the reins of power.*

*The modern era of outer space exploration is certainly no exception to water centrality. As space resource exploitation becomes an increasingly viable and lucrative sector of the globalized economy, both private and public entities have set their eyes on the vast water resources situated on and within celestial bodies, such as asteroids, planets, and moons.*

*The incalculable value of water has resulted in nations around the world creating domestic and international rules governing water rights on Earth. The field of space law, however, has not fully reckoned with the implications of the seemingly limitless celestial water resources ripe for exploitation. The current legal regimes governing celestial water resource collection and allocation are largely inadequate to guide those looking to harness celestial water. As climate change threatens Earth's dwindling freshwater reserves, the importance of regulating celestial water increases. Without forward-looking international consensus on how to regulate and manage water resources, humankind stands wholly unprepared to peacefully and efficiently utilize celestial water resources.*

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[*] J.D. Candidate, 2023, University of Georgia School of Law; B.A., 2015, University of Georgia. The author would like to extend a special thank you to Juliana Neelbauer (Partner at Fox Rothschild, LLP) for providing her expertise and professional guidance throughout this project, Dean Melissa J. Durkee (University of Georgia School of Law) for providing academic supervision, and Riley K. Gardner (J.D. Candidate, 2023, University School of Law) for helping to edit and proofread this *stellar* project.



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*This Note acts as a guide for lawmakers and legal thinkers who seek to preemptively fill the legal gaps in current celestial water law. The unique environment of outer space further serves to complicate the issue, lowering the usefulness of mapping Earth-based water law blindly onto space law. The special properties of water set it apart from other celestial resources. Water not only provides life-sustaining nourishment for spacefarers but also presents additional scientific and economic use in outer space as rocket fuel. Moreover, the stark difference between developed and developing nations who seek access to harvested celestial water provides an additional hurdle on what a "fair" framework would entail. These challenges necessitate a thoughtful, comprehensive international treaty regulating celestial water rights and use as soon as possible.*

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*Every era has been shaped by its response to the great water challenge of its time. And so it is unfolding—on an epic scale—today*. – Steven Solomon[1]

## I. INTRODUCTION

We stand on the precipice of a new era of opportunity. Humans have the capability to reach beyond our blue planet into the cosmos and harvest the resources of our solar system. Within reach are natural resources lying dormant in celestial bodies—asteroids, comets, moons, and planets. These celestial bodies contain a multitude of valuable resources including nickel, gold, platinum, and most importantly, *water*.[2] While the law governing resource extraction in space has been growing for decades, several ambiguities exist within the field.

It is time for both international and domestic authorities to consider seriously the creation of a sound, forward-looking legal regime to govern the extraction and use of water resources in outer space. Ideally, this would be accomplished through a new international celestial water treaty. Water is unique, not only for its life-sustaining characteristics but also for its ample economic value and practical uses, such as a potential source of rocket fuel. Therefore, it deserves special legal consideration. Moreover, outer space presents significant environmental challenges to water collection. Consequently, additional concerns should be preemptively addressed as the commercial space sector expands, such as water being located on or within celestial bodies as ice instead of its liquid form.[3] Wars are already fought over this

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[1] STEVEN SOLOMON, WATER: THE EPIC STRUGGLE FOR WEALTH, POWER, AND CIVILIZATION 4 (2010).

[2] *See* Angel Abbud-Madrid, *Space Resource Utilization*, PLANETARY SCI.: OXFORD RSCH. ENCYCS. 17, 26 (June 28, 2021) (discussing the vast quantities of carbon, silicon, and metal-based resources available from celestial bodies as well as analyzing the uses and abundance of water within celestial bodies, including the lunar surface).

[3] *See, e.g.*, Oak Ridge Nat'l Lab'y, *Scientists Create Exotic "Outer Space" Ice—Unlike Any on Earth*, SCITECH DAILY (June 2, 2021) [hereinafter *Scientists Create Exotic "Outer Space" Ice*], https://scitechdaily.com/scientists-create-exotic-outer-space-ice-unlike-any-on-earth ("Because interstellar space is so cold and is primarily a vacuum, the water we detect from Earth is usually in the form of amorphous ice . . . ."). Largely due to the near-perfect vacuum environment of outer space, little heat exists to excite water molecules into their liquid state,

precious resource.[4] Water's value will only increase as its scarcity on Earth steadily worsens due to overuse and environmental crises.[5] Forward-looking regulations stand to alleviate conflict over celestial water before it arises. Therefore, it is in the public interest to establish regulatory commercial and safety guidelines for space activities involving water.[6]

Part II of this Note demonstrates the necessity of immediate regulation regarding the quickly expanding space resource industry and why water management should be a core consideration. Part III discusses the current state of space law relevant to water resource management. Part IV examines the benefits and pitfalls of existing terrestrial water law frameworks through brief case studies. Part V discusses major concerns and potential issues that any celestial water treaty would need to address and suggests solutions.

## II. WHY NOW, WHY WATER?

### A. WHY NOW?

Hesitation in creating a sound regime governing celestial water may cause the final frontier to resemble the chaotic western frontier

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meaning entities seeking to extract water should expect to find it "in the form of amorphous ice." *Id.* For more information on why and how water freezes or boils in space, see Ethan Seigel, *Water in Space: Does It Freeze or Boil?*, FORBES (Dec. 23, 2016), https://www.forbes.com/sites/startswithabang/2016/12/23/water-in-space-does-it-freeze-or-boil/?sh=5f4bc0705f91 (providing data relating the temperatures and pressures at which water freezes and boils within space's vacuum).

[4] *See* Sandy Milne, *How Water Shortages Are Brewing Wars*, BBC (Aug. 16, 2021), https://www.bbc.com/future/article/20210816-how-water-shortages-are-brewing-wars (listing conflicts that have resulted from water scarcity in regions around the world, including India, China, Africa, Saudi Arabia, and beyond). Water shortages exacerbated by severe droughts "contributed to the worst humanitarian crisis since World War Two, when 20 million people across Africa and the Middle East were forced to leave their homes due to the accompanying food shortages and conflicts that erupted." *Id.*

[5] *See id.* ("Water scarcity affects roughly 40% of the world's population and, according to predictions by the United Nations and the World Bank, drought could put up to 700 million people at risk of displacement by 2030."). Milne also reports that water use increased at twice the rate of population growth and that "[w]ater crises have been ranked in the top five of the World Economic Forum's Global Risks by Impact list nearly every year since 2012." *Id.*

[6] *See* 51 U.S.C. § 50901(a)(14) ("[T]he public interest is served by creating a clear legal, regulatory, and safety regime for commercial human space flight.").

of old.[7] Failing to prophylactically establish laws and regulations around space exploration will lead to a lack of clarity which will inevitably result in competing legal interpretations and conflict.[8]

Both public and private entities have already begun to set up infrastructure to prepare for the commercial space age.[9] Some of the most modern innovative economic titans, including Jeff Bezos (Blue Origin), Elon Musk (SpaceX), and the founders of Google (Planetary Resources), have already taken substantial steps to dominate the fledgling space exploitation economy.[10] Private actors are racing toward the limitless riches of space with a zeal that would make even Columbus blush. This economic fervor is unsurprising considering that some estimates place the burgeoning space-based economic sector at trillions of dollars per year.[11]

Domestic governmental entities are likewise showing interest in commercial space exploration. For example, the National Aeronautics and Space Administration (NASA) routinely works

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[7] *See* Cecilia Jamasmie, *Experts Warn of Brewing Space Mining War Among US, China and Russia*, MINING (Feb. 2, 2021), https://www.mining.com/experts-warn-of-brewing-space-mining-war-among-us-china-and-russia/ (warning that the U.S., China, and Russia are already competing to dominate the "next Wild West").

[8] *See* Melissa J. Durkee, *Interstitial Space Law*, 97 WASH. U.L. REV. 423, 425–27 (2019) (arguing that the numerous gaps in space law make for an unclear area of legal jurisprudence). Dean Durkee further argues that the potential for "attributed lawmaking" exists, wherein the law follows the acts of private entities, not the other way around. *Id.* at 426. These unguided private actions would give private entities "a legally sanctioned role" in creating international norms, which would likely favor private interests over public interests. *Id.*

[9] *See id.* at 425 (discussing how major tech leaders are entering the space-based resource arena despite the planned commercial activity possibly being illegal under international law).

[10] *See id.* ("[Jeff Bezos, Elon Musk, and Google] are now entrants in the new commercial space race.").

[11] *See Frequently Asked Questions: SCaN Commercial Communications Services Division and Commercial Services Strategy*, NASA (Sept. 17, 2021) [hereinafter NASA FAQ], https://www.nasa.gov/directorates/heo/scan/services/nasas_commercial_communications_services/FAQ ("The global space economy in 2019 generated $366B in revenue."); *see also Space: Investing in the Final Frontier*, MORGAN STANLEY (July 24, 2020), https://www.morganstanley.com/ideas/investing-in-space (stating that "the global space industry could generate revenue of more than $1 trillion or more in 2040," only increasing with further infrastructure and technological advances); James Rathz, *Law Provides New Regulatory Framework for Space Commerce*, REG. REV. (Dec. 31, 2015), https://www.theregreview.org/2015/12/31/rathz-space-commerce-regulation ("The minerals in one asteroid in our solar system may be worth about $95 trillion, greater than the entire world's gross domestic product last year.").

with private companies to launch satellites and conduct research.[12] Further, the most recent U.S. presidential administrations promoted private commercial space resource extraction, acknowledging the importance of commercial space exploration for the U.S. economy.[13] Other nations have also drafted legislation to encourage private actors to enter the space mining game, including Luxembourg,[14] Japan,[15] and the United Arab Emirates.[16] Given the clear steps being taken to capitalize on the growing commercial space market, an unequivocal legal framework governing space resources is crucial.

### B. WHY WATER?

Water is a uniquely precious resource. According to author Steven Solomon, "control and manipulation of water should be a

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[12] *See, e.g.*, NASA FAQ, *supra* note 11 (listing some private and public entities NASA works with during space exploration, such as the privately owned SpaceX corporation).

[13] *See* U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704 (codified as amended in scattered sections of 42 U.S.C. and 51 U.S.C.) (encouraging private "competitiveness and entrepreneurship" in outer space during the Obama administration); *see also* Exec. Order No. 13,914, 85 Fed. Reg. 20,381 (Apr. 6, 2020) (reassuring private companies that Americans "have the right to engage in commercial exploration, recovery, and use of resources in outer space" during the Trump Administration). For further discussion of these policies, see *infra* Part III; *see generally* Mike Wall, *Presidential Visions for Space Exploration: From Ike to Biden*, SPACE (Jan. 20, 2021), https://www.space.com/11751-nasa-american-presidential-visions-space-exploration/2.html (listing presidential views of space exploration from President Eisenhower to current President Biden).

