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Mining CP

#### Counterplan: The appropriation of resources only from asteroids constrained by “beneficial use” in outer space by private entities is just.

#### Preserving international mechanisms for dispute management and coop solves a tragedy of the commons BUT appropriation is key to incentivizing asteroid mining

Heise, 18 -- Managing Notes Editor, Michigan Journal of International Law

[Jack, "Space, the Final Frontier of Enterprise: Incentivizing Asteroid Mining Under a Revised International Framework, 40 Mich. J. Int'l L. 189, 2018, <https://repository.law.umich.edu/mjil/vol40/iss1/5>, accessed 6-24-21]

III. A New International Framework to Govern the Space Economy

Asteroid mining creates tension within the OST as an activity that is prohibited by the treaty’s terms but largely in line with the treaty’s purpose. As such, the OST should be modified to allow for greater certainty and predictability with respect to asteroid mining. The possibility that asteroid mining could be illegal under international law likely disincentivizes entry into this new endeavor by adding risk and uncertainty. This section outlines what a revised framework should look like. First, the law governing space should remain international in nature to further the interests of peaceful cooperation and facilitate dispute resolution. Second, this framework should present minimal regulatory barriers for entry given the benefits that asteroid mining could bring to all mankind. The development of whaling law provides a use-ful historical example of how norms and rules for the asteroid mining industry could evolve in a way that facilitates efficient governance of this endeavor.

A. The Desirability of an International Framework

The preservation of space as a zone governed by international law, in contrast to a system predicated on national jurisdiction, is desirable in that it promotes peace, facilitates dispute resolution, and allows for more coordinated efforts in addressing issues relevant to all entities operating in space.98 As illustrated by the recent legislative activity in the United States and Luxembourg, the risk of inaction is the resultant domination of the extraterrestrial environment by individual nations rather than by international agreement.99 It would take only minor changes to the OST to resolve some of the ambiguities in the status quo and help bring the benefits of asteroid mining to humanity as a whole. A revision of this treaty rather than a wholesale abandonment of the agreement—whether that abandonment is in fact or merely in practice—would better maintain the international character of space.

The OST reflects Cold War era concerns about the militarization of space.100 Private companies, now ascendant in the growing space economy, simply do not have the military capacity or intention of sovereign governments. In short, the factual backdrop for the signing of the OST has changed. One straightforward means of authorizing private companies to extract space resources would be to revise the OST to clarify that the language in Article II prohibiting national appropriation does not apply to private companies. This could be achieved by simply adding a sentence to the end of Article VI: Under the revised treaty, companies shall remain under the supervision of the countries in which they are based but are not capable of national appropriation by use or occupation. This revision would create something of a line-drawing problem given the partnerships between sovereign space agencies and private companies,101 as well as a possible loophole by which unscrupulous nations could take advantage of the corporate form. Additional safeguards might be necessary to prevent this possibility. This revision could, however, promote peaceful coexistence and uniformity in space law, as well as create certainty as to the legality of asteroid mining by private companies.

Another possibility is to create a new set of international rules for extraction of space resources. Assignment of such property rights could take the form of a first-come, first-served system102 or it could depend on an Earth-side registration process.103 Arguably, extraction is different than the forbidden uses enumerated in the OST in that it is a temporary occupation and not inherently an exercise of military might or the flexing of sovereign muscle.104 While the United States and Luxembourg both interpret asteroid mining to be legal under the existing treaty,105 the promulgation of rules governing the endeavor would add clarity as to the legality of the enterprise. This approach would have the advantage of treating sovereign actors and private companies alike, but would require more substantial revision of the OST, or a new international agreement altogether.

An amended OST or a new treaty governing the extraction of space resources would have the benefit of maintaining the peaceful order of space. While admittedly the product of a different era, the post-national and peaceable foundation of the OST is still desirable in an international environment where many nations are armed to the proverbial nuclear teeth. Peaceful use of outer space is a laudable objective and one served most effectively by international agreement rather than by competing national claims of sovereignty.106

An international system would also facilitate dispute resolution. In a borderless and extra-jurisdictional realm like outer space, a system predicated on national sovereignty and ownership is not instructive as to whose laws—or whose choice of law rules—would control in the event of disputed title of an asteroid or the commission of a tort between two actors from different nations.107 The United Nations Convention on the Law of the Sea (the “UNCLOS”) established the International Tribunal for the Law of the Sea (the “ITLOS”) as a means of providing a venue in which similar disputes could be adjudicated between actors with conflicting legal regimes.108 Outer space has a great deal of similarity to the high seas: both are vast, both are easily treated as a non-appropriable international commons, and both are an in-between space in the sense of existing between bodies of terra firma. 109 An international mechanism like ITLOS ought to be established for resolving space disputes such that parties can seek a neutral arbiter to resolve conflict and laws can be uniformly applied to all entities irrespective of their country of origin.110

Finally, an international system could more easily allow for cooperation between nations and private entities in addressing issues that affect the spacefaring community as a whole. The emergence of space debris and the use of nuclear power sources in space are examples of developing issues that bear on the ease and safety of space travel for all.111 Left to national governments or individual corporations, it seems plausible that lack of oversight could result in a tragedy of the commons.112 By contrast, an international framework is well-suited to consider the problems of the space ecosystem in a way that transcends national boundaries. The UNCLOS Preamble, for example, demonstrates an awareness that “problems of ocean space are closely interrelated and need to be considered as a whole.”113 The compelling interests of peace, uniformity, and cooperation in outer space illustrate the desirability of an international framework to govern asteroid mining; to tweak rather than jettison the existing law. The resulting clarity and predictability would incentivize asteroid mining through reducing legal risk and uncertainty.

A counterproposal to an international framework is a system in which nations assign property rights according to domestic law. It would be possible to take a terra nullius approach to property rights relating to celestial bodies.114 In the Western Sahara advisory opinion, the International Court of Justice defined terra nullius as “a legal term of art employed in connection with ‘occupation’ as one of the accepted legal methods of acquiring sovereignty over territory.”115 For a nation to peaceably acquire sovereignty through occupation, the land must be “terra nullius—a territory belonging to no-one—at the time of the act alleged to constitute the ‘occupation[.]’ ”116 This legal approach was prevalent during the colonial era: explorers and emigrants acting in the name of European sovereigns declared ownership of territory by right of discovery and occupation.117 By authorizing U.S. citizens to extract materials from asteroids through the Commercial Space Launch Competitiveness Act, the United States has started down a path in which property rights in space flow from the jurisdiction of individual sovereign nations.118 Luxembourg has taken a similar approach through its own legislation.119

There are some notable advantages to this approach. The absence of an international policing or enforcement mechanism in space arguably points in favor of regulation by nations with spaceflight capacity. Given the generally acknowledged challenges of enforcing international law,120 one might wonder whether domestic governments might be better positioned to monitor and control private entities based within their borders. A nation-centric approach would also likely incentivize investment in asteroid mining, prompting countries and private actors to invest more aggressively so as not to lose the new space race.121 Assuming, as this Note does, that the development of the asteroid mining industry is in the interest of humanity as a whole, this approach has some appeal.

However, a nation-centric, first possession framework has drawbacks that highlight the desirability of an international governance regime for asteroid mining. First, the experience of colonization was one that prompted conflict between colonizers.122 The peaceful character of space is one of the great achievements of the OST, and it should not be jettisoned. Second, a regime characterized by national actors could spark a race to the bottom with respect to domestic regulation, leading to the same “flags of convenience” problem present in the maritime context as asteroid mining and spaceflight companies relocate to avoid taxes, labor and safety standards, and tort liability.123 An international framework, by contrast, could more easily prevent this problem by facilitating the creation of uniform standards for labor, safety, and liability, making relocation to under-regulated states a less attractive prospect. The drawbacks of a system governed by individual nations, in conjunction with the advantages of a global system illustrated above, point to the desirability of a revised framework governing asteroid mining that is international in character.

B. A System with Minimal Regulatory Barriers to Entry

Whatever approach is chosen to resolve the ambiguities in the OST ought not to be overly restrictive or create burdensome regulatory obstacles for private asteroid mining companies. Substantial regulation could discourage investment and hamper the development of an already capital-intensive and high-risk industry.124 The ideal regulatory system for asteroid mining should maintain an international character for the reasons described in the previous section but should not impose cumbersome regulation on asteroid mining companies at this stage in their development. Rather, allowing norms to develop over time through the resolution of disputes between asteroid mining companies would likely result in the most efficient regulatory system and would be more attractive to companies and nations that might be tempted to disregard the treaty.

The development of whaling custom offers insight into the extent to which “property rights may arise anarchically out of social custom.”125 The analogy to asteroid mining is strong in that both are extractive, high-risk, and capital-intensive industries that take place in what is effectively mare liberum (free sea).126 Herman Melville in Moby-Dick suggests the whaling industry was not governed by a “formal whaling code,” but rather that the “fishermen have been their own legislators and lawyers in this matter.”127 Over time, the custom developed that “I. A Fast-Fish belongs to the party fast to it [and] II. A Loose-Fish is fair game for anybody who can soonest catch it.”128 While Melville concedes that “the commentaries of the whalemen themselves sometimes consist in hard words and harder knocks—the Coke-upon-Littleton of the fist,”129 he also notes that this code is “universal, undisputed law applicable to all cases”130 that prevents “vexatious and violent disputes [arising] between the fishermen.”131 By and large, whalers were able to govern themselves by crafting norms over time that suited their needs.

Robert Ellickson, in his Hypothesis of Wealth-Maximizing Norms, cited the development of whaling norms as supporting the idea that, “when people are situated in a close-knit group, they will tend to develop for the ordinary run of problems norms that are wealth-maximizing.”132 Ellickson defines wealth-maximizing norms as those that minimize the sum of transaction costs and deadweight losses that the members of a group objectively incur.133 Those involved in the group activity are likely to develop rules in a utilitarian manner, preferring “bright-line rules that would eliminate arguments to fuzzy rules that would prolong disputes.”134 The few asteroid mining companies currently in existence are not only a close-knit group under Ellickson’s definition,135 but are best positioned to create rules that will give rise to greater clarity and reduce transaction costs due to their proximity to and soon-to-be-developed experience with the business of asteroid mining. Rules like these would incentivize asteroid mining through greater legal clarity and predictability, thus facilitating the delivery of asteroid mining’s benefits to all mankind.

The UNCLOS ratification debate helps illustrate why a more substantial regulatory regime might prove counterproductive for the international community. One of the primary reasons cited by American opponents of ratification is that accession to the treaty would subject American mining companies “to the whims of an unelected and unaccountable bureaucracy and would force them to pay excessive fees to the International Seabed Authority for redistribution to developing countries.”136 While other commentators have dismissed these concerns as “pure nonsense,” noting that these same companies favor accession to the treaty for the sake of having a clear legal claim to mined minerals,137 it is easy to imagine that a similar scheme of bureaucratic redistribution in the context of asteroid mining might be disregarded by the United States. A decision by nations leading the way on asteroid mining to opt out of a treaty would for all practical purposes cripple future treaty efforts. A key advantage of the proposed regulatory framework described in this Note is a practical one: it would offer the attractive prospect of legal clarity without an international bureaucratic bogeyman, making it more likely that key national stakeholders like the United States would sign on.

Conclusion

Maintaining the international character of outer space while allowing private companies to develop their own governing norms under a slightly revised OST would preempt the outbreak of a new race by sovereign governments to colonize space; create greater certainty for those undertaking the enterprise of asteroid mining; and permit the development of an efficient system tailored to maximize returns on celestial investment. The asteroid mining industry has the potential to confer benefits on all mankind as a means of facilitating space travel, spurring the development of science and technology, mitigating the potential for a calamitous asteroid impact, and facilitating climate change mitigation efforts. As such, it is in the interest of all nations to revise the OST to allow greater certainty in this endeavor. While the “entire unimaginable infinity of creation”138 is still out of reach based on our existing physics and engineering capabilities, asteroid mining is a critical step in beginning to harness celestial resources and more fully explore the intricacies of the universe around us.