[14] *See* Loi du 20 juillet 2017 sur l'exploration et l'utilisation des ressources de l'espace [Law of July 20, 2017, on the Exploration and Use of Space Resources], JOURNAL OFFICIEL DU GRAND-DUCHÉ DE LUXEMBOURG [J.O] [OFFICIAL GAZETTE OF LUXEMBOURG], July 28, 2017, No. 674 (granting Luxembourger corporations or registered European companies the ability to extract space resources for commercial use after obtaining approval from the Luxembourg government).

[15] *See Japan: Space Resources Act Enacted*, LIBR. CONG. (Sept. 15, 2021), https://www.loc.gov/item/global-legal-monitor/2021-09-15/japan-space-resources-act-enacted/ (summarizing how Japan's act grants entities the ability to obtain a permit from the Japanese government to extract space resources, defined as "water, minerals, and other natural resources that exist in outer space").

[16] *See UAE Space Law Details Announced to Facilitate Space Sector Development*, SPACEWATCH, https://spacewatch.global/2020/02/uae-space-law-details-announced-to-facilitate-space-sector-development (last visited Jan. 15, 2022) (covering the UAE's 2020 space policy, which includes the ability for the UAE to issue private ownership permits).

pivotal axis of power and human achievement throughout history is hardly surprising. Water has always been man's most indispensable natural resource, and one endowed with special, seemingly magical powers."[17] The story of human progress is intrinsically tied to water, and now, as we travel to the final frontier, there too water awaits along with the oft-forgotten truth: whoever controls water controls the means of life.[18] Indeed, water grants life-sustaining benefits necessary to survive space voyages, and control over water resources provides economic and political advantages due to its transportation and agricultural uses.[19]

Water has already been confirmed on numerous celestial bodies, including the Moon,[20] Mars,[21] distant moons,[22] and several near-

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[17] SOLOMON, *supra* note 1, at 3.

[18] *See id.* (arguing that the struggle over water is a primary factor in economic and political development of society).

[19] *See id.* ("[S]ocieties have struggled politically, militarily, and economically to control the world's water wealth: to erect cities around it, to transport goods upon it, to harness its latent energy in various forms, to utilize it as a vital input of agriculture and industry, and to extract political advantage from it.").

[20] *See, e.g.*, *NASA's SOFIA Discovers Water on Sunlit Surface of Moon*, NASA (Oct. 26, 2020), https://www.nasa.gov/press-release/nasa-s-sofia-discovers-water-on-sunlit-surface-of-moon (noting that the discovery of water on the sunlit lunar surface suggests that water may be trapped all over the moon, not just as ice in the shadows); *see also Scientists Find Evidence Moon May Have 10 Billion Tons of Water*, WASH. POST (Sept. 4, 1998), https://www.washingtonpost.com/archive/politics/1998/09/04/scientists-find-evidence-moon-may-have-10-billion-tons-of-water/47fcc16b-348a-4352-94bb-66c2c20ed0d8 ("As much as 10 billion tons of water may be frozen near the moon's poles, according to data from a lunar spacecraft—water enough to build a moon village or to fuel rocket ships cruising even deeper into space.").

[21] *See, e.g.*, *NASA Confirms Evidence That Liquid Water Flows on Today's Mars*, NASA (Sept. 28, 2015), https://www.nasa.gov/press-release/nasa-confirms-evidence-that-liquid-water-flows-on-today-s-mars (reporting on evidence that liquid water flows intermittently on present-day Mars).

[22] *See, e.g.*, *NASA Scientists Confirm Water Vapor on Europa*, NASA (Nov. 18, 2019), https://www.nasa.gov/feature/goddard/2019/nasa-scientists-confirm-water-vapor-on-europa (reporting that Europa, one of Jupiter's seventy-nine moons, contains a liquid ocean possibly twice the size of Earth's oceans beneath Europa's miles-thick ice surface).

Earth objects, such as asteroids[23] and comets.[24] Studies estimate that between 100 billion and 400 billion gallons of water lie in wait on near-Earth asteroids alone.[25]

Water's uses for drinking, washing, growing plants, and creating oxygen make it an essential resource for commercial space travel to be economically feasible.[26] As space resource extraction becomes increasingly viable, it is only natural that companies will seek to exploit and capitalize on celestial water.[27] Specifically, companies will try to profit from water's ability to sustain life during spaceflight and from the sale of celestial water back on Earth.[28]

Beyond water's obvious use as a life-sustaining resource, water serves an additional and perhaps equally important role: rocket fuel. Water is a key component in sustainable rocket fuel which can be used to refuel ships mid-spaceflight.[29] By breaking water down into its molecular components—hydrogen and oxygen—water can be converted into fuel.[30] By using water reserves mined from celestial bodies, one may develop a space-bound gas station allowing

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[23] *See, e.g.*, *NASA's Newly Arrived OSIRIS-REx Spacecraft Already Discovers Water on Asteroid*, NASA (Dec. 10, 2018), https://www.nasa.gov/press-release/nasa-s-newly-arrived-osiris-rex-spacecraft-already-discovers-water-on-asteroid (reporting on water detected on an asteroid 1.4 million miles from Earth).

[24] *See, e.g.*, *Comet Provides New Clues to Origins of Earth's Oceans*, NASA (May 23, 2019), https://www.nasa.gov/feature/comet-provides-new-clues-to-origins-of-earth-s-oceans (describing the different types of water detected on comets).

[25] *See, e.g.*, Meghan Bartels, *How Much Water May Be Tucked Away in Nearby Asteroids?*, SPACE.COM (Mar. 11, 2019), https://www.space.com/how-much-water-in-asteroids.html (discussing the number of near-Earth asteroids that could contain extractable water); Andrew S. Rivkin & Francesca E. DeMeo, *How Many Hydrated NEOs Are There?*, 124 J. GEOPHYSICAL RSCH.: PLANETS 128, 129 (2018) (analyzing research data for the number of celestial objects containing "hydrated minerals" between the Earth and the Moon).

[26] *See* Clara Moskowitz, *"Wet" Asteroid Could Be a Space Gas Station*, SPACE.COM (May 4, 2010), https://www.space.com/8339-wet-asteroid-space-gas-station.html (discussing how and why space explorers will want to build water-based "gas stations" on celestial bodies).

[27] *See id.* (describing the potential profit that can come from water on other bodies).

[28] *See id.* ("For manned missions, a source of water for drinking and for extracting oxygen to breathe would be good as a backup, though hopefully closed-loop life-support systems could recycle most of the initial supplies . . . .").

[29] *See id.* ("Water, or H2O, contains both hydrogen and oxygen, two of the most commonly used elements in propellant.").

[30] *See id.* ("[T]he water could be broken down into its component parts (hydrogen and oxygen) to make rocket fuel . . . .").

for cheaper and more sustainable space travel.[31] Jerry Sanders, leader of spaced-based resource utilization at NASA's Lunar Surface Systems Office, noted that "[i]f you're going to go repeatedly to an asteroid, then the ability to basically start setting up gas stations could be extremely beneficial."[32] Sanders points out that extracting water from the visited celestial body would call for less initial fuel, thus lightening cargo weight upon takeoff.[33] The gas stations would dramatically lower the cost of space travel, leading to an increased incentive to invest in commercial spaceflights and mining expeditions.[34]

The pricelessness and multi-faceted nature of water makes it ripe for potential conflict. Water rights have been the catalyst for countless wars and conflicts throughout history.[35] These problems have worsened as environmental disasters, such as droughts, hurricanes, and earthquakes, devastate water resources around the world.[36] Disputes over how to regulate extraction of space resources, including water, is already a major topic of international contention.[37] In an effort to avoid conflict, both domestic U.S. lawmakers and international authorities should immediately adopt a framework for regulating water's extraction, allocation, and use in space. Just as water is heavily regulated on Earth for sustainability and fairness, so too must water be regulated in space.

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[31] *See id.* (describing the benefits and operations of a hypothetical space gas station). The cost of bringing resources back from space to Earth was once economically indefensible, but the capability of using celestial water as a resource would alleviate that cost. *See* Allen Duane Webber, *Extraterrestrial Law on the Final Frontier: A Regime to Govern the Development of Celestial Body Resources*, 71 GEO. L.J. 1427, 1427–28 (1983) (noting the stark contrast between capturing lunar resources and capturing resources in Earth's orbit).

[32] Moskowitz, *supra* note 26.

[33] *See id.* (noting that longer trips without gas stations would require larger vessels to carry ever-increasing fuel loads).

[34] *See id.* (describing benefits of lowered costs of space travel).

[35] *See supra* note 4 and accompanying text.

[36] *See supra* note 4 and accompanying text.

[37] *See* Jeff Foust, *Japan Passes Space Resources Law*, SPACENEWS (June 17, 2021), https://spacenews.com/japan-passes-space-resources-law (noting that Russia and Japan have taken conflicting views on how to mine for space resources). Dmitry Rogozin, director general of the Russian state corporation Roscosmos, called the matter of space resource regulation a "very thorny issue" during the Global Space Exploration Conference 2021, demonstrating Russia's reluctance to adopt any unilateral laws regarding space resource extraction. *Id*.

## III. THE CURRENT STATE OF SPACE LAW

Given the inherent extraterritorial nature of outer space, international treaties are the primary source of law in the field.[38] The handful of treaties governing space exploration and resource management, however, are vague and outdated.[39] Moreover, none of the treaties specifically tackle issues of water management, allocation, or extraction.[40] Therefore, to understand celestial water rights, one must understand how the current legal framework handles space resources more broadly. Unfortunately, existing treaties are particularly unclear in this regard.[41] The treaties and policies most relevant to this Note's purposes are the Outer Space Treaty, the Moon Agreement, the Artemis Accords, and domestic U.S. space regulations, each of which are discussed below.

### A. THE OUTER SPACE TREATY

The most prominent and influential space law treaty is the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies of 1967 (Outer Space Treaty).[42] As the first major international treaty in the field, signed during the beginning of the Cold War's "Space Race," the Outer Space Treaty remains the

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[38] *See* RESTATEMENT (THIRD) OF FOREIGN RELS. L. § 102(2) (AM. L. INST. 1987) (laying out the sources of international law, which includes international agreements)

[39] *See Space Law Treaties and Principles*, U.N. OFF. FOR OUTER SPACE AFFS., https://www.unoosa.org/oosa/en/ourwork/spacelaw/treaties.html (last visited Jan. 15, 2022) (listing the most important space law treaties and principles). The treaties commonly referred to as the "five United Nations treaties on outer space" are: (1) The Outer Space Treaty, (2) The Rescue Agreement, (3) The Liability Convention, (4) The Registration Convention, and (5) The Moon Agreement. *Id.* This Note only addresses The Outer Space Treaty and The Moon Agreement because these treaties deal most directly with resource extraction.