#### “Beneficial use” solves every deficit AND provides incentives- appropriation is key

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[Ross, "The doctrine of appropriation and asteroid mining: Incentivizing the private exploration and development of outer space", Oregon Review of International Law 17, 2015, 183-204, accessed 1-9-22]

THE CURRENT INTERNATIONAL TREATIES THAT REGULATE THE OWNERSHIP OF ASTEROIDS FAIL TO INCENTIVIZE THE DEVELOPMENT AND EXPLORATION OF OUTER SPACE

Currently, there are two outdated international treaties that attempt to adjudicate the use and exploration of space. The first treaty, the Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1968), is an archaic but influential agreement ratified by nearly all of the world nations that have successfully launched a shuttle into space.47 The second treaty, The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979), was an attempt to reform some of the principles from the Outer Space Treaty that failed to garner popular acceptance because it was not signed by any nations with national space programs.48 While both treaties attempt to deal with many issues, including the ownership of celestial bodies, both fail to allow for the ownership and development of asteroids by government or private entities. Because they were written during the space race in a period of international distrust, it makes sense that these treaties would be concerned with tempering the race to establish sovereign control over celestial bodies. However, as space exploration shifts from being financed and controlled by national governments to being financed by private industry, these concerns may be less important.49

NASA (National Aeronautics and Space Administration), the U.S. space program, was once a well-funded program. It was the focus of the American people in 1961 when President John F. Kennedy announced before a joint session of Congress the ambitious goal of sending a man to the moon.50 The funding for NASA has dwindled in modern times, and the organization now gets around 0.5% of the federal budget, which is the lowest it has been since Kennedy’s 1961 speech.51

Despite a decrease in national space program funding, corporate space missions are on the rise. In 2010, President Obama proposed that NASA exit the business of flying astronauts from Earth to low Earth orbit and move it to private companies.52 Several companies have stepped up to bat, and corporate space programs now include space tourism, supply missions, and in one case a one-way colonization mission to Mars.53 Corporate interest in space tourism and development demonstrates a strong private commercial interest in space as an industry, which could serve to finance the exploration of space in a period where national governments do not have an active financial interest in space. However, under current international treaties, the ownership of asteroids is prohibited, preventing corporations willing to invest in asteroid mining from having a secure claim.

A. The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (1967) Prohibits Commercial Property Claims

The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies (Outer Space Treaty of 1967), is currently the most influential source of international legislation regarding space law.54 Ratified in 1967 by most of the U.N. nations that had successfully launched a shuttle into space, the Outer Space Treaty of 1967 carries much more weight than the subsequent “Moon Treaty” of 1978.

The Outer Space Treaty of 1967 addresses many different issues, including the military development of space,55 the commission of aid to distressed astronauts,56 international liability for damage caused by space objects,57 and the guaranteed cooperation between state-actors in space.58 While the agreement does an admirable job dealing with many of these issues, it fails to grant any kind of ownership claims over celestial bodies.

Under the Outer Space Treaty of 1967, both government and private entities are prohibited from claiming ownership over celestial bodies. Article II of the agreement explicitly states that, “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.”59

While this statement seems reasonable for preventing a government from, say, claiming the moon, it makes no distinction between the moon and asteroids, planets, meteorites, comets, or other celestial bodies. By preventing the ownership of celestial bodies, even those that have no utility beyond the resources they contain, the treaty effectively destroys the financial gain that could motivate corporations to explore and develop space.

B. The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (1979) Also Fails to Recognize the Need to Provide Ownership Rights in Celestial Bodies

The Agreement Governing the Activities of States on the Moon and Other Celestial Bodies of 1979 (The Moon Treaty) also fails to create property rights in celestial bodies in a way that would incentivize space travel.60 Widely considered a failure, the Moon Treaty was an attempt to reform the Outer Space Treaty of 1967, but it was not ratified by any nation that had successfully launched a shuttle into space.

The Moon Treaty took an idealistic approach to international space law, and if it were more effective it would have established an international regime to carry out its goals.61 The stated goals of the regime were to develop the natural resources of the moon and other celestial bodies, rationally manage those resources, and expand opportunities for parties to use and share the resources.62

While the creation of said regime never occurred, it is clear the drafters of the Moon Treaty clearly foresaw the need for international agreement regarding space resources. Among other things, the Moon Treaty prohibits state parties from developing a military presence on the moon or any other celestial body,63 or excluding other state parties from scientific investigation in space.64 The Moon Treaty also attempts to require that any scientific discoveries useful to mankind be shared with the Secretary-General of the United Nations as well as the public and the international scientific community.65 Unlike the Outer Space Treaty of 1967, the Moon Treaty calls for the U.N. to maintain control over space, and has numerous provisions that call for approval by the Secretary-General of the United Nations before a state party can act.

The Moon Treaty was an attempt to rationally manage space resources by creating an international regime to oversee space development. It fell short, however, by failing to grant substantive commercial rights that would incentivize space travel, making no distinction between planets, comets, asteroids, or space debris with respect to its provisions (like the Outer Space Treaty), and by applying its provisions exclusively to state parties with few references to private action.66

Article 11, paragraph 2 of The Moon Treaty states that “[t]he moon is not subject to national appropriation by any claim of sovereignty, by means of use or occupation, or by any means.”67 Thus, under the Moon Treaty, no entity can lay claim of ownership upon anything in space, regardless of the purpose of the claim. The agreement goes further to say explicitly that the surface, subsurface, and the natural resources in place on the moon will not become property of any state; international intergovernmental or nongovernmental organization; national organization or nongovernmental entity; or of any natural person.68 Put differently, the Moon Treaty explicitly prohibits both private and government actors from making commercial claims over the moon, and since the treaty is meant to apply to any celestial body within the solar system, it follows that the same rule applies to space resources like those found on asteroids. While protecting space resources for science is certainly a laudable goal, the Moon Treaty prevents commercial claims in space, effectively stonewalling space’s development. One can hardly imagine a corporation spending the tremendous amount of money necessary to launch a space mission if the only payoff would be the chance to do research that would ultimately have to be shared with the public, including the corporation’s competitors.

Like the Outer Space Treaty of 1968, the shortcomings of the Moon Treaty demonstrate the need for new international legislation regarding the right to own and use space resources like asteroids. The exploration and development of space could be incentivized and facilitated by a new international treaty that affords property rights to private and government entities in asteroids. The doctrine of appropriation would be a logical governing rule.

III THE APPLICATION OF THE DOCTRINE OF APPROPRIATION TO ASTEROID MINING WOULD INCENTIVIZE CORPORATE SPACE EXPLORATION WHILE PREVENTING WASTE AND ABSTRACT CLAIMS

Like water during the expansion of the American West, the exploration of space can be financed and incentivized by granting rights in resources to those who secure new resources and put them to beneficial use. Some legal scholars have suggested the traditional rule of capture be applied to asteroids,69 or that rights to asteroids be purchased directly from an international agency and owned as chattel.70 However, like water during America’s westward expansion, asteroids are not easily classified under traditional property regimes. Thus, a doctrine of appropriation would be more appropriate for asteroids than a traditional rule of capture or a chattel system, because a system based on the traditional rule of capture or chattel would result in waste, abstract claims, and complicated legal issues.

First, asteroid claims cannot be adjudicated under the traditional rule of capture, or as chattel, because such systems would be incredibly wasteful. As of now, scientists have observed approximately 450,000 asteroids in our solar system.71

But only a fraction of the observable bodies will be cost effective to mine. While it might one day be possible for a single entity to finance several mining missions at once, current costs associated with such a venture would limit almost any space-mining program to one or two asteroids, at least initially.72 The traditional rule of capture could allow an entity to quickly claim multiple asteroids merely by landing on them and planting a flag, without requiring the entity to show it can reasonably use the resources they have claimed. Even worse would be a system where the same corporation could claim asteroids simply by discovering their existence and registering the claim. Allowing this type of unregulated claim would incentivize larger corporations capable of space travel to quickly claim reachable asteroids, but the claims could easily outpace those entities’ realistic expectations on what they could use. Under a traditional rule of capture system, the solar system could be divvied up long before the resources could conceivably be mined. A rule similar to the doctrine of appropriation used for water claims in the United States would alleviate this concern by limiting claims to those where a claimant can show a reasonable beneficial use for the resource.

Another concern posed by the traditional rule of capture or chattel system would be the creation of abstract claims. Some legal scholars have advocated for a system where asteroids would be categorized as chattel, and rights in asteroids would be granted to an entity that could identify an asteroid and register ownership of it with an international agency.73 The advantage of such a system would be that it would allow an international agency to keep track of asteroids, and it would allow for the mapping of the reachable solar system. The problem with this approach, however, is that it would result in abstract claims. If an entity could claim the rights to an asteroid without actual possession, there is nothing to prevent that company from claiming ownership long in advance of any real possibility of landing on it. One of the reasons for creating the doctrine of appropriation was to limit abstract claims over resources that were not being used in any reasonable way. Just as the plaintiffs in Hague had no recourse against the third party who wasted the natural gas reserve, there would be no cause of action against an entity that has the rights to an asteroid, but chooses not to exercise them.74 This may be particularly harmful to society because asteroids contain volatiles that may be essential to creating rocket fuel in space, which, in turn, may be crucial to deep space exploration.

Using asteroid-bound volatiles to make rocket fuel would reduce the cost and increase the range of space exploratory missions, possibly improving the human race’s ability to explore and develop space. Under a system were entities could claim asteroids without actual possession, those entities could exclude others from landing on the asteroids and using such resources, even when such resources are languishing unused in space. To prevent the creation of such abstract claims over asteroids, the doctrine of appropriation could be modified as to only grant rights only to entities who are able to demonstrate both actual possession and beneficial use. This would ensure that asteroids claims are limited to those where the resources are actually being used, thus, maximizing the utility of such celestial bodies to society.

Finally, asteroids cannot be adjudicated under the traditional rule of capture or a chattel system because their unique propensity to collide with other celestial bodies would result in vexing legal issues. Pop culture has popularized the notion of an asteroid crashing into the surface of Earth in movies and books, but interspace collisions may be a real concern. Asteroids are constantly moving through space, and they often crash into other asteroids or space debris, and sometimes onto the surface of planets. So real is the concern that space agencies regularly keep track of NEOs, or Near Earth Objects, which include around 10,000 asteroids large enough to be tracked in space.75 Imagine the scenario in the popular movie Armageddon, where society wrestles with the mechanics of destroying a huge asteroid that is headed straight for Earth.76 It would be strange, indeed, if the situation were further complicated by an entity owning the asteroid. Would the Earth have to compensate the company for the loss of resources, or would the company be forced to assume liability for the damage caused by the collision? What if the asteroid, rather than crashing into Earth, crashed instead into another asteroid owned by different entity? It makes sense that a company with actual possession of an asteroid should have a claim for actual mining equipment destroyed, but it seems unreasonable to treat the entire rock as the entity’s chattel. By limiting asteroid claims under a doctrine of appropriation-like system, society will be saved the headache of attempting to adjudicate such absurd situations.

Because the traditional rule of capture or a chattel system for the ownership of asteroids would result in waste, abstract claims, and absurd legal dilemmas, a modified doctrine of appropriation should replace existing outdated international space law relating to asteroids.

CONCLUSION

The doctrine of appropriation is a reasonable rule for adjudicating asteroid claims, and it could easily be modified to apply to asteroid mining. In the context of water rights, the doctrine of appropriation requires that the claimant be a landowner in order to claim the right to use a water source. It does not make sense, however, for the international community to grant complete ownership over asteroids toa single entity, so the landowner requirement of the rule should be removed. A similar modification would need to be made to the "beneficial use" language of the doctrine.

In the context of water rights, an appropriator obtains rights only to water that he or she can reasonably put to beneficial use. The metals contained in asteroids have a high level of marketability. For that reason, a mining entity could potentially put any amount of obtained metal to beneficial use, in the sense that the resources can be sold. This, however, would defeat the purpose of the rule, which is to limit such unreasonable claims. To ameliorate this problem, the doctrine of appropriation could be modified to define "beneficial use "constructively by providing that beneficial use is assumed for any resources that have been removed from the asteroid that the mining entity can reasonably hope to transport to market in a return journey. With the astronomical cost of undertaking a trip to such an asteroid, this modification would limit mining entities to only what they can carry back, thereby leaving the untapped resources available to other entities capable of making the same trip. Considering the size and profitability of metal deposits on asteroids, this modification to the doctrine of appropriation would not be overly burdensome to corporate interests. At the same time, it would satisfy the economic imperative of promoting the rapid development of asteroid resources.

By changing the landowner requirement, and qualifying the “beneficial use" language, the doctrine of appropriation would be essentially ready for application to asteroid mining claims. The only other changes necessary would be some additional requirements that are common to other space related provisions, like those found in the Outer Space Treaty of 1968. For example, a reporting requirement or clause guaranteeing asylum for other astronauts. A functional rule might read something like this:

State parties or private entities may, upon actual possession, lay claim to natural resources found on or below the surface of asteroids. Rights to appropriate are given in order of seniority, starting with the first party to land on the surface of the asteroid and establish control over the resources, be it water, methane, metal, or any other beneficial substances. A party will be said to have established control over a resource once he has mined the substance and removed it from the asteroid. A senior appropriator may use as much of the asteroid's resources as he can take from the asteroid and put to beneficial use, and may continue to enlarge his share until another junior appropriator begins to appropriate resources from source for beneficial use. For the purposes of this Agreement, "beneficial use “refers to the amount of resources that an appropriator has removed from the asteroid that the actor may reasonably hope to bring home in a return voyage. Resources in excess of what an appropriator can reasonably hope to transport to market in a single voyage do not qualify as having a beneficial use, and are therefore not yet claimed. This means that the extraction of metal from an asteroid does not serve to provide ownership if the appropriator plans on letting the resources languish until another voyage is undertaken to secure the resources and bring them back to Earth. Junior appropriators receive rights in the source of resources (the asteroid) as they find it, and may prevent the senior appropriator from enlarging his share to the junior appropriator’s detriment under a no-injury rule. No state party will attempt to hinder other parties from landing on or using the asteroid, and parties will assist other entities on an asteroid, should they need emergency assistance. Mining claims on asteroids will be reported to the Secretary-General of the United Nations, and state parties agree to release the location of the asteroid, and any scientific findings to the United Nations, the general public, and the scientific community. In the event that the asteroid is on a collision course with any other celestial body, all state parties agree to follow the course of action suggested by the United Nations. Should the United Nations decide the asteroid must be destroyed, no state party may claim liability for resources contained within the asteroid, but not yet captured. This provision applies only to asteroids as classified by the scientific community, and does not apply to planets, comets, meteorites, or any other celestial body not mentioned.

There is no doubt that asteroids may be extremely beneficial to mankind, both as a source of resources and as a jumping-off point to far off locations in space. The human-race has progressed scientifically and technologically to the point that space travel is within commercial reach, and the need for new international laws governing the ownership of space has never been more apparent. The Outer Space Treaty of 1968 made great strides in developing rational rules for space and many of its provisions should be maintained in their original form. However, by allowing ownership of asteroids under the doctrine of appropriation, the international community can incentivize the exploration and development of space in a way that reflects the needs of society in general, without vesting an absolute monopoly in a single entity. The doctrine of appropriation helped drive American westward expansion, and its application to space mining would help drive the human race in its expansion into the space, the final frontier.

#### Even pricing in the costs of mining, the economic benefits outweigh- the counterplan jumpstarts a space economy that spills over to tech innovation, planetary defense, and climate change

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[Jack, "Space, the Final Frontier of Enterprise: Incentivizing Asteroid Mining Under a Revised International Framework, 40 Mich. J. Int'l L. 189, 2018, <https://repository.law.umich.edu/mjil/vol40/iss1/5>, accessed 6-24-21]

A casual Internet search for asteroid mining is likely to turn up sky-high dollar value estimates of asteroids. From Neil deGrasse Tyson saying that asteroid mining will make the first trillionaire,12 to a Goldman Sachs note stating that a single asteroid could contain $25–$50 billion worth of platinum relative to a $2.6 billion cost of an asteroid-grabbing spacecraft,13 to reports that NASA is sending a probe to an asteroid worth $10,000 quadrillion, the profit element of this enterprise is not lost on observers.14 However, these estimates depend on the extraction of metals like platinum, their return to Earth, and sale at the current market price, which, as the aforementioned Goldman Sachs note concedes, would “crater the global price of platinum . . . .”15

Instead of attempting to mine metals, the initial step in asteroid mining proposed by Planetary Resources, the most prominent asteroid mining company in existence today, is to mine asteroids for water.16 By making propellant available in space, asteroid mining “increases the payload capacity of rockets, enables the creation of a space highway with fuel depots located at various points of need throughout the Solar System, and allows spacecraft to travel much farther.”17 In other words, the business of asteroid mining, at least in its infancy, is not about harvesting valuable metals and returning them to Earth,18 but rather about providing raw materials to enable the growth of the space economy.

The impetus to provide in-space materials to the space economy is a matter of physics. Launching an object into space is expensive: SpaceX’s Falcon 9—with the capacity to carry just over 50,000 pounds of payload into low Earth orbit19—costs an estimated $36.7 million to launch and uses between $200,000 and $300,000 in fuel each trip.20 If asteroid mining companies were able to provide some of the propellant in space, that would not only reduce fuel costs, but would reduce the overall launch weight, freeing up more space for payload.21

In sum, should asteroid mining companies be able to provide fuel in space, it could dramatically reduce the costs of transporting rockets and cargo into space—both into low Earth orbit and to more distant targets, like Mars. Having this infrastructure in place could also reduce the long-term costs of the asteroid mining business itself, given that the business model involves launching objects into space. While a 2012 study estimated the total cost of an asteroid retrieval mission at $2.6 billion,22 a substantial reduction in launch costs would result in meaningful savings.23 This model of asteroid mining as a provider of in-space resources, then, can facilitate the growth of the space economy: future forays into space would have their costs greatly reduced by a “space highway with fuel depots.”24

B. Public and Private Actors in the Asteroid Mining Space

Both private companies and the space agencies of sovereign governments bear mentioning in a full discussion of asteroid mining. The role of the private sector in space has expanded substantially in the past decade, leading some commentators to suggest that the private sector has eclipsed the public sector in this arena.25 The asteroid mining industry, as detailed above, both depends upon and tends to facilitate this development. Sovereign space agencies, by contrast, conduct a waning share of activity in space and increasingly operate by way of public-private partnerships as an investor in the space economy.26 This marks an important shift from the factual backdrop of the original OST in that private, independent companies are increasingly taking the wheel.

As explored above, the asteroid mining business facilitates the growth of the space economy by reducing launch costs. However, the future of asteroid mining as a lucrative industry also depends upon the existence and growth of a robust space economy. The symbiotic relationships that could develop between private companies deserves emphasis. The viability of asteroid mining depends on a space economy to which asteroid mining companies can sell fuel and metals: the lack of a current market in asteroid resources should resolve itself “when the space population hits critical mass, demanding infrastructure.”27 For spaceflight companies,28 a crucial component to reduce costs is access to propellant in space.29

Sovereign governments continue to play a significant, albeit declining, role in the space economy. NASA’s share of the national budget decreased from 4.4% in 1966 to 0.5% in 2014.30 Its current strategy centers on partnership with the private space economy: “NASA helps mitigate financial risk, while the private sector conducts research and innovation more efficiently than NASA can . . . .”31 Similarly Luxembourg, which lacks its own space agency,32 opened a 200 million Euro fund in 2016 to bring asteroid mining companies to the country.33 Planetary Resources has availed itself of opportunities offered by both NASA and Luxembourg, performing contract work with the former and securing funding from the latter.34

While sovereign governments do hold some of the purse strings relevant to asteroid mining companies and the space economy as a whole, private companies are increasingly displacing national space agencies.35 A private space economy that is increasingly independent from sovereign governments tends to undermine the factual framework upon which the original OST relied.36 Specifically, Article VI assigns responsibility for nongovernmental entities to national governments, the implicit assumption likely being that private entities would be acting at the behest of a sovereign.37 This concern is increasingly unsubstantiated in an environment in which private, independent companies are ascendant.38

C. Global Benefits of Asteroid Mining

Asteroid mining has the potential to facilitate space travel, an outcome the OST holds to be in the interest of humanity as a whole.39 The potential of asteroid mining to reduce the cost of spaceflight, moreover, could facilitate the growth of the space economy. Asteroid mining thus aligns with another stated purposes of the OST in the sense that an expanded space economy could provide substantial benefits to all mankind.40 First, in seeking to face the challenges posed by space travel, the public sector space race gave rise to numerous technological innovations, ranging from LEDs to emergency blankets to memory foam.41 It seems likely that the private space race would result in a similar degree of innovation, the products of which could benefit people across the globe.

Second, a successful mission to Mars could provide benefits beyond a mere sense of interplanetary accomplishment. NASA suggests that, given the parallels between the formation and evolution of Mars and Earth, a voyage there could help “us learn more about our own planet’s history and future.”42 The scientific advancements from such a mission cannot currently be anticipated and are difficult to predict, but “expand[ing] the frontiers of knowledge” in this manner could well bring benefits to all mankind.43

Third, the development of asteroid mining technology could also help advance asteroid diversion tactics. The development of the technology required to conduct successful asteroid mining operations could “help us to divert any incoming asteroids.”44 This is of great importance since NASA recently eliminated its Asteroid Redirect Mission due to funding cuts;45 NASA’s project was hailed by some scientists as a “critical step in demonstrating we can protect our planet from a future asteroid impact . . . .”46 Asteroid mining could step in and fill an important void. While the probability of an Armageddon-causing impact is low, the effects of an impact would be extremely severe.47 Even some mitigation of this risk as a byproduct of asteroid mining would be a benefit to humanity as a whole.

Finally, reduced launch costs could facilitate measures to combat global climate change. One proposed solution for canceling out predicted increases in average worldwide temperature is to “prevent[] . . . about 1% of incoming solar radiation—insolation—from reaching the Earth. This could be done by scattering into space from the vicinity of Earth an appropriately small fraction of total insolation.”48 Asteroid mining could facilitate such measures in that “[t]echnologies that could greatly decrease the cost of space-launch could make a telling difference in the practicality of all types of spacedeployed scattering systems of scales appropriate to insolation modulation.”49 There are certainly intermediate measures to combat climate change that ought to be taken first, but asteroid mining would facilitate this expedited solution. While some of the benefits of asteroid mining would doubtless accrue primarily to those nations with asteroid mining companies within their borders, the benefits noted in this section—space exploration as a general proposition, technological and scientific development, improvement of asteroid diversion technology, and facilitated means of swiftly countering climate change—would inure substantially to the benefit of all mankind.

#### Asteroids cause extinction

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[Seth, Risk-Risk Tradeoff Analysis of Nuclear Explosives for Asteroid Deflection, Risk Analysis, vol. 39, no. 11, November 2019, p. 2427-2442, <https://doi.org/10.1111/risa.13339>, accessed 1-8-22]

4.3 Severity of Asteroid Collision and Violent Nuclear Conflict

Both asteroid collisions and nuclear weapons detonations involve explosions. Their effects are likewise similar. A primary difference is the absence of ionizing radiation from asteroid collisions.

The standard physical measure for the severity of asteroid collisions and nuclear detonations is the amount of energy released, in units of tons (T), kilotons (KT), or megatons (MT) of TNT equivalent.10 The 2013 Chelyabinsk asteroid collision was about 20m in diameter and 500KT (Brown et al., 2013). This is about double the smallest size believed to be able to cause damage on Earth’s surface; smaller collisions explode harmlessly in the upper atmosphere (Harris et al., 2015). The Chicxulub impactor was an estimated 10km and 108MT (Chapman & Morrison, 1994). Nuclear weapons have been made as small as around 10T (the U.S. W54 weapon) and as large as 50MT (the Soviet Tsar Bomba). There is no physical limit to how large of a nuclear weapon can be built. Common nuclear weapon yields are tens to hundreds of KT, and some have yields of several MT (Kristensen and Norris, 2018a, 2018b, 2018c).

The extent of the damage depends on the amount of energy released and the location on Earth. The 1908 Tunguska collision caused ecological damage across a wide area of Siberia but no significant human harm, though if it had collided four hours later it could have hit Saint Petersburg (Longo, 2007). The locations of asteroid collisions are essentially random, so most occur at ocean locations. The locations of nuclear weapons explosions are not random. In military planning, most nuclear weapons are targeted at either cities or military installations, while test explosions are conducted in remote locations or underground to minimize harm.

The local harms from asteroid collisions and nuclear weapons explosions are relatively simple and well understood. The immediate vicinity is disturbed or destroyed. The Hiroshima and Nagasaki bombings provide indicative data. They were hit with bombs of 15-20KT yield detonated at altitudes around 500-600m (to maximize damage) over the center city. Fatalities were about 120,000 people in Hiroshima and 60,000 in Nagasaki; the Hiroshima number is likely larger due to flatter terrain and drier conditions that enabled the blast and accompanying firestorm to spread (Toon et al., 2007). Nuclear detonations with higher yields and at larger cities could bring many times more fatalities.