[40] *See id.* (noting that the treaties "deal with issues such as . . . the exploitation of natural resources in outer space" generally, but not water specifically).

[41] *See* Michael J. Listner, *The Ownership and Exploitation of Outer Space: A Look at Foundational Law and Future Legal Challenges to Current Claims*, 1 REGENT J. INT'L L. 75, 87–89 (2003) (discussing how gaps left in the foundational space treaties regarding space resources create legal issues private entities and States have yet to meaningfully address).

[42] 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].

foundational document in space law.[43] As of March 2022, 112 nations have ratified the treaty, including the United States.[44] The treaty maintains an expressly egalitarian perspective on the right to outer space, "[r]ecognizing the common interest of all mankind in the progress of the exploration and use of outer space for peaceful purposes" and "that the exploration and use of outer space should be carried on for the benefit of all peoples irrespective of the degree of their economic or scientific development."[45]

The Outer Space Treaty makes no mention of water. Consequently, little guidance exists as to how celestial water should be treated under international law beyond the nebulous guiding principles applicable to all other space resources. Because celestial water is likely embedded within a celestial body in the form of ice, it is best understood in terms of other extractable mineral resources for the purposes of interpreting space law.[46] To truly understand the basic question of what is currently allowed under the Outer Space Treaty, the broader issue of rights surrounding space property and resource extraction must be analyzed.

The Outer Space Treaty touches on the topic of resource ownership but fails to do so with any specificity.[47] As a result, debate continues over exactly what is prohibited.[48] Article II of the Outer

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[43] *See, e.g.*, Erin C. Bennett, *To Infinity and Beyond: The Future Legal Regime Governing Near-Earth Asteroid Mining*, 48 TEX. ENV'T. L.J. 81, 84 (2018) ("The Outer Space Treaty forms the basis of international space law and is the first treaty adopted that effectively regulates outer space."); *see also* Listner, *supra* note 41, at 77 ("The Outer Space Treaty is the primary agreement concerning space law for two reasons. Not only was it the first in time and set forth the basic principles of space law, but its articles and principles are further articulated by the various treaties that have subsequently been drafted.").

[44] COMM. ON PEACEFUL USES OF OUTER SPACE, STATUS AND APPLICATION OF THE FIVE UNITED NATIONS TREATIES ON OUTER SPACE 10 (Mar. 28, 2022).

[45] Outer Space Treaty, *supra* note 42, pmbl.

[46] *See supra* note 3 and accompanying text.

[47] *See* Outer Space Treaty, *supra* note 42, art. II ("Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."); *see also* Carl Q. Christol, *Article 2 of the 1967 Principles Treaty Revisited*, 9 ANNALS AIR SPACE & L. 217, 220–21 (1984) (noting that the Outer Space Treaty "makes no explicit reference to the exploration, use, and exploitation of the resources of the environment" and that "[t]he agreement neither expressly authorizes nor prohibits the exclusive acquisition of the resources of the area").

[48] *See* 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, 163 (2016) (remarking that the Outer Space Treaty

Space Treaty states that "[o]uter space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."[49] This language could mean that celestial bodies cannot be appropriated as a whole, though extracted resources may still be claimed once pulled from the body.[50] When Article II's language is read in tandem with the Outer Space Treaty's other Articles, which repeatedly promote the concept of "exploration and use of outer space" for "the benefit and in the interest of . . . all mankind,"[51] many scholars believe that the drafters intended for space resources to be privately or publicly owned as long as the entire celestial body is not wholly appropriated by a nation.[52]

The Outer Space Treaty also fails to offer any clarity as to whether private entities are prohibited from extracting and owning celestial resources. Article VI imputes upon States "international responsibility" for their non-governmental actors, making the actions of private entities attributable to their respective State.[53] Therefore, it is reasonable to conclude that private entities may extract and use space resources under the authority of a State.[54] The Treaty, however, is ambiguous as to the limitations it places on the State's ability to enable private entities to commercially exploit

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almost "purposely use[s] language that allows for multiple conflicting interpretations," most likely for political expedience during the Cold War). "On the one hand, Article II can be read in conjunction with Article I to support a socialist reading that reflects communitarian exploitation of space" or "from a liberal viewpoint that frees space from State sovereignty, but contemplates the development of commercial activities as a 'use of space.'" *Id.* at 163–64.

[49] Outer Space Treaty, *supra* note 42, art. II.

[50] *See* Blount & Robinson, *supra* note 48, at 164 ("[T]he Treaty Regime allows for the free use and exploration of outer space and prohibits any claims of sovereignty as mechanism for establishing the first right.").

[51] Outer Space Treaty, *supra* note 42, art. I.

[52] *See* Christol, *supra* note 47, at 220 (interpreting Article II to allow for ownership and use of space given that Article I lets nations engage in "[t]he exploration and use of outer space," that Article III references States' ability to "carry on activities in the exploration and use of outer space," and that Article VI refers to the possibility that private actors may be active in outer space).

[53] *See* Blount & Robinson, *supra* note 48, at 166–67 (noting that a private entity's misuse of space would be attributable to the sovereign State enabling the private actor rather than the private actor itself).

[54] *See id.* (tracing the responsibility of states over private actors).

space resources.[55] Overall, the significant gaps in the Outer Space Treaty leave room for interpretation.

### B. THE MOON AGREEMENT

A second relevant treaty is the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (Moon Agreement).[56] Although the Moon Agreement focuses on the Earth's moon, it's language explicitly extends its application to all celestial bodies in the solar system except Earth.[57] As of the writing of this Note, the Moon Agreement has only been ratified by eighteen States, compared to the Outer Space Treaty's 112 ratifiers.[58] The discrepancy in the number of participating States can be attributed to the Moon Agreement's treatment of the exploitation of space's natural resources.[59]

The Moon Agreement's provisions echo the Outer Space Treaty's egalitarian "all mankind" principals, but it goes a step further by explicitly disavowing private and national property ownership.[60] Article 11 of the Moon Agreement states that "[t]he moon is not

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[55] *See id.* at 167 ("[A] State is obligated to maintain control over all commercial actors, but it must extend rights and obligations to them within a narrow jurisdictional framework constructed by the Outer Space Treaty.").

[56] Agreement Governing the Activities of States on the Moon and Other Celestial Bodies, Dec. 5, 1979, 1363 U.N.T.S. 22 [hereinafter Moon Agreement].

[57] *See id.* art. 1 ("The provisions of this Agreement relating to the moon shall also apply to other celestial bodies within the solar system, other than the earth, except in so far as specific legal norms enter into force with respect to any of these celestial bodies."). For a general (albeit dated) discussion of how the Moon Agreement relates to celestial resources, including lunar water, see Kevin V. Cook, *The Discovery of Lunar Water: An Opportunity to Develop a Workable Moon Treaty*, 11 GEO. INT'L ENV'T. L. REV. 647, 648 (1999) (arguing that the then-recent discovery of lunar water provides an opportunity to revisit the Moon Agreement).

[58] *See* COMM. ON PEACEFUL USES OF OUTER SPACE, *supra* note 44 (reporting the number of States ratifying the Moon Agreement). The U.S. does not consider the Moon Agreement binding. *See* discussion *infra* section III.D.

[59] *See* Glenn H. Reynolds, *Outer Space and Peace: Some Thoughts on Structures and Relations*, 59 TENN. L. REV. 723, 732 (1992) (noting that due to the equitable approach of the Moon Agreement "no major space power has joined the Moon Treaty, and it is unlikely to play a significant role in governing space resource development").

[60] *See* Moon Agreement, *supra* note 56, art. 11, ¶ 3 ("Neither the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State, international intergovernmental or non-governmental organization, national organization or non-governmental entity or of any natural person.").

subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any other means."[61] In lieu of private or national ownership rights, the Moon Agreement provides that States have the right to explore and use the Moon "on the basis of equality and in accordance with international law and the terms of this Agreement" and without discrimination based on a State's level of economic or technological prowess.[62] The denial of lucrative property rights and strict international obligations, however, have led the U.S. and other nations to increasingly criticize the Moon Agreement. Dissent grew as Cold War paranoia present during the treaty's drafting gradually ceded to a model of international economic cooperation and private enterprise.[63] The fiercely equitable approach of the Moon Agreement leaves the industrialized space powers little incentive to invest in commercial space activities, thereby discouraging the overall economic and scientific development of space exploration.

Further, unlike the Outer Space Treaty, the Moon Agreement addresses natural resources specifically, stating that "[n]either the surface nor the subsurface of the moon, nor any part thereof or natural resources in place, shall become property of any State" or other entity.[64] Parties to the Agreement are required to establish procedures governing the exploitation of lunar natural resources as exploitation becomes feasible.[65] The Moon Agreement seems to purposefully restrict private and national entities' ability to commercialize space, ultimately leading to the Moon Agreement's downfall.

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[61] *Id.* art. 11, ¶ 2.

[62] *Id.* art. 11, ¶ 4; *see id.* art. 15, ¶ 2 (describing how Article 15 gives States the power to enforce the provisions of the Agreement against one another if a State party has reason to believe a State is violating the terms).

[63] *See* Reynolds, *supra* note 59, at 727–28 (arguing that the commercialization of outer space will inhibit future conflict and may have even contributed to the end of the Cold War). The U.S. has been a vocal opponent of the Moon Treaty for exactly this reason. *See* discussion *infra* section III.D.

[64] Moon Agreement, *supra* note 56, art. 11, ¶ 3.

[65] *See id.* art. 11, ¶ 5 (obligating parties to set up an appropriate regime).

C. THE ARTEMIS ACCORDS

To address the holes in space law, many leading nations adopted the Artemis Accords: Principles for Cooperation in the Civil Exploration and Use of the Moon, Mars, Comets, and Asteroids for Peaceful Purposes (Artemis Accords).[66] Signed in October 2020, the Artemis Accords distinctly "recogniz[e] the global benefits of space exploration and commerce" and the "benefit[s] for all humankind to be gained from cooperating in the peaceful use of outer space."[67] The Artemis Accords were adopted with the stated purpose of "provid[ing] for operational implementation of important obligations contained in the Outer Space Treaty and other instruments," essentially serving as a clarifying supplement to the Outer Space Treaty.[68] As of October 2021, thirteen States have embraced the Artemis Accords.[69] NASA expects membership to increase as more private entities and countries become interested in commercial space exploration.[70]

The Artemis Accords pointedly address the issue of space resource ownership. Section 10 states that signatories "affirm that the extraction of space resources does not inherently constitute national appropriation under Article II of the Outer Space Treaty," expressly adopting an interpretation of the Outer Space Treaty allowing for private ownership rights in space.[71] This clarification aims to "reduce uncertainty" in the area of space law, but it also

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[66] NASA, THE ARTEMIS ACCORDS: PRINCIPLES FOR COOPERATION IN THE CIVIL EXPLORATION AND USE OF THE MOON, MARS, COMETS, AND ASTEROIDS FOR PEACEFUL PURPOSES (2020) [hereinafter Artemis Accords].

[67] *Id.* pmbl.

[68] *Id.* § 1.

[69] *See The Artemis Accords: Principles for a Safe, Peaceful, and Prosperous Future*, NASA, https://www.nasa.gov/specials/artemis-accords/index.html (last visited Jan. 4, 2023, 4:24 PM) (providing an overview of the Artemis Accords' purposes). As of October 2021, the thirteen countries that have embraced the Artemis Accords are Australia, Brazil, Canada, Italy, Japan, Luxembourg, New Zealand, Poland, South Korea, Ukraine, the United Arab Emirates, the United Kingdom, and the United States. *Id.*

[70] *See International Partners Advance Cooperation with First Signings of Artemis Accords*, NASA (Oct. 13, 2020), https://www.nasa.gov/press-release/nasa-international-partners-advance-cooperation-with-first-signings-of-artemis-accords ("Additional countries will join the Artemis Accords in the months and years ahead, as NASA continues to work with its international partners to establish a safe, peaceful, and prosperous future in space.").

[71] Artemis Accords, *supra* note 66, § 10, ¶ 2.

demonstrates the signatories political endorsement of the private ownership interpretation of space resources.[72] If the ideology of the Artemis Accords becomes the dominant ethos on the international stage, private ownership of space resources will become the international legal norm.

D. DOMESTIC U.S. LAW

Because a treaty does not legally bind the U.S. until consented to by a two-thirds vote in the Senate and ratified by the President, U.S. international obligations regarding space law can be limited to those agreed upon in the Outer Space Treaty.[73] Recently, the U.S. and a handful of other States have taken it upon themselves to begin crafting a domestic legal framework for space exploration and resource extraction.[74] This trend signals an increased interest in space resources and commercial development, providing even more reason to prospectively regulate celestial water resources.

In 2015, the Obama Administration oversaw the U.S. Commercial Space Launch Competitiveness Act (the Act) which aimed to encourage private actors to enter space for commercial use.[75] It was Congress's explicit intent "[t]o facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating more stable and predictable regulatory conditions, and for other purposes."[76] The Act intends to open the commercial space sector to U.S. citizens and "discourage government barriers to the development in the United States of economically viable, safe, and stable industries for commercial exploration for and commercial recovery of space

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[72] *See id.* § 1 ("Adherence to a practical set of principles, guidelines, and best practices in carrying out activities in outer space is intended to increase the safety of operations, reduce uncertainty, and promote the sustainable and beneficial use of space for all humankind.").

[73] *See* Amanda M. Leon, *Mining for Meaning: An Examination of the Legality of Property Rights in Space Resources*, 104 VA. L. REV. 497, 524 (2018) ("[T]he conservative scope of U.S. international obligations with respect to outer space can be limited to those put forth and agreed upon in the [Outer Space Treaty]." (citing U.S. CONST. art. II, § 2, cl. 2)).

[74] *See supra* notes 13–16 and accompanying text.

[75] U.S. Commercial Space Launch Competitiveness Act, Pub. L. No. 114-90, 129 Stat. 704 (codified as amended in scattered sections of 42 U.S.C. and 51 U.S.C.).

[76] *Id.* pmbl.

resources."[77] This would entitle any U.S. citizen to "possess, own, transport, use, and sell the asteroid resource or space resource obtained."[78] The Act broadly defines "citizens of the United States" to potentially include individuals, U.S. companies, and any entity who organizes under U.S. law to use space commercially.[79] Moreover, the Act serves as a symbolic representation for both domestic and international entities that the U.S. plans to exploit space resources.[80] Some scholars believe, however, that in enacting a law promoting private resource extraction, the U.S. may be violating the terms of the Outer Space Treaty.[81]

The Trump Administration took further steps to pave the way for exploitation of space resources, particularly for private entities.[82] In an executive order, the Administration stated that continued, long-term exploration of celestial bodies will "require partnership with commercial entities to recover and use resources, including water and certain minerals, in outer space."[83] The U.S. explicitly distanced itself from the Moon Agreement, signaling the intent to pursue private commercial space resource extraction.[84] The order stated that "[u]ncertainty regarding the right to recover and use space resources, including the extension of the right to commercial recovery and use of lunar resources," discourages Americans from "the right to engage in commercial exploration, recovery, and use of resources in outer space, consistent with applicable law."[85] The

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[77] *Id.* § 51302(a)(2).

[78] *Id.* § 51303.

[79] *Id.* § 51301(3); *see also* K.G. Orphanides, *American Companies Could Soon Mine Asteroids for Profit*, WIRED (Dec. 11, 2015, 10:09 AM), https://www.wired.co.uk/article/how-to-mine-asteroids-for-fun-and-profit (noting that the Act has received support from foreign investors because "not only individuals but also corporations, including those that are not wholly US owned, qualify as US citizens").

[80] *See* Orphanides, *supra* note 79 (pointing out that "commercial resource exploitation could fuel technological development in a new space race," drawing in investors from overseas).

[81] *See* Blount & Robinson, *supra* note 48, at 161–62 (noting that, while actors in the commercial sector praise the U.S. government's approach toward space resource privatization, many scholars view the legislation as a potential violation of international space law).

[82] *See* Exec. Order No. 13,914, 85 Fed. Reg. 20,381 (Apr. 6, 2020) (reenforcing the right of U.S. citizens to privately extract and own space resources for commercial purposes).

[83] *Id.*

[84] *See id.* ("The United States is not a party to the Moon Agreement.").

[85] *Id.*

United States' move toward private space resource ownership sends a strong signal that private space resource ownership is likely to become the norm in the near future.

## IV. POSSIBLE LEGAL FRAMEWORKS FOR CELESTIAL WATER LAW: CASE STUDIES

### A. DOMESTIC U.S. FRAMEWORKS

Due to the vast diversity of geographic landscapes in the U.S., water law varies between the east coast, which has an abundance of water, and the west coast, which is significantly more arid. The varying approaches provide two possible frameworks that the U.S. may adopt when creating a celestial water law regime, each with its own consequences to consider. This Note uses examples of water disputes from each region to examine the diverging frameworks in action and their potential application to celestial water law.

*1. East Coast Approach*: Florida v. Georgia. The eastern coast of the U.S. has developed a rich history of water resource allocation law. Due to the abundance of water, most jurisdictions in the east adopted the "riparian doctrine" of water rights.[86] The riparian doctrine grants rights to water use to whomever occupies the land closest to the water.[87] If two entities occupy the land along the water, rights are apportioned between them, creating a sort of reasonable shared use.[88]

The Supreme Court restated general principles guiding riparian apportionment rights in 2021 when it heard a case concerning an interstate water dispute in *Florida v. Georgia*.[89] The two states were bickering over rights to water deriving from the Apalachicola-

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[86] *See Water Wars: Who Controls the Flow?*, NPR (June 15, 2013, 6:19 AM) [hereinafter *Water Wars*], https://www.npr.org/2013/06/15/192034094/rivers-run-through-controversies-over-who-owns-the-water?ft=1&f=1025 (discussing the differences between eastern and western water law regimes in the U.S. and providing examples of disputes under each).

[87] *See id.* ("[Under] the riparian doctrine, if you live close to the river or to that water body [or] lake, you have reasonable rights to use that water . . . ." (alterations in original)).

[88] *See id.* (explaining the appropriation doctrine).

[89] 141 S. Ct. 1175 (2021).

Chattahoochee-Flint River Basin.[90] Because the river flows through both states, the two states are coequal riparian right holders.[91] The conflict between the states resulted from metro Atlanta's increased water usage, coupled with numerous droughts in the region.[92] As metro Atlanta expands, the city uses more water out of the Lake Lanier reservoir on the Chattahoochee River, meaning that "people living downstream, in Alabama and Florida, have less."[93] Florida filed a complaint against Georgia alleging that Georgia was using more than its fair share of the water and that Georgia's unreasonable overconsumption of the basin water resulted in the collapse of Florida's oysteries.[94] Georgia responded that the actual cause of Florida's harm was Florida's own mismanagement of its oysteries.[95]

The Court invoked the "guiding principle of the equitable apportionment analysis," which states that, "where upstream and downstream States are both riparian States," both states have an "equal right to make a reasonable use of interstate waters."[96] Under a riparian analysis, the Court required Florida to prove two things: (1) a threatened or actual injury "of serious magnitude" caused by upstream water consumption; and (2) that "the benefits of the [apportionment] substantially outweigh the harm that might result."[97] The Court unanimously held that Florida failed to prove either prong of the analysis by clear and convincing evidence.[98] Florida did not establish that it was "'highly probable' that Georgia's alleged overconsumption played more than a trivial role" in

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[90] *See id.* at 1178 (stating that Florida brought the action because Georgia, as the upstream right holder, consumes a large share of water from interstate rivers in the Apalachicola-Chattahoochee-Flint River Basin).

[91] *See id.* at 1180 (noting a guiding principle that both states have an equal right to use).

[92] *See id.* at 1178–79 (pinpointing metro Atlanta as a major consumer of the Chattahoochee water source).

[93] *Water Wars, supra* note 86.

[94] *See Florida*, 141 S. Ct. at 1179 ("Georgia's overconsumption of Basin waters causes sustained low flows in the Apalachicola River, which in turn harm its oyster fisheries and river ecosystem.").

[95] *See id.* at 1180–81 (laying out Georgia's counterarguments for Florida's own harm to the oysteries).

[96] *Id.* at 1180.

[97] *Id.*

[98] *See id.* at 1182 (holding that Florida failed to meet its burden).