In comparison, local effects from asteroid collisions could be larger than single nuclear detonations due to their potential for larger event energies. However, local effects from asteroid collisions would typically see less human harm due to their occurrence at random locations, which are likely to be uninhabited or sparsely populated. Asteroid risk analyses commonly calculate local severity based on the population within a 2 to 4 psi blast overpressure damage area (Canavan, 1993, 1994; Garrick, 2008; Mathias, 2017; Stokes et al., 2003), which is based on studies of nuclear weapons (Glastone, 1962; Glastone & Dolan, 1977).

A sufficiently large asteroid collision at an ocean would cause a tsunami. The current literature lacks consensus on how severe the tsunami would be. Gusiakov et al. (2010) propose that several massive asteroid-caused tsunamis have occurred in recent millennia, but this proposition is hotly disputed (Bourgeois & Weiss, 2009; Goff et al., 2010; Pinter & Ishman, 2008). Other studies suggest that asteroid-caused tsunamis are much less severe (Gisler, Weaver, & Gittings, 2011; Korycansky & Lynett, 2005).

The most severe asteroid collisions and nuclear wars can cause global environmental effects. The core mechanism is the transport of particulate matter into the stratosphere, where it can spread worldwide and remain aloft for years or decades. Large asteroid collisions create large quantities of dust and large fireballs; the fire heats the dust so that some portion of it rises into the stratosphere. The largest collisions, such as the 10km Chicxulub impactor, can also eject debris from the collision site into space; upon reentry into the atmosphere, the debris heats up enough to spark global fires (Toon, Zahnle, Morrison, Turco, & Covey, 1997). The fires are a major impact in their own right and can send additional smoke into the stratosphere. For nuclear explosions, there is also a fireball and smoke, in this case from the burning of cities or other military targets.

While in the stratosphere, the particulate matter blocks sunlight and destroys ozone (Toon et al., 2007). The ozone loss increases the amount of ultraviolet radiation reaching the surface, causing skin cancer and other harms (Mills, Toon, Turco, Kinnison, & Garcia, 2008). The blocked sunlight causes abrupt cooling of Earth’s surface and in turn reduced precipitation due to a weakened hydrological cycle. The cool, dry, and dark conditions reduce plant growth. Recent studies use modern climate and crop models to examine the effects for a hypothetical IndiaPakistan nuclear war scenario with 100 weapons (50 per side) each of 15KT yield. The studies find agriculture declines in the range of approximately 2% to 50% depending on the crop and location.11 Another study compares the crop data to existing poverty and malnourishment and estimates that the crop declines could threaten starvation for two billion people (Helfand, 2013). However, the aforementioned studies do not account for new nuclear explosion fire simulations that find approximately five times less particulate matter reaching the stratosphere, and correspondingly weaker global environmental effects (Reisner et al., 2018). Note also that the 100 weapon scenario used in these studies is not the largest potential scenario. Larger nuclear wars and large asteroid collisions could cause greater harm. The largest asteroid collisions could even reduce sunlight below the minimum needed for vision (Toon et al., 1997). Asteroid risk analyses have proposed that the global environmental disruption from large collisions could cause one billion deaths (NRC, 2010) or the death of 25% of all humans (Chapman, 2004; Chapman & Morrison, 1994; Morrison, 1992), though these figures have not been rigorously justified (Baum, 2018a).

The harms from asteroid collisions and nuclear wars can also include important secondary effects. The food shortages from severe global environmental disruption could lead to infectious disease outbreaks as public health conditions deteriorate (Helfand, 2013). Law and order could be lost in at least some locations as people struggle for survival (Maher & Baum, 2013). Today’s complex global political-economic system already shows fragility to shocks such as the 2007- 2008 financial crisis (Centeno, Nag, Patterson, Shaver, & Windawi, 2015); an asteroid collision or nuclear war could be an extremely large shock. The systemic consequences of a nuclear war would be further worsened by the likely loss of major world cities that serve as important hubs in the global economy. Even a single detonation in nuclear terrorism would have ripple effects across the global political-economic system (similar to, but likely larger than, the response prompted by the terrorist attacks of 11 September 2001).

It is possible for asteroid collisions to cause nuclear war. An asteroid explosion could be misinterpreted as a nuclear attack, prompting nuclear attack that is believed to be retaliation. For example, the 2013 Chelyabinsk event occurred near an important Russian military installation, prompting concerns about the event’s interpretation (Harris et al., 2015).

The ultimate severity of an asteroid collision or violent nuclear conflict use would depend on how human society reacts. Would the reaction be disciplined and constructive: bury the dead, heal the sick, feed the hungry, and rebuild all that has fallen? Or would the reaction be disorderly and destructive: leave the rubble in place, fight for scarce resources, and descend into minimalist tribalism or worse? Prior studies have identified some key issues, including the viability of trade (Cantor, Henry, & Rayner, 1989) and the self-sufficiency of local communities (Maher & Baum, 2013). However, the issue has received little research attention and remains poorly understood. This leaves considerable uncertainty in the total human harm from an asteroid collision or nuclear weapons use. Previously published point estimates of the human consequences of asteroid collisions12 and nuclear wars (Helfand, 2013) do not account for this uncertainty and are likely to be inaccurate.

Of particular importance are the consequences for future generations, which could vastly outnumber the present generation. If an asteroid collision or nuclear war would cause human extinction, then there would be no future generations. Alternatively, if survivors fail to recover a large population and advanced technological civilization, then future generations would be permanently diminished. The largest long-term factor is whether future generations would colonize space and benefit from its astronomically large amount of resources (Tonn, 1999). However, it is not presently known which asteroid collisions or nuclear wars (if any) would cause the permanent collapse of human civilization and thus the loss of the large future benefits (Baum et al., 2019). Given the enormous stakes, prudent risk management would aim for very low probabilities of permanent collapse (Tonn, 2009).

#### Warming turns nuclear war and death spirals make resilience impossible.

Beard et al. 21 [S.J. Beard, Lauren Holt, Asaf Tzachor, Luke Kemp, Shahar Avin, Phil Torres, and Haydn Belfield, \* Centre for the Study of Existential Risk, “Assessing climate change’s contribution to global catastrophic risk,” 2021, *Futures*, Vol. 127, https://doi.org/10.1016/j.futures.2020.102673, Table 1 & Fig. 2 Omitted]

3.1. Climate change and planetary boundaries

While most of the impacts of climate change so far have fallen within the range of what was experienced during the Holocene, the rate of change is faster than in the Holocene and we are now beginning to see climate change push beyond these boundaries. In the latest edition of the planetary boundaries’ framework, climate change is placed in the zone of increasing risk, implying that while this boundary has been breached, there remains some potential for normal functioning and recovery (Steffen et al., 2015). It thus lies between what the authors identify as the ‘safe zone’ and other ‘high risk’ transgressions, such as disruption to the biochemical flows of nitrogen and phosphorus and loss of biosphere integrity.

As part of their discussion of BRIHN Baum and Handoh (2014) note that climate change is the planetary boundary for which the risk to humanity has received most meaningful consideration and they suggest that this attention is deserved. Yet little research attention has been paid to climate change’s extreme or catastrophic effects. Kareiva and Carranza (2018) argue that, despite currently falling outside of the area of high risk, climate change has the clear potential to push humanity across a threshold of irreversible loss by “changing major ocean circulation patterns, causing massive sea-level rise, and increasing the frequency and severity of extreme events… that displace people, and ruin economies.” Even if humanity was resilient to each of these individual impacts, a global catastrophe could occur if these impacts were to occur rapidly and simultaneously.

One scenario that has received comparatively more attention is that of the global climate crossing a tipping point that would trigger environmental feedback loops (such as declining albedo from melting ice or the release of methane from clathrates) and cascading effects (such a shifting rainfall patterns that trigger desertification and soil erosion). After this point, anthropogenic activity may cease to be the main driver of climate change, making it accelerate and become harder to stop (King et al., 2015).

Other scenarios can be discerned from the numerous historical cases in which the modest, usually regional, climatic changes experienced during the Holocene have been implicated in the collapse of previous societies, including the Anasazi, the Tiwanaku, the Akkadians, the Western Roman Empire, the lowland Maya, and dozens of others (Diamond, 2005, Fagan, 2008). These provide a precedent for how a changing climate can trigger or contribute to societal breakdown. At present, our understanding of this phenomena is limited, and the IPCC has labelled its findings as “low confidence” due to a lack of understanding of cause and effect and restrictions in historical data (Klein et al., 2014). Further study and cooperation between archaeologists, historians, climate scientists and global catastrophic risk scholars could overcome some of these limitations by identifying how the impacts of climate change translate into social transformation and collapse, and hence what the impacts of more rapid and extreme climatic changes might be. There is also the potential for larger studies into how global climate variations have coincided with collapse and violence at the regional level (Zhang, Chiyung, Chusheng, Yuanqing, & Fung, 2005; Zhang et al., 2006). However, these need to be interpreted and generalized with care given the differences between pre-industrial and modern societies.

Societies also have a long history of adapting to, and recovering from, climate change induced collapses (McAnany and Yoffee, 2009). However, there are two reasons to be sceptical that such resilience can be easily extrapolated into the future. First, the relatively stable context of the Holocene, with well-functioning, resilient ecosystems, has greatly assisted recovery, while anthropogenic climate change is more rapid, pervasive, global, and severe. Large-scale states did not emerge until the onset of the Holocene (Richerson, Boyd, & Bettinger, 2001), and societies have since remained in a surprisingly narrow climatic niche of roughly 15 mean annual average temperature (Xu, Kohler, Lenton, Svenning, & Scheffer, 2020). A return to agrarian or hunter-gatherer lifestyles could thus have more devastating and long-lasting effects in a world of rapid climate change and ecological disruption (Gowdy, 2020).7 Second, modern human societies may have developed hidden fragilities that amplify the shocks posed by climate change (Mannheim 2020) and the complex, tightly-coupled and interdependent nature of our socio-economic systems makes it more likely that the failure of a few key states or industries due to climate change could cascade into a global collapse (Kemp, 2019).

A third set of plausible scenarios stem from climate change’s broader environmental impacts. Apart from being a planetary boundary of its own, Steffen et al. (2015) point out that climate change is intimately connected with other planetary boundaries (see Table 1). Climate change is thus identified by the authors as one of two ‘core’ boundaries with the potential “to drive the Earth system into a new state should they be substantially and persistently transgressed.” This transformative potential was elaborated on in subsequent work exploring how the world could be pushed towards a ‘Hothouse Earth’ state, even with anthropogenic temperature rises as low as 2 °C (Steffen et al., 2018).

The connection between climate change and biosphere integrity (the survival of complex adaptive ecosystems supporting diverse forms of life) is particularly strong. The IPCC is highly confident that climate change is adversely impacting terrestrial ecosystems, contributing to desertification and land degradation in many areas and changing the range, abundance and seasonality of many plant and animal species (Arneth et al., 2019). Similarly, the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) has reported that climate change is restricting the range of nearly half the world’s threatened mammal species and a quarter of threatened birds, with marine, coastal, and arctic ecosystems worst affected (Diaz et al., 2019). According to one estimate, climate change could cause 15–37 % of all species to become ‘committed to extinction’ by mid-century (Thomas et al., 2004).

Disruption to biosphere integrity can have profound economic and social repercussions, ranging from loss of ecosystem services and natural resources to the destruction of traditional knowledge and livelihoods. For instance, desertification, which threatens a quarter of Earth’s land area and a fifth of the population, is already estimated to cost developing nations 4–8 % of their GDP (United Nations, 2011). Many other rapid regime shifts involving loss of biosphere integrity have been observed, including shifts in arid vegetation, freshwater eutrophication, and the collapse of fish populations (Amano et al. 2020). There is a theoretical possibility of still more profound regime shifts at the global level (Rocha, Peterson, Bodin, & Levin, 2018). However, the contribution of loss of biosphere integrity to GCR is yet to be assessed. Kareiva and Carranza (2018) argue that it is unlikely to threaten human civilization, due both to a lack of plausible mechanisms for this threat and the fact that “local and regional biodiversity is often staying the same because species from elsewhere replace local losses.” However, in their classification of GCRs, Avin et al. (2018) suggest the potential for ecological collapse to threaten the safety boundaries of multiple critical systems with diverse spread mechanisms at a range of scales, from the biogeochemical and anatomical to the ecological and sociotechnological. Note that both these studies were conducted for largely conceptual purposes and should not be taken as rigorous analyses of this risk, this topic warrants further investigation.