Florida's harm.[99] The Court concluded that, although Georgia has a responsibility to use water from the Chattahoochee River in a reasonable manner, Florida did not meet "the exacting standard necessary to warrant the exercise of this Court's extraordinary authority to control the conduct of a coequal sovereign."[100]

Through its ruling in *Florida v. Georgia*, the Court makes clear that, under a coequal riparian regime, all water use that is not proven to be substantially unreasonable will be permitted.[101] The party alleging injury has the burden of showing that the harm was directly caused by the other party's overconsumption.[102] This regime suggests that those who have rights to water and do not overconsume to an unreasonable extent will find little interference from courts, even if some overconsumption arises from time to time.[103] It also encourages riparian right holders to consume more because any water unused by one party may be overconsumed by the other.[104]

If left unchallenged, the Supreme Court's current interpretation of the riparian doctrine in *Florida v. Georgia* will likely carry over to celestial water if a similar regime develops in space. If so, it is likely that the shared use of a celestial body's water source will encourage actors to consume the water as efficiently as possible since failure to do so would create an opportunity for a rival right holder to overconsume in response. Left unchecked, this could create situations where actors race to exploit the water resources of celestial bodies in a manner that maximizes profit. Unless the celestial body has some method of replenishing said water source, such as rainfall, the water source could be quickly depleted. Any potential celestial water treaty will benefit from disincentivizing zero-sum water consumption or making rights as coequal as possible to reduce overexploitation and conflict.

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[99] *Id.* (quoting Colorado v. New Mexico, 467 U.S. 310, 316 (1984)).

[100] *Id.* at 1183.

[101] *See id.* (ruling in favor of Georgia while emphasizing that the water use must be "reasonable").

[102] *See id.* (stating the party bringing suit must meet an "exacting standard" necessary to warrant the Court's exercise of extraordinary authority to control the conduct of coequal sovereigns).

[103] *See id.* (highlighting the extraordinary use of the Court's power).

[104] *See id.* (conditioning Georgia's use only on the requirement of reasonableness).

*2. West Coast Approach:* Arizona v. California. In arid places, like much of the western U.S., communities often do not have enough water to go around. Many western jurisdictions have adopted the prior appropriation doctrine, which grants the person with the oldest water right use of all the water to which they are entitled before any other entity with a later-in-time water right.[105] This "first in time, first in right" system was useful during the western expansion era of the U.S. when populations were sparse, but it has since caused significant controversy as more people migrated to places like California, Arizona, and Colorado.[106] Extended droughts further exacerbated this tension, causing the affected states and Mexico to consistently renegotiate the terms of the various water allocation arrangements.[107]

*Arizona v. California* exemplifies the struggle of the evolving needs of water allocation in western states.[108] *Arizona v. California* is a series of Supreme Court cases beginning in 1931,[109] most recently involving an issued consolidated decree in 2006[110] and all revolving around conflicts of Colorado River water allocation.[111] The common law produced by the *Arizona v. California* series; related Colorado River water laws governing two nation-states, seven U.S. states, and thirty tribal sovereigns; and two interstate water compacts collectively make up the "Law of the River."[112] The *Arizona v. California* series reflects the changing negotiations between the involved parties as access and quantity of the available

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[105] *See Water Wars*, *supra* note 86 (providing an example of the prior appropriation doctrine in action by examining the Klamath Basin water dispute). This article notes that in arid places, like the American west, the person with the "oldest water right gets all the water they are entitled to first" due to a lack of water to go around. *Id.*

[106] Josh Patashnik, Arizona v. California *and the Equitable Apportionment of Interstate Waterways*, 56 ARIZ. L. REV. 1, 3–4 (2014) (tracing the Court's equitable apportionment jurisprudence in the west over the first half of the twentieth century).

[107] *See id.* at 49 ("Climate change, combined with rapid rates of population growth in the West, seems likely to put increasing stress on limited water supplies, exacerbating existing interstate water conflicts.").

[108] *See id.* at 49–51 (concluding that the changing climate and population in western states are creating a drive to revisit the water law established in cases like *Arizona v. California*).

[109] Arizona v. California, 283 U.S. 423 (1931).

[110] Arizona v. California, 547 U.S. 150 (2006).

[111] *See* ANTHONY DAN TARLOCK & JASON ANTHONY ROBISON, LAW OF WATER RIGHTS AND RESOURCES § 10:29 (2022) (summarizing Congress's power to apportion interstate waters).

[112] *Id.*

water has shifted throughout the decades.[113] Junior water right holders with later-in-time rights find themselves with less and less water as the years go by, resulting in more lawsuits and conflicts over water resources.[114]

A movement in western water law has been pushing back against the prior apportionment doctrine because it systematically benefits some states over others simply due to historic or geographical luck.[115] The trend of the *Arizona v. California* cases, as well as similar western water caselaw, has shown that western states are moving away from the traditional "first-come, first-served" doctrine and toward a more equitable apportionment regime.[116] Water law should be practical, useful, and flexible.[117] When the harsh doctrine of prior appropriation creates a system of huge loss for some, courts tend to avoid strict enforcement.[118] This change acknowledges the growing concern over water scarcity in recent decades.[119]

### B. RELEVANT INTERNATIONAL FRAMEWORKS

Space law is firmly grounded in international treaties and is generally understood to be a branch of international law.[120] As a

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[113] *See* Patashnik, *supra* note 106, at 36–37 (tracing how cases have shifted during the decades).

[114] *See id.* at 42–43, 47–48 (discussing difficulties placed upon junior right holders).

[115] *See id.* at 46 ("The Court should approach these cases as a court of equity would, seeking to achieve a fair and reasonable result for all the sovereigns involved, rather than applying inflexible legal rules.").

[116] *See* Anthony Dan Tarlock, *The Legacy of* Schodde v. Twin Falls Land and Water Company*: The Evolving Reasonable Appropriation Principle*, 42 ENV'T. L. 37, 61–62 (2012) (providing an example of courts shifting away from prior appropriation in western and midwestern states).

[117] *See id.* at 63 (arguing that courts have space to adjust existing water rights to promote more efficient use of the resource by requiring senior right holders to take reasonable steps to avoid harming junior right holders).

[118] *See id.* at 59–60 ("The first possible lesson is that when prior appropriation creates a large class of losers and the economic stakes are high, there are pressures on courts and administrators to make a crude cost-benefit analysis and step back from strict enforcement by finding the seams in the doctrine that blunt its harshness.").

[119] *See id.* at 59 (pointing out that the inflexibility of the prior appropriation doctrine becomes even more difficult and harsh in times of drought).

[120] *See, e.g.*, Ian Hedges, *How the Rest Was Won: Creating a Universally Beneficial Legal Regime for Space-Based Natural Resource Utilization*, 40 VT. L. REV. 365, 376 (2015) (noting that "'[d]ue to the vast political, military, and economic implications of the advent of space

result, many scholars have attempted to analogize space law to other branches of international law.[121] This Note covers some relevant aspects of international law principles and doctrines that form a basis for a prospective celestial water law treaty.

*1. The Common Heritage of Mankind Doctrine*. Much of the debate over the legal status of space resources derives from the Common Heritage of Mankind Doctrine (Common Heritage Doctrine) in relation to space law.[122] In short, the Common Heritage Doctrine states that certain territorial zones exist beyond any national sovereignty—e.g., the open ocean, the sea floor, and the Moon—and that the resources in these zones are not subject to national appropriation.[123] Instead, the international community, through treaties and norms of international law, administers the area for the benefit of collective humankind without preference for any political entities.[124] Note that this doctrine concerns the resources in the territory rather than claims over the territory itself.[125] The Common Heritage Doctrine is less concerned with

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technology' . . . the United Nations created multiple treaties, principles, and resolutions pertaining to space law" during the Cold War).

[121] *See, e.g.*, *id.* at 381–83 (analogizing space law to international regimes like the Law of the Sea and the law governing Antarctica). For earlier, similar comparisons, see Reynolds, *supra* note 59 (analogizing space law to the law governing the high seas, law governing Antarctica, and the law governing international airspace).

[122] *See* Harminderpal Singh Rana, Note, *The "Common Heritage of Mankind" & the Final Frontier: A Revaluation of Values Constituting the International Legal Regime for Outer Space Activities*, 26 RUTGERS L.J. 225, 228–30 (1994) (analyzing the effects of the Common Heritage of Mankind Doctrine on space law).

[123] *See id.* ("Under the CHM principle, no one legally owns international areas designated as part of the 'common heritage of mankind.'"). Rana adds that no single, universally accepted definition of Common Heritage Doctrine areas exists, though certain generally agreed upon elements include that (1) the area is not subject to appropriation, (2) all States share in the area's resource management, (3) States must share in the derived benefits of the area's resources, (4), the area must be dedicated to peaceful purposes exclusively, and (5) the area should be preserved for posterity. *Id.* at 228–29.

[124] *See id.* ("[N]o state or group of states could legally own any part of an international area.").

[125] *See* Carol R. Buxton, *Property in Outer Space: The Common Heritage of Mankind Principle vs. the "First in Time, First in Right" Rule of Property Law*, 69 J. AIR L. & COM. 689, 692 (2004) ("Because the principle renders claim of title to designated international, common heritage areas worthless and unrecognized, the issue for countries becomes access.").

territorial rights and more concerned with whether the resources in question are used to benefit humankind.[126]

Given the language of the space law treaties discussed earlier in this Note, the applicability of the Common Heritage Doctrine over outer space is not the issue.[127] Rather, disagreement arises from how broadly the Common Heritage Doctrine should apply to space resources.[128] Two competing interpretations of the Common Heritage Doctrine are to blame for much of the confusion over space resource extraction.[129] First, developing nations support a "common property" approach, which holds that harvested resources should be equitably distributed among all States, regardless of which entity actually extracted the resource.[130] This approach would prevent a monopolization of space resources and allow less economically advantaged nations to participate and benefit in space exploitation.[131] Second, developed nations prefer to read the Common Heritage Doctrine more narrowly, admitting that, although the needs of developing nations should be considered, the entity engaged in resource extraction ultimately determines what is equitable.[132] Developed nations argue that an overly broad interpretation would discourage resource extraction and harm

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[126] *See id.* ("The common heritage principle seems unconcerned with *ownership* of designated areas, but rather focuses on the 'uses of them for the benefit of humankind, to serve the common interest of peoples everywhere.'").

[127] *See* Rana, *supra* note 122, at 226–27 (noting that the Common Heritage Doctrine can be seen in the Moon Agreement as well as the Outer Space Treaty and therefore forms an essential part of space law); *see also supra* section III.A and accompanying text.

[128] *See* Rana, *supra* note 122, at 230–32 (analyzing the conflicting views of the Common Heritage Doctrine in the area of space law).

[129] *See id.* (arguing that two distinct interpretations of the Common Heritage Doctrine are in use: the view of developing nations and that of developed nations).

[130] *See id.* at 230–31 (referencing developing nations' comments from the Law of the Sea Convention and Moon Treaty negotiations).

[131] *See id.* at 231 n.37 (arguing that developing nations invoked the Common Heritage Doctrine with three major goals in mind: (1) to prevent space resources from being monopolized by developed nations; (2) guarantee direct participation of developing countries in resource management; and (3) distribute derived benefits in the interests of developing countries).