3.2. Classifying climate change’s contributions to global catastrophic risk

Climate change’s contribution to GCR goes well beyond its impact on the earth system. Taking Avin et al.’s list of critical systems, we note that previous studies have mostly focused on the effects of climate change on physical and biogeochemical systems (e.g. global temperature and sea-level rise) or the lower-level critical systems that are most directly related to human health and survival (e.g. Heath Stress). However, these represent a very limited assessment of risk as it only accounts for climate change as a direct hazard/ threat and our "ontological" vulnerabilities to it. A more comprehensive risk assessment must consider the higher-order critical systems threatened by climate change passively (through a lack of alternatives) and actively (through intentional design).

The probability of a global catastrophe is higher when sociotechnological and environmental systems are tightly coupled, creating a potential for reinforcing feedback loops. If environmental change produces social changes that perpetuate further environmental change, then this could actively work against our efforts at adaptation. When this change has the potential to produce significant harm, via human vulnerabilities and exposure, we describe such loops as ‘global systems death spirals.’ These spirals could produce self-perpetuating catastrophes, whereby the energy and resources required to reverse or adapt to collapse are beyond the means of dwindling human societies. Feedback loops like this could thus create tipping points beyond which returning to anything like present conditions would become extremely difficult. Global systems would shift to very different states in which the prospects for humanity would likely be bleaker.

In the rest of this section, we explore just one potential spiral, between an ecological system (the biosphere) and two sociotechnological systems (the human food and global political systems). We explore each system and its interactions. Fig. 2 illustrates our model of this spiral.

3.2.1. The human food system

Climate change’s impact on biosphere integrity (discussed in the previous section) could harm the human food system due to loss of ecosystem services, disruption of the cycles of water, nitrogen and phosphates, and changes in the dynamics of plant and animal health (B´elanger & Pilling, 2019). Crossing this planetary boundary is already having severe implications for global food security, including loss of soil fertility and insect-mediated pollination (Diaz et al., 2019).

Systems for the production and allocation of food are already enduring significant stress. The sources of stress include climate change, soil erosion, water scarcity, and phosphorus depletion. The natural resource base, arable land and freshwater upon which food production rely are being degraded. While global food productivity and production has increased dramatically over the past century to meet rising demand from an expanding global population and rising standard of living, these constraints and risks are increasing the vulnerability of our global food supply to rapid and global disruptions that could constitute global catastrophes (Baum, Denkenberger, Pearce, Robock, & Winkler, 2015).

Climate change will further reduce food security in at least three interconnected ways. First, it will affect growing conditions, including direct threats to agricultural yields from heat, humidity, and precipitation in many regions; although initially improving conditions in some (Lott, Christidis, & Stott, 2013). Second, it will increase the range of agricultural pests and diseases (Harvell et al., 2002). Third, it will increase the occurrence of extreme weather events that impair the integrity of food production and distribution networks, from production to harvest, post-harvest, transport, storage, and distribution, thereby increasing our vulnerability and exposure to supply shocks (Bailey et al., 2015). The IPCC estimates, with medium confidence, that at around 2 °C of global warming the risk from permafrost degradation and food supply instabilities will be ‘very high’, while at around 3 °C of global warming the risk from vegetation loss, wildfire damage, and dryland water scarcity will also be very high (Arneth et al., 2019). Very few studies have considered the impacts of 4 °C of global warming or more; however, the IPCC highlighted one study finding that any potential agricultural gains from climate change will be lost by this point and there could be a decrease of 19 % in maize yields and 68 % in bean yields in Africa, an 8 % reduction in yields in South Asia, and a substantial negative impact on fisheries by 2050 (Porter et al., 2014). Furthermore, multiple extreme weather events could disrupt food distribution networks (Bailey and Wellesley, 2017).

While there are opportunities to adapt, disruption to the entire global food system cannot be resolved via food aid alone. Indeed, there is the potential for isolationist or heavy-handed responses that would do more harm than good. Given the high degree of interconnectivity and feedback within the global food system, our initial research suggests that any one of these climate change effects could trigger scenarios that would critically undermine the global food system’s ability to meet the minimum nutrition for well-being; making food security for all an unachievable goal, let alone rise to the challenge of continuing to grow (A. Tzachor, 2019, 2020); this would constitute what Kuhlemann (2019) terms a ‘threshold of significance.’

3.2.2. The global political system

Disrupting the global food system can create and exacerbate conflict and state failure (Brinkman & Hendrix, 2011). However, once again, this needs to be seen against the backdrop of a global political system under stress, with climate change as a significant contributing factor. Climate change influences political systems in many ways, from being a locus of activism and a stimulus for reform to driving rising inequality and population displacement (Arneth et al., 2019; Diffenbaugh & Burke, 2019). This is not a new phenomenon, changes in the climate are believed to have contributed to conflict between people and states throughout human history, driven by resource scarcity, population displacement, and inequality (Lee, 2009; Mach et al., 2019). As part of a comprehensive risk assessment of climate change, King et al. (2015) conducted an extensive literature review on climate change and conflict and used this to inform a series of international wargaming exercises. These found that climate change is expected to increase international conflict while highlighting the role that population displacement, state failure, and water and food insecurity would play in this (see also Mach et al., 2019; Natalini, Jones, & Bravo, 2015).

Quantitative studies of the impact of climate change on violence and conflict have provided more mixed results. A survey of empirical studies by Detges (2017) found that there may be multiple differing trends: extreme weather events appear to have more significant effects on violence than do long-term climate trends, while levels of small-scale conflict and interpersonal violence appear to be more affected than large-scale conflicts and international war. Empirical studies also highlight how climate change’s impact on conflict is predominantly as a risk multiplier and intensifier. Thus, climate change may contribute more by increasing our vulnerability to other conflict-inducing factors, such as loss of livelihood, forced migration, environmental change, and food insecurity, than by acting as a direct cause of conflict (Abel, Brottrager, Cuaresma, & Muttarak, 2019; Hsiang, Burke, & Miguel, 2013; Schubert et al., 2008).8

Of particular relevance to GCR is the effect of climate change on the risk of nuclear war (Parthemore, Femia, & Werrell, 2018). However, to our knowledge, this has never been rigorously assessed, although the potential is certainly there. One recent model of the risk of nuclear war highlighted how varied, and common, incidents with the potential to trigger a nuclear exchange are (Baum, de Neufville, & Barrett, 2018). It outlined 14 different causal pathways to an exchange, including the escalation of conventional wars and international crises, human error, and the emergence of new non-state actors. For all but two of these, they identify historical examples of potentially precipitating incidents, with 60 incidents in total (i.e. a little less than one a year). This suggests that the absence of nuclear war was less due to a lack of potential causes, tan the global political system’s ability to defuse them. Thus, the real significance of climate change may be its capacity to undermine this system: the combination of social, political, and environmental disruption, a lingering sense of global injustice, and rising food, water, and energy insecurity could increase the probability that crises escalate or that false alarms are mistaken for genuine emergencies. This topic needs further research.

3.3. The emergence of a global systems death spiral

Yet, we should not conclude that a nuclear exchange is the only, or even most likely, scenario in which political instability might produce a global catastrophe. Conflict and political instability, even of moderate severity, are themselves two of the most significant drivers of biodiversity loss due to breakdowns in monitoring, governance, and (public and private) property rights (Baynham-Herd, Amano, Sutherland, & Donald, 2018). This closes a potentially reinforcing feedback loop between loss of biosphere integrity, food insecurity and political breakdown.

The mechanisms by which these cascading failures might spread include many of the natural, anthropogenic, and replicator effects identified by Avin et al. (2018), making them harder to contain. At the natural level, climate change involves changes to the global atmospheric and biogeochemical systems and poses other naturally spreading harms, like global ecological collapse. At the anthropogenic level, the global interconnectedness of sociotechnological systems means that while small shocks are easier to recover from, larger shocks can be harder to contain and control. Finally, biological and informational replication can also spread the negative impacts of climate change, from vector-borne diseases and invasive species to climate fatalism and dangerous geoengineering technologies.

Given these numerous spread mechanisms, critical system failures could precipitate global catastrophes. Furthermore, the spiral we have explored is unlikely to be the only set of interlinked systemic disruptions that climate change could initiate (other death spirals could involve bio-insecurity and disease), nor are these the only causal connections between these three systems. Until we understand the nature of such death spirals better, we must act cautiously. We now turn to consider what this would mean.

### 2

Satellites DA

#### Private company focus on satellites key for improved internet connection

**Russon 21** – Technology of Business Reporter, BBC News

[Mary-Ann Russon, “Satellite boom attracts technology giants,” BBC News, 1-29-21, <https://www.bbc.com/news/business-55807150>]

**Sir Richard Branson's rocket company Virgin Orbit has joined a growing list of private companies that can launch satellites into orbit.** Earlier this month, [**10 payloads were lofted**](https://www.bbc.co.uk/news/science-environment-55699262) on the Virgin Orbit rocket, which was launched from under the wing of one of the entrepreneur's old 747 jumbos. Sir Richard is hoping to tap into what is a growing market for small, lower-cost satellites. Space has traditionally had a high barrier to entry. Today, just seven firms make up 75% of the industry, according to Scott Campbell, director at Deloitte Ventures. The space industry is worth $380bn (£285bn), and 60% of that is commercial. But previously, virtually all investment into space was by governments, he says. The first real shift came in 2011 when US President Barack Obama opened up space to businesses, and now more disruption is coming. "The new space race and start-up scene is almost entirely based around space applications: what can I do with data from space?" says Mr Campbell. Traditionally, building and launching a satellite to collect data or enable communications costs hundreds of millions of dollars. The satellites weighed up to six tonnes, were the size of a bus, and would be sent up into geostationary orbit - 35,786km (22,236 miles) above the Earth. But today, you could send up a so-called nanosat weighing just 25-50kg into low-Earth orbit (160-1,000km above Earth) for between $100,000 and $1m. Launch prices are also falling because technology giants are driving demand, says Mark Boggett, chief executive of British venture capital firm Seraphim Capital. "Because tech firms need to launch their own satellites in the thousands [for space internet networks], this further drives down the cost of launch and storage for everyone else," he says. "Whole new industries of businesses can benefit from using this data, essentially democratising space." And of course, if more data is being transmitted back to Earth, someone will need to process it. As a result, Deloitte's Scott Campbell has seen "an explosion of businesses around space". In 2011, there were 234 space-related firms in the UK, rising to 948 companies in 2018. As for satellites, today there are fewer than 9,000 in orbit, according to Seraphim. OneWeb, SpaceX, Planet, Spire and Amazon have put up 10% of these satellites since 2016, but there are 200 smaller firms behind them who are projected to launch 25,000 satellites over the next four years. One smaller firm is nanosat manufacturer NanoAvionics, which announced plans in October to create 400 new jobs in the UK. The firm saw revenues soar 300% in the last year. "In the old days, we launched one satellite that had lots of sensors on it. But today, we've launched hundreds of satellites that have the same one sensor, and that's a much cheaper, repeatable way to do it with more consistent data," says Robin Sampson, head of operations at NanoAvionics UK. PWC UK's space lead Dinesh Patel says the nanosat market is worth only £1.8bn today, but annual growth rates of 20% are projected. Satellites have traditionally been used for communications, TV services and tracking the weather, but new cheaper options are attracting tech giants with **big plans**. Late last year Microsoft announced it was teaming up with Elon Musk's SpaceX. Their partnership, Azure Space, [**plans to combine**](https://news.microsoft.com/transform/azure-space-partners-bring-deep-expertise-to-new-venture/#:~:text=our%20partners%20below.-,SpaceX,via%20SpaceX's%20Starlink%20satellite%20network.) Microsoft's cloud computing services with a global network of satellites. Tom Keane, corporate vice president at Microsoft Azure, tells the BBC that space makes it possible to "move computing to the edge", which means processing data much closer to users' devices than ever before. "The edge could be anywhere - on a device... you're wearing, it could be something you're carrying, it could be in your car," he says. "Space allows you to connect all of that infrastructure together, and then you can use artificial intelligence [like] predictive analytics to gain insights over things that were previously not connected together." Ground stations, which receive data from satellites, are also potential money makers for IT giants. Microsoft Azure's Tom Keane plans to revolutionise ground stations, which are currently "expensive and often monolithic devices" and hook them up to Microsoft's data centres. "Today, in many cases, data [from ground stations] may not be used, or it's certainly not used as broadly as it could be. By connecting that ground station, you take the data from space... to solve problems that you can't solve today." Another opportunity is to connect the **3.8 billion people** in rural areas who **still** do not have an internet connection. SpaceX in particular [**has been launching batches of small satellites**](https://www.bbc.co.uk/news/science-environment-55775977) into orbit since 2018 to form a huge constellation, with the aim of providing **instant broadband anywhere on Earth**. Other businesses will hope to make money by collecting data from nanosats, processing it with artificial intelligence, and using it in innovative ways to solve problems. Firms are looking to collect Earth observation data like weather, heat signatures and atmospheric gas composition to help farmers, for example, and to monitor things like flood defences, traffic and construction sites.