[132] *See id.* at 231 (arguing that developed nations sought to "minimize changes in existing economic and legal conditions governing access and use of international [Common Heritage Doctrine] resources").

humankind's ability to benefit from space exploration in the long run.[133]

Both sides of the debate create obstacles to space exploration.[134] Any workable celestial water treaty would need to address the conflicting interpretations in a manner that would appease both developed and developing nations while still maintaining the peaceful intentions behind the Common Heritage Doctrine.

*2. The Open Sea and Antarctica.* On the surface, the international treaties governing the open oceans (the U.N. Convention on the Law of the Sea)[135] and Antarctica (the Antarctic Treaty)[136] appear to be useful analogies for conceptualizing sovereign ownership in space law because they both invoke the Common Heritage Doctrine.[137] Antarctica and the open ocean seem as comparable to outer space as anything: cold, dark, harsh, and desolate. Key differences, however, diminish the usefulness of a blanket application of these regimes to outer space.

Looking to Antarctica, full application of the Antarctic Treaty is unlikely to be fruitful for two reasons. First, the Antarctic Treaty prohibits resource extraction, largely for environmental and scientific reasons, and if a similar ban is applied to space in the current economic climate, it would lead to the same international discontent that plagues the Moon Agreement.[138] Second, the environmental concerns behind the prohibition on resource extraction in Antarctica are not relevant to space mining.[139] In fact,

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[133] *See id.* (noting that developed nations argued long-term common good would be harmed by adopting too narrow of an interpretation of the Common Heritage Doctrine).

[134] *See generally id.* (providing a detailed discussion of the pros and cons of each approach).

[135] United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS].

[136] The Antarctic Treaty, Dec. 1, 1959, 402 U.N.T.S. 71.

[137] *See* Rana, *supra* note 122, at 228–30 (discussing how the Common Heritage Doctrine affects other branches of international law as an analogy to how it would affect space).

[138] *See supra* section III.B.

[139] *See* Reynolds, *supra* note 59, at 725 (discussing how the ban on resource extraction in Antarctica is largely a result of environmental considerations). Antarctica plays a pivotal role in regulating the Earth's climate in a way that is inapplicable to outer space activities. *See Climate Crisis in Antarctica*, ASOC, https://www.asoc.org/advocacy/climate-change-and-the-antarctic (last visited Jan. 5, 2023) (noting how increasing global temperatures are affecting both Antarctica and the whole world). For example, the ice sheets in Antarctica act as a heat sink that affects the climate of the planet and disruption of important Antarctic species, such

taking advantage of space water could have beneficial effects on the Earth's biosphere, such as bringing in additional water to drought-stricken regions and giving Earth's resources time to recover from present overexploitation.[140] Notably, Antarctica also differs from outer space because several nations have made territorial claims to the continent, though these claims were later not recognized by the Antarctic Treaty's signatories.[141] Last, although the Antarctic Treaty does not expressly include the Common Heritage Doctrine, the language of the Treaty includes similar notions,[142] and application of the Common Heritage Doctrine to Antarctica is widely advocated by legal scholars.[143]

The law governing international oceans offers some useful insight into a Common Heritage Doctrine approach to space water allocation, though inherent challenges to this egalitarian approach remain. Where the law of the sea does discuss resource rights, it largely relates to salvaging and biosphere resources, such as fish.[144] While salvaging human-made space vehicles may eventually become an important topic in space property law, virtually all space resources of value remains situated on or within celestial bodies.[145] Because the sea's resources are discussed with environmental rather than economic impacts in mind, the resource rights provisions are largely inapplicable to space resources, which will have little, if any, impact on the Earth's environment. Moreover, space resources, unlike Earth's limited resources, remain nearly

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as krill, could break down the local and global food chain. *See id.* (cataloguing the ways in which Antarctica affects the global ecosystem).

[140] *See* Reynolds, *supra* note 59, at 725 (arguing commercial space activity is "unlikely to have any direct physical effect on the Earth's biosphere or climate at all" as "any indirect effects are likely to be benign, or else actively good").

[141] *See* Rana, *supra* note 122, at 237 n.66 (noting that Argentina, Australia, Chile, France, New Zealand, Norway, and the United Kingdom have staked territorial claims in Antarctica).

[142] *See* The Antarctic Treaty, *supra* note 136, art. I ("Antarctica shall be used for peaceful purposes only.").

[143] *See, e.g.*, Rana, *supra* note 122, at 237–38 (detailing how Antarctica is treated as a Common Heritage Doctrine zone despite lacking express language found in other treaties).

[144] *See* UNCLOS, *supra* note 135, art. 6(1) (providing an example of how the treaty obligates avoiding certain actions to protect marine life and respect the law of salvaging).

[145] *See, e.g.*, Rathz, *supra* note 11 (noting that private and public entities are increasingly investing in space mining to retrieve the valuable resources from within celestial bodies).

limitless.[146] Furthermore, the law of the high seas focuses more on travel and environmental concerns, largely ignoring resource extraction.[147] While these are considerations space law should eventually address, they are beyond the focus of this Note.

*3. Deep Sea Mining.* A more apt parallel to space is the international law governing deep sea mining.[148] Deep sea mining reflects many of the concerns and challenges that are present in space water exploitation, particularly because most celestial water is likely to be harvested as a solid rather than a liquid.[149] Much like space, the deep sea contains a horde of valuable resources, namely gas and oil, in a location that is beyond traditional State jurisdiction.[150] The law surrounding deep sea mining's development is summarized briefly below. Particular attention is paid to the United States' response to deep sea mining law. The tension between the international community and the U.S. over deep sea resources closely resembles how the U.S. has responded to restrictions on private entities exploiting space resources, such as those contained in the Moon Agreement.[151]

In 1970, the United Nations adopted a resolution which declared the deep seabed as the common heritage of humankind.[152] Similar to the modern expanding space resource market, the world became increasingly aware of the vast mineral wealth within the seabed

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[146] *See* Hamilton DeSaussure, *Maritime and Space Law, Comparisons and Contrasts (An Oceanic View of Space Transport)*, 9 J. SPACE L. 93, 99, 103 (1981) (arguing that concerns over protecting marine environments and uniform navigation rules will likely not be significant in space law).

[147] *See id.* at 103 ("While it should be superficially attractive to transfer concepts being developed in this most vital area from the sea to space, it probably is not a useful analogy. First, because the law of the sea is itself in a state of confusion on this subject, and second, because the distinctive characteristics of the two environments call for entirely different approaches to the problem.").

[148] *See generally* G.A. Res. 2749 (XXV), Declaration of Principles Governing the Seabed and the Ocean Floor, and Subsoil Thereof, Beyond the Limits of National Jurisdiction (Dec. 17, 1970).

[149] *See supra* note 3 and accompanying text.

[150] *See* Clive Schofield, *New Marine Resource Opportunities, Fresh Challenges*, 35 U. HAW. L. REV. 715, 726–27 (2013) (noting that the seabed contains not only oil but also key minerals like gold, tin, and diamonds).

[151] *See supra* section III.B.

[152] *See supra* note 148.

and sought to exploit those resources.[153] Although the U.S. voted in favor of the resolution, it later issued a statement in which it declared the resolution was not binding and that the U.S. reserved its right to explore and exploit the deep seabed until it became a party to an international treaty.[154] This perfectly mirrors its reaction to the Moon Agreement.[155] With disagreement fermenting, the international community needed to decide between potential theories of property ownership.[156] Developing nations supported an equitable approach, while the U.S. and more economically advantaged nations supported a free-access philosophy.[157] Ultimately, the United Nations sided with developing countries, and in response, the U.S. enacted the Deep Seabed Hard Mineral Resources Act, which permits the U.S. to issue licenses to entities looking to mine the sea floor.[158] To resolve this dispute, the

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[153] *See* Katherine Dixon, *Law of the Sea—Deep Seabed Mining—United States Position in Light of Recent Agreement and Exchange of Notes with Five Countries Involved in Preparatory Commission of United Nations Convention on the Law of the Sea*, 18 GA. J. INT'L & COMP. L. 497, 499 (1988) (documenting the historical development of the emergence of international law governing deep sea mining); *see also* Wesley S. Scholz, *The Law of the Sea Convention and the Business Community: The Seabed Mining Regime and Beyond*, 7 GEO. INT'L ENV'T L. REV. 675, 675 (1995) (debating the impact of international deep sea mining laws on businesses by commenting on laws "that affect the oil and gas, marine transportation, and telecommunications industries").

[154] *See* U.N. GAOR, 25th Sess., 1799th mtg. at 20–21, 28, U.N. Doc. A/C.1/PV.1799 (Dec. 15, 1970) (recounting the United States' position on the proposed laws covering deep seabed extraction).

[155] *See supra* section III.B.

[156] *See* Dixon, *supra* note 153, at 498–99 (discussing three popular theories of property ownership during the early stages of deep sea mining's development). The first theory, *res communes*, supported by developing nations, "view[ed] the ocean bed as the common heritage of mankind, and therefore propose[d] that states which exploit the resources beneath international waters should equitably divide the resulting proceeds among all the nations of the world." *Id.* at 499. The second, advocated by the U.S. and more developed nations, was that "the deep seabed may be . . . exploited as a freedom of the high seas pursuant to customary international law," though States may not inherently claim sovereignty over specific areas of the seabed. *Id.* at 499–500. The third, *res nullius*, provided that "the deep seabed belongs to no one, and that a state may exercise sovereignty over a particular area based solely on appropriation." *Id.* at 500.

[157] *See id.* (arguing that developing nations believed more economic benefit could be derived if access to seabed resources were more equitably distributed).

[158] 30 U.S.C. §§ 1401–73 (1980). Congress stated in the Act that "uncertainty among potential investors [was] . . . likely to discourage or prevent the investments necessary to develop deep seabed mining technology," echoing the Trump Administration's executive order

international treaties were renegotiated to limit international regulatory power over seabed mining and to provide developed nations veto powers.[159] Though the U.S. remains an outlier in rejecting international governance of seabed mining, it still follows many international rules as customary international law.[160]

The third United Nations Conference on the Law of the Sea (UNCLOS III) governs deep sea mining.[161] According to UNCLOS III, the international seabed and its resources are the "common heritage of mankind," making it comparable to the Outer Space Treaty because both require extracted resources to benefit all humanity.[162] Pursuant to UNCLOS III, States that mine the deep seabed must distribute economic shares to developing States, encourage and complete marine scientific research, promote the transfer of technology and scientific knowledge among States, and promote the participation of developing States in activities within the deep seabed.[163] The International Seabed Authority (ISA) ensures implementation of each of these requirements.[164] UNCLOS III grants the ISA power to establish rules and procedures for mining, mineral rights, and the subsequent distribution of wealth to developing States.[165]

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that repudiated the Moon Agreement. *See id.* § 1401(a)(13), (a)(15), (b)(5) (reassuring private investors and informing the United Nations of its position to the proposed international seabed regime).

[159] Agreement Relating to the Implementation of Part XI of the United Nations Convention on the Law of the Sea of 10 December 1982, tit. 6(a), July 28, 1994, 1836 U.N.T.S. 3.

[160] *See* Catherine Danley, *Diving to New Depths: How Green Energy Markets Can Push Mining Companies into the Deep Sea, and Why Nations Must Balance Mineral Exploitation with Marine Conservation*, 44 WM. & MARY ENV'T. L. & POL'Y REV. 219, 240 (2019) (arguing that the law of the sea remains a powerful force that the U.S. respects despite not joining the treaties).

[161] United Nation Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS III].

[162] *See id.* art. 136 ("The [international seafloor] and its resources are the common heritage of mankind.").

[163] *See id.* art. 140 ("[P]articular consideration [is taken into account for] the interests and needs of developing States and of peoples who have not attained full independence or other self-governing status recognized by the United Nations . . . .").

[164] *See id.* art. 156 (establishing the ISA).

[165] *See id.* art. 160 (enumerating the powers the ISA possesses).

Indicating its displeasure with the United Nations' stance, the U.S. remains absent from the ISA and UNCLOS III.[166] Instead, the U.S. relies on the self-granted licensing authority of the Deep Seabed Hard Minerals Resource Act, suggesting that the U.S. may behave similarly if it finds a potential space law treaty unacceptable.[167] Some have mounted pressure to urge the U.S. to finally join UNCLOS III, but these efforts ultimately failed.[168] While the U.S. might be able to mine deep sea minerals without ratifying UNCLOS III, the inability of the U.S. and the international community to reach a compromise threatens diplomatic conflict.[169] The U.S. opposition may serve as a potential case study of how an imperfect celestial water law treaty could create conflict if it fails to secure the support of developed nations.

Deep sea mining presents a comparable example of what issues may arise as space exploration advances. Given the similarities between the language and purpose behind the Outer Space Treaty and UNCLOS III, the U.S. reaction to the equitable distribution aspects of both treaties, and the method of extraction, deep sea mining offers an interesting analogue to likely legal challenges for any space resource regime. By looking deeper into the challenges created in seafloor mining regimes, the international community

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[166] *See* Danley, *supra* note 160, at 257 (discussing the history of the United States' relationship with UNCLOS III and arguing that "[i]f the United States wants to improve renewable energy developments, remain competitive in the global mineral and technology markets, have a voice on deep-sea mining regulations, or encourage U.S. entities to mine in the Area, it must ratify UNCLOS III").

[167] *See id.* at 255 ("Instead of treaty ratification, however, the United States crafted its own licensing authority over deep-sea mining in 1980 through the Deep Seabed Hard Minerals Resource Act.").

[168] For example, Lockheed Martin tried, and failed, to convince the U.S. Senate to ratify UNCLOS III in 2012. *See id.* at 256 (recounting Lockheed Martin's efforts); *see also* Stewart M. Patrick, (*Almost) Everyone Agrees: The U.S. Should Ratify the Law of the Sea Treaty*, THE ATLANTIC (June 10, 2012), https://www.theatlantic.com/international/archive/2012/06/-almost-everyone-agrees-the-us-should-ratify-the-law-of-the-sea-treaty/258301/ (arguing the U.S. should ratify the treaties surrounding the law of the sea). The United States' stubborn refusal to join UNCLOS III prevents it from taking advantage of ISA contracts, weaking its position in the growing deep sea mining market. *See* Danley, *supra* note 160, at 256 ("Effectively, the political blockade prohibits domestic companies from pursuing mineral rights in the Area, forcing many U.S. companies to turn to their foreign subsidiaries 'to the detriment of the United States.'").

[169] *See* Danley, *supra* note 160, at 260 (arguing that the risks of U.S. not joining UNCLOS III could be both economic and political).

may avoid the controversies present in UNCLOS III as they relate to the U.S. when drafting regulations allocating celestial water.

## V. MAJOR CONCERNS AND POTENTIAL ISSUES

This section addresses concerns raised throughout this Note. Although this Note suggests possible solutions and considerations that a potential celestial water treaty should address, the conceivable provisions to a practical celestial water treaty are limitless. The suggestions below are meant to act as a guide rather than a definitive writing. The best solutions will depend on the economic, political, and environmental circumstances at the time of drafting.

### A. PROPERTY OWNERSHIP

One of the first issues any prospective celestial water treaty must address is the confusing state of property rights in outer space. The Cold War era treaties governing the current framework are vague and outdated, and in the current era of globalized market capitalism, the original rationale behind forbidding resource ownership is antiquated.[170] These policies stand as a huge barrier to scientific and economic advancement in space exploration.[171]

Economically developed nations, such as the U.S., will certainly push back against any water rights regime that heavily restricts profitability and freedom of ownership.[172] Rights over captured water resources make investment in space exploration more appealing.[173]

Potential celestial water treaties should compromise between private ownership rights and the egalitarian principles of the Common Heritage Doctrine to increase the chance of universal

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[170] *See* Reynolds, *supra* note 59, at 729–30 (arguing that Cold War tactics are no longer relevant).

[171] *See id.* at 730 (noting that the west and the former Soviet Union could combine their expertise). This view is backed by the U.S. federal government. *See* 51 U.S.C. § 50901 (stating that one of the key purposes of Congress's promotion of commercial space endeavors is to incentivize the continued improvement and evolution of space technology and capabilities).

[172] *See* Rana, *supra* note 122, at 231 (listing the reasons developed nations fiercely dislike egalitarian international water law frameworks).

[173] *See supra* note 7 and accompanying text.

acceptance. Although the goals of developed and developing nations appear at odds, rejection of developing nations' "common property" interpretation does not mean complete acceptance of a national appropriation regime.[174] One workable approach could grant private ownership rights to private entities, thereby avoiding issues with the Outer Space Treaty's prohibition on national appropriation.[175] This approach might obligate private entities to harvest the water in sustainable ways, alleviating developing nations' fears that developed nations would deplete nearby water sources and encouraging harvesters to satisfy the environmental concerns present in the Common Heritage Doctrine and the Outer Space Treaty.[176] Additionally, a limited shared rights structure would advance the protective principals of the Outer Space Treaty.[177] This could take the form of private right holders sharing water resources in times of need or for specified scientific purposes.[178] While the forms this shared rights structure could take are numerous, burdensome implementing requirements could discourage developed nations from ratifying the treaty, similar to what occurred with the U.S. rejection of the deep sea mining provisions in UNCLOS III.[179]

The Artemis Accords move in the right direction by balancing extraction by private entities and the egalitarian principles in the Outer Space Treaty, which the U.S. has embraced.[180] Because the Artemis Accords seek to open space to economic development without straying too far from the humanitarian ideas of the Common Heritage Doctrine, a likeminded celestial water treaty would likely gain acceptance from developed and developing States alike. A celestial water treaty like this, however, must ensure that

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[174] *See* Rana, *supra* note 122, at 233–34 (arguing that a synthesized definition of the Common Heritage Doctrine would work best).

[175] *See* discussion *supra* section III.A.

[176] *See* Outer Space Treaty, *supra* note 42, arts. I, IX (encouraging "freedom of scientific investigation" and that entities should avoid activities that cause "potentially harmful interference" with use of outer space).

[177] *See id.* art. IX (promoting a cooperative vision of activities on the Moon).

[178] This would also likely satisfy Article V of the Outer Space Treaty by encompassing the "assistance to the astronauts" requirement. *Id.* art. V.

[179] *See* discussion *supra* section IV.B.*3*.

[180] *See supra* section III.C.

developing countries are not forgotten about or injured by an overly capitalistic approach to commercial space exploitation.

### B. WATER'S UNIQUE PROPERTIES IN OUTER SPACE

It is helpful to remember the simple fact that water in space behaves differently than water on Earth.[181] The physical properties of water as it behaves in the unique environment of space present obstacles which may frustrate any framework that thoughtlessly replicates a terrestrial water law regime. The biggest difference between terrestrial water and celestial water is that, in the cold vacuum of space, water will most likely be found as a solid.[182] Because terrestrial water law is based around water in its liquid state, any celestial water law framework will need to adjust accordingly. This difference in form should lead to two lines of water law: one governing liquid water and another governing solid ice. Some considerations of these differences are discussed below.

First, solid celestial ice will need to be extracted via mining, much like a solid mineral resource.[183] Therefore, a successful celestial water law framework should reflect much of the concerns found in laws governing mining.[184] This fact makes the framework governing deep sea mining a useful starting point for the creation of a celestial water law regime.[185] Issues like licensure, disposal of waste, and regulation of mining infrastructure already appear in UNCLOS III.[186] By making the appropriate adjustments, like providing more freedom to developed nations to mine, UNCLOS III can act as a guiding document for the first celestial water law treaty.

A second consideration is that solid celestial ice generally does not flow like liquid water.[187] This means issues that arise between upstream and downstream neighbors will almost certainly not occur. For example, overuse issues by an upstream right holder, as

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[181] *See, e.g.*, Seigel, *supra* note 3 (explaining why water in space is often in ice form).

[182] *See id.* (explaining how space's vacuum leads to the presence of ice).

[183] *See id.* (explaining that water initially boils and then freezes in space).

[184] *See id.* (discussing why the presence of ice matters for extraction and regulation).

[185] *See* discussion *supra* section IV.B.*3*.

[186] *See* discussion *supra* section IV.B.*3*.

[187] *See Scientists Create Exotic "Outer Space" Ice*, *supra* note 3 (explaining how and why space ice is amorphous).

in *Florida v. Georgia*, will not occur.[188] Further, laws regulating technology taking advantage of water's flow, such as dams, collective reservoirs, ships, and canals, will be immaterial.

Besides considering variations between Earth-bound water and celestial water, big picture differences between Earth and space must also be considered. For example, smaller celestial bodies will have significantly less gravity than Earth, meaning little to no atmosphere and less atmospheric pressure.[189] Additionally, because water boils quickly at low pressure, celestial ice will be prone to evaporation once mined, which could potentially cause water to skip its liquid phase.[190] Further, if a celestial body lacks atmosphere, it will typically have a lower overall temperature and vacuum-like conditions, which will likely cause water to appear in its solid state, as mentioned above.[191]

A particularly astute celestial water treaty should therefore consider the effect of the lack of pressure, wild temperature shifts, and solar radiation on space water resources. Regulations controlling the storage and mining of celestial water should provide space-voyaging entities guidance in this regard. For example, space-based infrastructure meant to store or mine water should be

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[188] *See* discussion *supra* section IV.A.*1*.