#### Better connection required for telehealth – access suffers without it

**Balasubramanian 20** – M.D, J.D

[ Sai Balasubramanian, “Elon Musk’s Starlink May Potentially Revolutionize Healthcare,” Forbes, 11-27-2020, <https://www.forbes.com/sites/saibala/2020/11/27/elon-musks-starlink-may-potentially-revolutionize-healthcare/?sh=37c89b241e03>]

One of Elon Musk’s relatively recent and most successful ventures is [SpaceX](https://www.spacex.com/mission/), an advanced aerospace technology company with a mission of “Making Humanity Multiplanetary.” The company has celebrated some incredible milestones thus far, from its successful transportation of astronauts into space, to its valiant strides in making rocket technology reusable, and therefore, more cost-efficient. One interesting sub-division of SpaceX is Starlink, which is Musk’s venture into increasing global connectivity. Starlink’s [mission](https://www.starlink.com/) is to use a global network of low Earth orbit satellites to eventually “deliver high speed broadband internet to locations where access has been unreliable, expensive, or completely unavailable.” While satellite internet itself is not a novel concept, most of the traditional systems use **dated technology** that have far less capabilities with regards to internet speed, connectivity, and sustainability. Starlink’s goal is to provide high-speed broadband internet, using cutting-edge satellite systems that will also **not add to** the space pollution created by traditional systems. As of now, the company states that it “is targeting service in the Northern U.S. and Canada in 2020, rapidly expanding to near global coverage of the populated world by 2021.” For many, high-speed broadband internet has incredible implications for connectivity.

One of the most important potential benefits of this technology may be its impact on healthcare and access-to-care in **underserved areas**. For decades, it has been a well-recognized fact that [rural sites in America](https://www.npr.org/sections/health-shots/2019/05/21/725118232/the-struggle-to-hire-and-keep-doctors-in-rural-areas-means-patients-go-without-c) have **poor access** to healthcare. This has not been helped by the rising trend of burnout in healthcare professions, in addition to an ever-growing physician shortage. Experts have articulated that the rise of telemedicine may be one possible solution to help with this issue. Digital platforms that can effectively and safely deliver healthcare without regard to distance or location can potentially provide a viable solution to connecting underserved populations with the care they need. The Covid-19 pandemic has been a great test of this technology. As stay-at-home and social distancing orders became the norm this year due to coronavirus, many healthcare systems, and in-turn patients, often had to rely on telehealth for their care needs. Of course, as telehealth services continue to grow, regulators, healthcare professionals, and innovators will need to keep a close eye on many issues that will inevitably emerge, including data-storage concerns, cybersecurity problems, and most importantly, how best to protect patient privacy and information. The latter is especially concerning, given the growing trends in healthcare [cybersecurity breaches](https://www.forbes.com/sites/saibala/2020/10/17/healthcare-cybersecurity-continues-to-be-a-major-concern/) in the past decade. However, if the appropriate oversight bodies can indeed resolve the issues that telemedicine entails, there is significant opportunity for this technology to make an impact. The market has been receptive of this as well, with telehealth companies gaining massive amounts of utilization and market share just this year alone. In fact, [studies indicate](https://www.globenewswire.com/news-release/2020/07/29/2069575/0/en/Telehealth-Market-to-Exhibit-25-2-CAGR-till-2027-Rising-Preference-for-E-visits-Owing-to-Their-Cost-effectiveness-will-Boost-Growth-Fortune-Business-Insights.html) that the telehealth market is poised for a 25.2% CAGR (compound annual growth rate) and a valuation of nearly $559.5 billion by 2027. Nonetheless, one of the most important limiting factors for telemedicine is connectivity. Due to the same degree of distance that causes healthcare shortages in rural areas, these locations often also lack reliable and high-speed internet connections—the kind that is needed to support stable telemedicine applications and platforms.

This is where Starlink could potentially become a game-changer. If the Starlink service can indeed provide high-speed broadband internet services to rural populations, it may **resolve** yet another piece of the puzzle in increasing access-to-care in underserved communities. Furthermore, the applications of this technology are **endless** and go **far beyond** the American paradigm of rural healthcare. Starlink’s concept, if proven to be scalable and effective, may be able to one day provide internet worldwide, providing the opportunity for underserved communities across the globe to receive much needed medical attention.

#### Telehealth communications solve pandemics

**Monaghesh and Hajizadeh 20** – Department of Health Information Technology Student Research Committee

[Elham Monaghesh and Slireza Haajizadeh, “ The role of telehealth during COVID-19 outbreak: a systematic review based on current evidence,” BMC Public Health, 08-01/2020, <https://link.springer.com/article/10.1186/s12889-020-09301-4>]

Coronaviruses, a genus of the coronaviridae family, may cause illness in animals or humans [[1](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR1), [2](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR2)]. In humans, several coronaviruses are known to cause infections of respiratory ranging from the common cold to more serious diseases. The most recently discovered coronavirus causes coronavirus disease-19 (COVID-19) [[1](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR1)]. The disease originated in Wuhan, China and has kept spreading widely to other regions of the world [[3](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR3)]. Primitive symptoms of COVID-19 contain fever, dry cough, breathing difficulty, and boredom [[4](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR4), [5](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR5)]. Elderly people and those with underlying medical problems such as hypertension, heart problems, and diabetes are more susceptible to develop the disease in its form of most intensive [[1](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR1)]. This universal event has been announced a pandemic by the World Health Organization (WHO) [[6](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR6)]. A **significant factor** in slowing down the transmission of the virus is the “social gap” or social distancing that is made possible by the reduction of person-to-person contact [[7](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR7), [8](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR8)]. To reduce transmission, travel restrictions have been appointed and enforced around the world, and most cities have been quarantined [[9](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR9)]. However, people who are not infected with the COVID-19, especially those who are at greater risk of developing the disease (e.g. Elderly people and those with underlying diseases), should receive daily care without the risk of exposure to other patients in the hospital [[7](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR7)]. Moreover, under strict infection control, unnecessary personnel such as clinical psychiatrists strongly refuse to enter COVID-19 patient’s ward [[10](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR10), [11](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR11)]. Natural disasters and epidemics pose many challenges in providing health care [[12](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR12)]. As a result, unique and innovative solutions are needed to address both the critical needs of patients with COVID-19 and other people who need healthcare service. In this respect, technological advances provide new options [[13](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR13)]. Although the ultimate solution for COVID-19 will be multifaceted, it is one of the effective ways to use existing technologies to facilitate optimal service delivery while minimizing the hazard of direct person-to-person exposure [[7](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR7), [14](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR14)]. The use of telemedicine at the time of epidemic conditions (COVID-19 pandemic) has the potential to improve research of epidemiological, control of disease and management of clinical case [[7](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR7), [14](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR14), [15](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR15)]. The use of telehealth technology is a twenty-first century approach that is both patient-centered and protects patients, physicians, as well as others [[16](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR16), [17](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR17)]. Telehealth is the delivery of health care services by health care professionals, where distance is a critical factor, through using information and communication technologies (ICT) for the exchange of valid and correct information [[18](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR18)]. Telehealth services are renderdusing real-time or store-and-forward techniques [[19](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR19)]. With the rapid evolution and downsizing of portable electronics, most families have at least one device of digital, such as smartphones [[20](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR20)] and webcams that provide communication between patient and healthcare provider [[21](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR21)]. Video conferencing and similar television systems are also used to provide health care programs for people who are hospitalized or in quarantine to reduce the risk of exposure to others and employees [[7](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR7)]. Physicians who are in quarantine can employ these services to take care of their patients remotely [[8](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR8), [22](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR22)]. In addition, covering multiple sites with a tele-physician can **address** some of the challenges of the workforce [[8](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR8), [23](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR23)]. There are various benefits in using technology of telehealth, especially in non-emergency / routine care and in cases where services do not require direct patient-provider interaction, such as providing psychological services [[24](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR24)]. Remote care **reduces** the use of resources in health centers, improves access to care, while **minimizing** the risk of direct transmission of the infectious agent from person to person [[25](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR25)]. In addition to being beneficial in keeping people safe, including the general public, patients and health workers, another important advantage is providing widely access to care givers [[12](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR12)].. Therefore, this technology is an attractive, **effectual and affordable option** [[14](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR14), [26](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR26), [27](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR27)].

Patients are eager to use telehealth, but hindrances still exist [[28](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR28), [29](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR29)]. The barriers of implementing these programs also largely depend on accreditation, payments systems, and insurance [[8](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR8)]. Furthermore, some physicians are concerned about technical and clinical quality, safety, privacy, and accountability [[23](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR23), [30](https://link.springer.com/article/10.1186/s12889-020-09301-4#ref-CR30)]. Telehealth can become a basic need for the general population, health care providers, and patients with COVID-19, especially when people are in quarantine, enabling patients in real time through contact with health care provider for advice on their health problems. Thus, the aim of this review was to identify and systematically review the role of telehealth services in preventing, diagnosing, treating, and controlling diseases during COVID-19 outbreak. We recognized eight studies that presented precious data on telehealth regarding the status of people infected with COVID-19. Telehealth has the capability to incorporate several organizations and situations of health care into one virtual network, led by the central clinic. This network can contain physical locations in different region: central and remote clinics, prevention centers, private clinics, and, private offices of physicians, centers of rehab state and all registered patients within their locations. By using virtual care for very regular, essential medical care, and deferring elective procedures or yearly checkups, we can free up medical staff and equipment required for those who become seriously ill from COVID-19.

Additionally, by not congregating in small spaces like waiting rooms, the ability of the coronavirus to transmission from one person to another were thwart. Keeping people discrete is called “social distancing”. Keeping healthcare staffs discrete from patients and other providers is “medical distancing”. In present time the Telehealth is one strategy to help us carry out this. Telehealth can mobilize all aspects of healthcare potentials to decrease transmission of disease, conduct people to the right level of health care, ensure safety for provide health services online, protect patients, clinicians, and the community from exposure to infection, and finally diminish the burden on the healthcare providers and health system. Some of the telehealth usage cases for patients were control and triage during the outbreak of COVID-19 pandemic, self and distance monitoring, treatment, patients after discharge in health centers (follow-ups) and implementation of online health services. These methods have the potential to **reduce morbidity and mortality during pandemic**. For all healthcare workers and clinicians with mild symptoms can still work remotely with patients, facilitate quick access to medical decision making, seek second opinion for severe cases of patients, exchange cross-border experiences, and offer teleradiology and online trainings for health workers. To provide continued access to necessary health services, telehealth should be a **key weapon** in the fight against the COVID-19outbreak.

#### Next pandemic causes extinction

Bhadelia, 21 -- Center for Emerging Infectious Diseases Policy & Research founding director

[Nahid, MD, MALD, "What do we need to build resilience against the next pandemic?," Center for Emerging Infectious Diseases Policy & Research, 5-18-2021, https://www.bu.edu/ceid/2021/05/18/placeholder-blog-post/, accessed 10-18-2021]

What do we need to build resilience against the next pandemic?

We have lost close to 3.4 million souls to COVID-19 globally over the last year. By some estimates, the real number may be much higher than that because the excess deaths this year are closer to between 7 and 13 million, after accounting for those who died without a diagnosis and those who died because they could not receive timely care for another medical condition. And the pandemic, despite the receding cases in high-resource countries, is nowhere near its end.

Lives lost are the tip of iceberg. We cannot quantify the pain felt by family members remaining behind. Livelihoods and businesses have been devastated. The pandemic’s impact reaches into all recesses of our personal and public lives. It has and will continue to undo decades of work globally on reducing poverty, improving education and health, and empowering women. An IMF study last year showed how, in the five years after major epidemics, income inequality continues to increase in affected countries. Similar trends are already being seen in five countries with the heaviest death tolls from COVID-19. As communities around the world deal with the wreckage of their economies, 95 million more people have been pushed into extreme poverty, with another 200 million predicted to be at risk between now and the year 2030. And this does not even cover the multidimensional impact of poverty. How long will it take for us to recover from this pandemic? How do we take stock and pandemic-proof our communities?