[189] *See, e.g.*, Matt Williams, *What Is the Atmosphere Like on Other Planets?*, UNIVERSE TODAY (Jan. 7, 2016), https://www.universetoday.com/35796/atmosphere-of-the-planets (providing an overview of the different atmospheric makeups of the planetary bodies in our solar system). For example, Mercury and Mars are smaller than Earth, and therefore have less gravity to maintain a pull on the gas particles necessary to form an atmosphere. *See id.* (detailing atmospheric differences). Larger planets, such as Jupiter and Saturn, have extremely thick atmospheres, resulting in even more atmospheric pressure that will affect the properties of water particles. *See id.* (describing Jupiter and Saturn's atmospheres); *see also* Holly Shaftel, *10 Things: Planetary Atmospheres*, NASA (May 14, 2018), https://solarsystem.nasa.gov/news/436/10-things-planetary-atmospheres (providing an overview of the atmospheric makeup of planets in our solar system as well as a few large exoplanets).

[190] *See* Seigel, *supra* note 3 (providing data relating the temperatures and pressures at which water freezes and boils within space's vacuum).

[191] *See, e.g.*, Williams, *supra* note 189 (providing the example that, because of Mars's thin atmosphere and its greater distance from the Sun, the surface temperature of Mars is much colder than that of Earth).

regulated within certain parameters to maximize safety and minimize waste of water resources.[192]

Last, potential celestial water frameworks have the advantage of being prospective. It would benefit humankind to plan for foreseeable contingencies involving water management, namely man-made water storage to accompany space colonies.[193] On Earth, humans set up civilization around sources of water, following water sources as they naturally occurred.[194] When creating space infrastructure, however, humankind will have the opportunity to shape the water source as we see fit. This will allow humankind to craft terraformed rivers, and regulation dictating a man-made water source's flow, length, depth, and quantity may preemptively be legislated to mitigate potential conflicts that have resulted on Earth.[195]

### C. NATIONAL ACCOUNTABILITY AND DUTIES

Any prospective celestial water treaty would be incomplete without a section that covers the member-States' obligations to each other and humanity. The Outer Space Treaty imposes an obligation upon its ratifiers to use space for peaceful purposes for the benefit of all humankind.[196] Considering water's inherent tie to life and its importance to space exploration, these high-minded principals easily apply to space water resources. Notably, striving for peaceful space exploration does not contradict the exploitation of celestial

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[192] See TEX. WATER CODE ANN. § 26.341 (West 2021) for an Earth-based example of a safety-minded water storage regulation promoting safety "by adopting requirements for the design, construction, operation, and maintenance of storage vessels, with the objective of protecting groundwater and surface water resources."

[193] *See, e.g.*, Mark Garcia, *Proposed Station Water System Looks to Retired Shuttles*, NASA (Aug. 26, 2015), https://www.nasa.gov/feature/proposed-station-water-system-looks-to-retired-shuttles (last updated Aug. 7, 2017) (showcasing a proposed potable water system meant for the International Space Station).

[194] *See* SOLOMON, *supra* note 1, at 3 (commenting that human societies have long built around water resources to maintain political, economic, and military control over the "seemingly magical" resource).

[195] *See* Milne, *supra* note 4 (discussing conflicts driven by water shortages); *see also supra* Part IV.

[196] *See supra* section III.A.

water because a market system based on private ownership works best when conflict is at a minimum.[197]

Further, the Outer Space Treaty's obligation to provide aid to space voyagers regardless of national origin should be reiterated and clarified in any celestial water treaty.[198] Water is arguably the most important natural resource for sustaining life, and in the harsh environment of outer space, life is at a notable disadvantage. Providing water to space travelers in need ensures that commercial entities will protect human life and promotes a sense of human cooperation. A clause ensuring this cooperation is vital and should receive little political pushback, assuming the provision is reasonably measured. States may object if the provision requires a party to turn over all or a substantial amount of water to a needy traveler. Therefore, tempering the clause with phrases like "as much as is needed" or "sufficient water" may reassure commercial space travelers that they will receive aid in case of emergency without inspiring fear that an entire journey's haul will be turned over to another, less prepared party.

### D. ADJUSTING PROVISIONS FOR CELESTIAL BODIES

Given the vast differences between the types of celestial bodies that contain water, an efficient celestial water treaty should differentiate legally between how water resources are treated on each type of celestial body. Celestial bodies of high significance and scientific value, such as the Moon and Mars, require specific, precise legislative consideration. On the other hand, legislation governing less significant celestial bodies, like asteroids and comets, may allow commercial actors more freedom in extraction. Next, this Note addresses special treaty considerations for the Moon, other planets, other natural satellites, asteroids, and comets.

*1. The Moon.* Commercial exploitation of lunar water deposits should be limited, if not outright banned, to preserve the natural

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[197] *See* Reynolds, *supra* note 59, at 729–30 (arguing that commercial space activity will prosper if conflict is avoided and that peaceful commercial space activity may even serve to rectify current terrestrial conflicts).

[198] *See* Outer Space Treaty, *supra* note 42, art. V (obligating signatories to provide aid to astronauts regardless of national origin).

beauty and scientific value of our closest celestial sister.[199] Even the most avid opponents of the Moon Agreement would likely shy away from claiming that the lunar surface should be completely stripped of its water.[200] Overexploitation would be disastrous for Earth due to the Moon's effect on our planet.[201] For example, the Moon affects Earth's weather and tides.[202]

*2. Planets and Natural Satellites*. Water exploitation on planets and a planet's natural satellites requires specific legislation tailored to the circumstances of each celestial body.[203] It may be useful to create categories for planets and natural satellites based on each celestial body's size, scientific value, and amount of water. For example, some natural satellites contain vastly more water than others.[204] This would mean that some natural satellites will have enough water to support fuel stops, while others would have enough water to potentially support large quantities of life.[205] Still yet, others may barely have water at all.[206] A thoughtful celestial water

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[199] *See* Houston We Have a Podcast, *The Value of the Moon*, NASA (Oct. 18, 2019), https://www.nasa.gov/johnson/HWHAP/the-value-of-the-moon (discussing how the geology and scientific value of the Moon is essential for scientific understanding of space, Earth, and other celestial bodies).

[200] *See id.* (noting the scientific value of studying lunar water).

[201] *See, e.g.*, Katherine Latham, *The Subtle Influence of the Moon on Earth's Weather*, BBC (Aug. 23, 2021), https://www.bbc.com/future/article/20210820-the-subtle-influence-of-the-moon-on-earths-weather (explaining how the Moon affects, among other things, the Earth's orbit, tides, rotation, species population sizes, and weather patterns).

[202] *See id.* ("The most obvious effect the Moon has on the Earth can be seen in the ocean tides. . . . A world without tides would have very different weather systems.").

[203] *See, e.g.*, Williams, *supra* note 189 (discussing the unique atmospheres and properties of each planet in our solar system).

[204] *Compare* Bruce M. Cordell, *The Moons of Mars: A Source of Water for Lunar Bases and LEO*, 1985 LUNAR & PLANETARY INST. 809, 809 (stating that Phobos and Deimos, the two moons of Mars, may contain somewhat useful amounts of water), *and* Elizabeth Howell, *Europa: Facts About Jupiter's Icy Moon and Its Ocean*, SPACE.COM, https://www.space.com/15498-europa-sdcmp.html (last updated Oct. 26, 2022) (denoting that Europa contains deep oceans under its icy crust and may even support water-based life), *with* Matt Williams, *What Are Gas Giants?*, UNIVERSE TODAY (Aug. 9, 2017), https://www.universetoday.com/33506/gas-giants/ (describing how gas giants like Jupiter may contain Earth-sized amounts of water in the form of vapor).

[205] *See supra* note 204 and accompanying text.

[206] *See, e.g.*, Jet Propulsion Lab'y, *Carbon Worlds May Be Waterless, Finds NASA Study*, NASA (Oct. 25, 2013), https://www.jpl.nasa.gov/news/carbon-worlds-may-be-waterless-finds-nasa-study (reporting that some studies show that Earth-sized planets rich in carbon may lack water).

treaty would attempt to balance the economic potential of water-rich planets or satellites with sustainability provisions meant to ensure the water is not permanently polluted or depleted. If humans hope to ever colonize other celestial bodies in our solar system, we must be careful not to overexploit the resources of a potential future colony.

*3. Asteroids and Comets.* Given the sheer amount of asteroids and comets in this solar system alone, water located on these bodies may often be completely siphoned for commercial use with little to no detrimental effect on the Earth.[207] Therefore, even the complete stripping of a water-rich asteroid or comet will leave plenty more bodies for later use.[208] It should be noted that, if a near-Earth asteroid or comet is somehow broken apart by extraction activities, the debris could hurdle toward our planet and potentially cause severe damage.[209] A potential celestial water law treaty should require that extraction activities occur at a safe distance from Earth and that any potential debris is properly disposed.[210] The vast discrepancies between size, shape, and composition make a one-size-fits-all regulatory framework difficult.[211] These differences, however, can largely be ignored because asteroids and comets are more numerous and less scientifically essential than the more limited planets in our solar system.

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[207] *See, e.g.*, Jason Major, *How Many Asteroids Are Out There?*, UNIVERSE TODAY (Sept. 25, 2012), https://www.universetoday.com/97571/how-many-asteroids-are-out-there/ (reporting that there more than 150 million asteroids in the inner solar system that are larger than 100 meters).

[208] *See id.* (detailing the vast number of potential asteroids).

[209] *See Space Debris and Human Spacecraft*, NASA (May 26, 2021), https://www.nasa.gov/mission_pages/station/news/orbital_debris.html, (reporting that approximately 23,000 pieces of debris larger than a softball are orbiting Earth, traveling at speeds up to 17,500 miles per hour). Even tiny flecks of paint can damage spacecrafts when traveling at thousands of miles per hour, and if large enough asteroid debris were to contact space vehicles or enter Earth, massive damage could result. *See id.* (describing risks associated with space debris).

[210] *See id.* (showing how NASA tracks, plans, and reacts to dangerous debris to protect space equipment and Earth).

[211] *See supra* notes 207–209 and accompanying text.

## VI. CONCLUSION

The international community has attempted to regulate our activity in space since exploration first became feasible. Unfortunately, the legal framework currently in place has become increasingly antiquated, and both private and public actors have already begun to exploit resources in space commercially. Unless the law is developed appropriately, commercialized extraction of space water will be dangerously underregulated, and conflict will be inevitable. A resource as exceedingly valuable as water must be treated thoughtfully by our legal system, regardless of where it is found. Space law must adapt to modern changes in technology, politics, and economics. A sound legal framework will assist humans as we expand into outer space in search of knowledge, prosperity, and water.