More urgently, COVID-19 may not be the last pandemic we face in our lifetimes. The existential threat of pandemics doesn’t decrease because we are already facing one. In fact, this pandemic worsens the risk for new threats because our effort and resources are depleted, and our surveillance and healthcare systems are overstretched. And because the risk of new infectious diseases seeping into the human population from animal reservoirs is going to continue to grow as we see grow in numbers, require more land, raise more animals, put down more roads, use up more wetlands, and close the gap between us and natural habitats where yet undiscovered viruses lurk. How can we ensure that economically devastated communities coming out of this pandemic recover without worsening the tenuous balance we have with the world around us?

Within our own lifetimes, we have seen the impact of climate change, another existential crisis, transition from something we heard about in news reports to something we experience in our personal lives in the form of changing weather patterns, health effects, increased risk of natural disasters, and rising sea levels. Over the next decades, these factors will exponentially increase the incidence of many infections and change the distribution of others.

And as we tackle these complex problems, new challenges are arising: despite becoming ever more globally connected, our perceptions of reality continue to be disparate. In the deluge of digital data, many among us are falling prey to misinformation and disinformation. The urgency of outbreaks, the shifting scientific knowledge base that comes from tackling emerging pathogens, and political interference have all contributed to the signal getting lost in the noise. The role of disinformation is only going to expand in future emergencies. How do we share timely information in crisis? How do we, in government, science, and public health, earn and build the trust of our communities so ours is the voice they listen to during the fray? How do we listen more carefully to them? How do we involve them in making us all safer?

We can no longer ignore infectious threats on the other side of the world, and we can no longer practice isolationist policies. Because COVID-19 painfully instructed us that outbreaks aren’t just something that happen on the news in distant communities, but instead, they can reach into our homes and rip away our loved ones.

There are moments in history when our actions require collective metacognition and urgency. This has to be one of those moments.

The Center for Emerging Infectious Diseases (CEID) Policy & Research was founded because the time is now for collective transdisciplinary research and response. Every step of the way in this pandemic, the questions haven’t been just scientific, they have also been legal, economic, cultural, and ethical. CEID’s mission is to tug at the threads of all the complex systems that leave us vulnerable to new epidemics and help us answer some of the questions posed above. Through research, collaborative action, community engagement, and training, we hope to find ways to secure us against future global threats. I hope you will reach out with ideas, collaborate with us, and check back often to see where our work is taking us.

We are not rudderless as we head into this future. The COVID-19 pandemic, like recent Ebola virus disease outbreaks and other recent emergencies, has shown that investment in sciences, global collaboration, public health, and health-systems readiness can decrease our vulnerability. We need not only to invest in diagnostics, vaccines, and therapeutics but also find a new way of approaching the problems. My own experience serving as an outbreak responder in multiple emergencies has underscored for me again and again that epidemics fracture us along lines of existing weakness. Because at the terminus of all international surveillance for outbreaks are many communities that do not have access to care. When families can’t access care, we can’t stop cases from becoming clusters, which then become outbreaks. When communities can’t equitably access vaccines, it makes it harder for them to recover, and we continue to suffer collectively from the global economic impact and through the appearance of new variants. When structural racism keeps parts of our communities from being protected, diagnosed, and cared for, all of us are at risk. When it comes to infectious diseases outbreaks, health inequity is a threat to all our survival.

At the launch of our center, we asked public health experts and scientists, “What do we need to do to build resilience against the next pandemic?” Over the next few months, we will continue asking this question to different disciplines, covering those working on health and economic equity, lawmakers, the business community, artists and musicians, and those in media and journalism. Because the solutions, like the questions, require all of us.

## CASE

### 1NC Debris

#### No ‘space war’ – Insurmountable barriers and everyone has an interest in keeping space peaceful

**Dobos 19**

[(Bohumil Doboš, scholar at the Institute of Political Studies, Faculty of Social Sciences, Charles University in Prague, Czech Republic, and a coordinator of the Geopolitical Studies Research Centre) “Geopolitics of the Outer Space, Chapter 3: Outer Space as a Military-Diplomatic Field,” Pgs. 48-49] TDI

Despite the theorized potential for the achievement of the terrestrial dominance throughout the utilization of the ultimate high ground and the ease of destruction of space-based assets by the potential space weaponry, the utilization of space weapons is with current technology and no effective means to protect them far from fulfilling this potential (Steinberg 2012, p. 255). In current global international political and technological setting, the utility of space weapons is very limited, even if we accept that the ultimate high ground presents the potential to get a decisive tangible military advantage (which is unclear). This stands among the reasons for the lack of their utilization so far. Last but not the least, it must be pointed out that the states also develop passive defense systems designed to protect the satellites on orbit or critical capabilities they provide. These further decrease the utility of space weapons. These systems include larger maneuvering capacities, launching of decoys, preparation of spare satellites that are ready for launch in case of ASAT attack on its twin on orbit, or attempts to decrease the visibility of satellites using paint or materials less visible from radars (Moltz 2014, p. 31). Finally, we must look at the main obstacles of connection of the outer space and warfare. The first set of barriers is comprised of **physical obstructions**. As has been presented in the previous chapter, the outer space is very challenging domain to operate in. Environmental factors still present the largest threat to any space military capabilities if compared to any man-made threats (Rendleman 2013, p. 79). A following issue that hinders military operations in the outer space is the predictability of orbital movement. If the reconnaissance satellite's orbit is known, the terrestrial actor might attempt to hide some critical capabilities-an option that is countered by new surveillance techniques (spectrometers, etc.) (Norris 2010, p. 196)-but the hide-and-seek game is on. This same principle is, however, in place for any other space asset-any nation with basic tracking capabilities may quickly detect whether the military asset or weapon is located above its territory or on the other side of the planet and thus mitigate the possible strategic impact of space weapons not aiming at mass destruction. Another possibility is to attempt to destroy the weapon in orbit. Given the level of development for the ASAT technology, it seems that they will prevail over any possible weapon system for the time to come. Next issue, directly connected to the first one, is the utilization of weak physical protection of space objects that need to be as light as possible to reach the orbit and to be able to withstand harsh conditions of the domain. This means that their protection against ASAT weapons is very limited, and, whereas some avoidance techniques are being discussed, they are of limited use in case of ASAT attack. We can thus add to the issue of predictability also the issue of easy destructibility of space weapons and other military hardware (Dolman 2005, p. 40; Anantatmula 2013, p. 137; Steinberg 2012, p. 255). Even if the high ground was effectively achieved and other nations could not attack the space assets directly, there is still a need for communication with those assets from Earth. There are also ground facilities that support and control such weapons located on the surface. Electromagnetic communication with satellites might be jammed or hacked and the ground facilities infiltrated or destroyed thus rendering the possible space weapons useless (Klein 2006, p. 105; Rendleman 2013, p. 81). This issue might be overcome by the establishment of a base controlling these assets outside the Earth-on Moon or lunar orbit, at lunar L-points, etc.-but this perspective remains, for now, unrealistic. Furthermore, **no contemporary actor will risk full space weaponization in the face of possible competition and the possibility of rendering the outer space useless.** No actor is dominant enough to prevent others to challenge any possible attempts to dominate the domain by military means. To quote 2016 Stratfor analysis, "(a) war in space would be devastating to all, and preventing it, rather than finding ways to fight it, will likely remain the goal" (Larnrani 20 16). This stands true unless some space actor finds a utility in disrupting the arena for others.

#### Mis-highlighting of their card. It actually admits impact in more than a century away – even with increasing levels of debris

Chelsea **MuñOz-Patchen, 19** - ("Regulating the Space Commons: Treating Space Debris as Abandoned Property in Violation of the Outer Space Treaty," University of Chicago, 2019, 12-6-2021, https://cjil.uchicago.edu/publication/regulating-space-commons-treating-space-debris-abandoned-property-violation-outer-space)//AW

Debris poses a threat to functioning space objects and astronauts in space, and may cause damage to the earth’s surface upon re-entry.29 Much of the small debris cannot be tracked due to its size and the velocity at which it travels, making it impossible to anticipate and maneuver to avoid collisions.30 To remain in orbit, debris must travel at speeds of up to 17,500 miles per hour.31 At this speed even very small pieces of debris can cause serious damage, threatening a spacecraft and causing expensive damage.32 There are millions of these very small pieces, and thousands of larger ones.33 The small-to-medium pieces of debris “continuously shed fragments like lens caps, booster upper stages, nuts, bolts, paint chips, motor sprays of aluminum particles, glass splinters, waste water, and bits of foil,” and may stay in orbit for decades or even centuries, posing an ongoing risk.34 Debris ten centimeters or larger in diameter creates the likelihood of complete destruction for any functioning satellite with which it collides.35 Large nonfunctional objects remaining in orbit are a collision threat, capable of creating huge amounts of space debris and taking up otherwise useful orbit space.36 This issue is of growing importance as more nations and companies gain the ability to launch satellites and other objects into space.37 From February 2009 through the end of 2010, more than thirty-two collision-avoidance maneuvers were reportedly used to avoid debris by various space agencies and satellite companies, and as of March 2012, the crew of the International Space Station (ISS) had to take shelter three times due to close calls with passing debris.38 These maneuvers require costly fuel usage and place a strain on astronauts.39 Furthermore, the launches of some spacecraft have “been delayed because of the presence of space debris in the planned flight paths.”40 In 2011, Euroconsult, a satellite consultant, projected that there would be “a 51% increase in satellites launched in the next decade over the number launched in the past decade.”41 In addition to satellites, the rise of commercial space tourism will also increase the number of objects launched into space and thus the amount of debris.42 The more objects are sent into space, and the more collisions create cascades of debris, the greater the risk of damage to vital satellites and other devices relied on for “weather forecasting, telecommunications, commerce, and national security.”43 The Space Debris Mitigation Guidelines44 were created by UNCOPUOS with input from the IADC and adopted in 2007.45 The guidelines were developed to address the problem of space debris and were intended to “increase mutual understanding on acceptable activities in space.”46 These guidelines are nonbinding but suggest best practices to implement at the national level when planning for a launch. Many nations have adopted the guidelines to some degree, and some have gone beyond what the guidelines suggest.47 While the guidelines do not address existing debris, they do much to prevent the creation of new debris. The Kessler Syndrome is the biggest concern with space debris. The Kessler Syndrome is a cascade created when debris hits a space object, creating new debris and setting off a chain reaction of collisions that eventually closes off entire orbits.48 The concern is that this cascade will occur when a tipping point is reached at which the natural removal rate cannot keep up with the amount of new debris added.49 At this point a collision could set off a cascade destroying all space objects within the orbit.50 In 2011, The National Research Council predicted that the Kessler Syndrome could happen within ten to twenty years.51 Donald J. Kessler, the astrophysicist and NASA scientist who theorized the Kessler Syndrome in 1978, believes this cascade may be a **century away**, meaning that there is **still time to develop a solution**.52

#### 3.Turn - Risks are overestimated AND private companies ensure that satellite constellations don’t collide – Starlink, Space-X, OneWeb

**Wattles 19**

This card – more recent – describes the ways in which Oneweb and Starlink are learning

Describes private company satellite constellations

Describes the ways in which private companies are create constellations that won’t lead to mass collisions

Describes that create unsafe satellite collisions isn’t profitable for companies – they will do everything in their power to avoid it

[ Jackie Wattles – Reporter, “Space junk poses terrifying threats. Here’s what that means for SpaceX’s megaconstellation,”: CNN Business, 05-30-2019, <https://www.cnn.com/2019/05/30/tech/spacex-starlink-space-junk-debris/index.html>]

SpaceX fired [60 small satellites](http://www.cnn.com/2019/05/15/tech/spacex-starlink-internet-satellites-first-launch/index.html) into orbit last week, the first installment of an internet-beaming [megaconstellation](http://www.cnn.com/2019/05/23/business/spacex-starliner-revenue-business-case/index.html) that the company hopes will grow to include thousands of satellitesin just a few years. Elon Musk’s space company is just one of several with its eyes on beaming broadband to Earth from space. Companies including Amazon [(AMZN)](https://money.cnn.com/quote/quote.html?symb=AMZN&source=story_quote_link) and [OneWeb](http://www.cnn.com/2019/03/13/tech/oneweb-space-debris-junk-low-earth-orbit/index.html) also have similar plans. Looking ahead, [a lot could go wrong for them](http://www.cnn.com/2019/05/23/business/spacex-starliner-revenue-business-case/index.html) — financially or technologically. The most nightmarish calamity, however unlikely, wouldn’t just impact their businesses. It could set back all of human civilization. Imagine this scenario: A single satellite loses power and smashes, uncontrolled, into anothersatellite. They explode, sending plumes of junk charging through space at [23 times](https://www.nasa.gov/mission_pages/station/news/orbital_debris.html) the speed of sound. A piece of that debris slams into another satellite, and it sets off a chain reaction that obliterates everything orbiting in nearby altitudes. In low-Earth orbit, that could include multibillion-dollar networks like Starlink, the [International Space Station](https://www.nasa.gov/mission_pages/station/news/orbital_debris.html), spy satellites and [Earth-imaging](https://www.cnn.com/2015/03/12/tech/mci-planet-labs-doves/index.html) technology. Nothing would remain except an impenetrable graveyard of rubbish that could ground rocket launches for years, maybe even [centuries](https://www.nasa.gov/news/debris_faq.html). In the rarest of situations, [all satellite technology](http://www.bbc.com/future/story/20130609-the-day-without-satellites) could be done for. GPS services wouldcut out; weather tracking technology would be lost, potentially grounding commercial flights worldwide; satellite television and phone service would be gone; the loss in bandwidth couldclog ground-based systems and jam up internet and phone services. From there, [economies](https://phys.org/news/2017-05-space-junk-satellites-economies.html) could be crippled. Such a scenario remains **highly, *highly* unlikely**. Space is huge and satellites are still far from “crowded” up there. But the price of space travel is plummeting, meaning loads of new satellites are going up each year, while the risk of collisions climbs exponentially higher, explains Jonathan McDowell, an astronomer at the Harvard-Smithsonian Center for Astrophysics. “If you put up 10 times the [current total] number of satellites, the risk isn’t just ten times as big — it’s 100 times bigger,” McDowell told CNN Business, describing the risk of a collision. While a single crash might not lead to a doomsday scenario, any incident can create problems. Musk, for his part, says SpaceX takes the problem very seriously: “We are taking great pains to make sure there’s not an orbital debris issue,” he told reporters during a recent conference call. Each active Starlink satellite will be able to automatically dodge traceable pieces of debris headed their way, Musk said. The satellites will also save enough fuel at the end of their lives so that they can intentionally plunge back toward Earth to get out of the way of new devices, SpaceX says. Even if a satellite unexpectedly dies, it’ll be in such a low altitude that gravity will naturally pull it out of orbit in one-to-five years, according to the company. The Federal Communications Commission, which approves satellites for launch, approved of SpaceX’s designs and [said](https://docs.fcc.gov/public/attachments/DA-19-342A1.pdf) its Starlink satellites have “**zero, or near zero” risk of collision** while operational. The first 60 Starlink satellites have now been in orbit about a week, and everything seems to be going smoothly. **No** malfunctioning satellites or failed propulsion systems have been reported.

SpaceX’s debris mitigation plan **matches or exceeds** expert guidelines on best practices. SpaceX competitor OneWeb also has [plans](https://www.cnn.com/2019/03/13/tech/oneweb-space-debris-junk-low-earth-orbit/index.html) to ensure its satellites don’t become spaceborne garbage.With spaceflight growing cheaper and more common, however, businesses with all types of [goals](https://www.nbcnews.com/mach/science/startup-wants-put-huge-ads-space-not-everyone-board-idea-ncna960296) (and little stake in whether or not space stays safe) can afford to send something into orbit. Yet no formal international rules or punishments exist to hold satellite operators accountable for debris creation or general carelessness in space. Some countries, [including the United States](https://www.fcc.gov/document/fcc-launches-review-rules-mitigate-orbital-space-debris), are considering stricter regulations. For now, companies and organizations mostly have to take it upon themselves to research and invest in being good patrons of space. “It’s like any kind of environmental stewardship,” Kelso said. There isn’t always a business incentive to do the right thing, but “you don’t want to reach the point where you’re saying, ‘Gee, I wish we did this earlier.’”

**4.No impact: space junk doesn’t create very many problems**

**Zielinski 10 – contributing writer in science for Smithsonian.com**

[Sarah, “The Problem with Space Junk,” Smithsonian.com, 5-Aug-10,

https://www.smithsonianmag.com/science-nature/the-problem-with-space-junk-32774755/, accessed 6-26-19]

There's a lot of space junk—or, as NASA calls it, "orbital debris"—circling high above our heads: around 19,000 objects larger than 10 centimeters, 500,000 between 1 and 10 cm in size, and tens of millions of pieces smaller than 1 cm. Generally, all that junk isn't much of a problem. If it falls towards Earth, it burns up before it reaches the surface; **no one has ever been harmed by falling space debris and no property on the surface has ever been destroyed.** **Spacecraft are often hit by tiny bits of junk without any damage, and they have shields to protect from larger debris. The likelihood of collision with one of the larger pieces is low.** It does happen, though: in 2009, a U.S. Iridium satellite was destroyed in a collision with a Russian communications satellite that had been deactivated in 1995. How long a piece stays in orbit depends on its altitude: at 600 kilometers, a piece will stay up for only a few years, but at 1,000 km or higher it can orbit the Earth for a century. The build-up of greenhouse gases in the atmosphere is lengthening the time that all that junk stays in the atmosphere, according to new research. At higher altitudes, excess greenhouse gases cools the air and makes it less dense and decreases the drag on the debris. (This doesn't mean greenhouse gases are causing global cooling. The upper altitudes are cooler because greenhouse gases are trapping heat closer to the surface.) Space.com explains: Even though air density at these altitudes is only about a billionth of that of the Earth's surface, it still provides sufficient drag to slow down objects in low-Earth orbit (LEO), causing their eventual re-entry. As the atmospheric density in the thermosphere decreases, however, debris can remain in orbit up to 25 percent longer, said Hugh Lewis, from the School of Engineering Sciences.There are plenty of ideas on how to clean up the skies: laser brooms, giant helium-filled balloons, rockets filled with water, nanosatellites with solar sails, a ballistic orbital debris removal system. (That list doesn't even include any of the proposed solutions from the science fiction world.) DARPA, the Defense Department's research arm, recently added orbital debris cleaners to its wish list. NASA notes that the best way to deal with space junk it "to prevent the unnecessary creation of additional orbital debris." That isn't always a successful goal, however, as the tale of the astronaut who dropped a $100,000 tool kit illustrates. So if you've got a good solution for getting rid of the millions of pieces that are orbiting overhead, NASA or DARPA just might be interested.

**5.Century to solve space debris before impact – plan not key**

**Burns quoting Kessler 13**

[Corrinne, Guardian reporter, 11-15-2013, "Space junk apocalypse: just like Gravity?," Guardian, https://www.theguardian.com/science/blog/2013/nov/15/space-junk-apocalypse-gravity, accessed 8-28-2019]

I asked Donald Kessler himself. A former Nasa astrophysicist, it was Kessler who, in 1978, first proposed that a runaway cascade of collisions was a possibility. He'd been studying meteorite collisions and, out of personal curiosity, decided to apply his algorithm to satellites, too. "The results of those calculations surprised me – I didn't realise it could be that bad," he tells me over a crackly telephone line. (Through the wonder of satellite technology, he is speaking to me from the deck of a boat charting the waters of eastern Europe.) "But it's building up as I expected. The cascade is happening right now – the Kosmos-Iridum collision was the start of the process. It has already begun." Are we in trouble? Not yet. Kessler syndrome isn't an acute phenomenon, as depicted in the movie – it's a slow, decades-long process. "It'll happen throughout the next 100 years – we have time to deal with it," Kessler says. "The time between collisions will become shorter – it's around 10 years at the moment. In 20 years' time, the time between collisions could be reduced to five years." Fortunately, communications satellites are, in the main, situated high up in geosynchronous orbit (GEO), whereas the risk of collisions lies mainly in the much lower, and more crowded, low Earth orbit (LEO).

#### 6.No debris cascades—This ev answers all aff warrants

Fange 2017 (Daniel Von Fange, Web Application Engineer, Founder and Owner of LeanCoder, Full Stack, Polyglot Web Developer, “Kessler Syndrome is Over Hyped”, 5/21/2017, http://braino.org/essays/kessler\_syndrome\_is\_over\_hyped/)

Kessler Syndrome is overhyped. A chorus of online commenters great any news of upcoming low earth orbit satellites with worry that humanity will to lose access to space. I now think they are wrong.

What is Kessler Syndrome?

Here’s the popular view on Kessler Syndrome. Every once in a while, a piece of junk in space hits a satellite. This single impact destroys the satellite, and breaks off several thousand additional pieces. These new pieces now fly around space looking for other satellites to hit, and so exponentially multiply themselves over time, like a nuclear reaction, until a sphere of man-made debris surrounds the earth, and humanity no longer has access to space nor the benefits of satellites.

It is a dark picture.

Is Kessler Syndrome likely to happen?

I had to stop everything and spend an afternoon doing back-of-the-napkin math to know how big the threat is. To estimate, we need to know where the stuff in space is, how much mass is there, and how long it would take to deorbit.

The orbital area around earth can be broken down into four regions.

Low LEO

- Up to about 400km. Things that orbit here burn up in the earth’s atmosphere quickly - between a few months to two years. The space station operates at the high end of this range. It loses about a kilometer of altitude a month and if not pushed higher every few months, would soon burn up. For all practical purposes, Low LEO doesn’t matter for Kessler Syndrome. If Low LEO was ever full of space junk, we’d just wait a year and a half, and the problem would be over.

High LEO - 400km to 2000km. This where most heavy satellites and most space junk orbits. The air is thin enough here that satellites only go down slowly, and they have a much farther distance to fall. It can take 50 years for stuff here to get down. This is where Kessler Syndrome could be an issue.

Mid Orbit - GPS satellites and other navigation satellites travel here in lonely, long lives. The volume of space is so huge, and the number of satellites so few, that we don’t need to worry about Kessler here.

GEO - If you put a satellite far enough out from earth, the speed that the satellite travels around the earth will match the speed of the surface of the earth rotating under it. From the ground, the satellite will appear to hang motionless. Usually the geostationary orbit is used by big weather satellites and big TV broadcasting satellites. (This apparent motionlessness is why satellite TV dishes can be mounted pointing in a fixed direction. You can find approximate south just by looking around at the dishes in your northern hemisphere neighborhood.) For Kessler purposes, GEO orbit is roughly a ring 384,400 km around. However, all the satellites here are moving the same direction at the same speed - debris doesn’t get free velocity from the speed of the satellites. Also, it’s quite expensive to get a satellite here, and so there aren’t many, only about one satellite per 1000km of the ring. Kessler is not a problem here.

How bad could Kessler Syndrome in High LEO be?

Let’s imagine a worst case scenario.

An evil alien intelligence chops up everything in High LEO, turning it into 1cm cubes of death orbiting at 1000km, spread as evenly across the surface of this sphere as orbital mechanics would allow. Is humanity cut off from space?

I’m guessing the world has launched about 10,000 tons of satellites total. For guessing purposes, I’ll assume 2,500 tons of satellites and junk currently in High LEO. If satellites are made of aluminum, with a density of 2.70 g/cm3, then that’s 839,985,870 1cm cubes. A sphere for an orbit of 1,000km has a surface area of 682,752,000 square KM. So there would be one cube of junk per .81 square KM. If a rocket traveled through that, its odds of hitting that cube are tiny - less than 1 in 10,000.

So even in the worst case, we don’t lose access to space.

Now though you can travel through the debris, you couldn’t keep a satellite alive for long in this orbit of death. Kessler Syndrome at its worst just prevents us from putting satellites in certain orbits.

In real life, there’s a lot of factors that make Kessler syndrome even less of a problem than our worst case though experiment.

* Debris would be spread over a volume of space, not a single orbital surface, making collisions orders of magnitudes less likely.
* Most impact debris will have a slower orbital velocity than either of its original pieces - this makes it deorbit much sooner.

I’m removing Kessler Syndrome from my list of things to worry about.

#### 7.Turn – only new private tech can solve for space debris – their card is old

**Giordano 21**

[ David Giordano – Staffer, “Space Debris: Another Frontier in the Commercialization of Space,” Columbia Journal of Transnational Law, 10-31-2021, <https://www.jtl.columbia.edu/bulletin-blog/space-debris-another-frontier-in-the-commercialization-of-space>]

In the Summer of 2021, we got a glimpse of what some hope will be commonplace in the future: space tourism. [While it might be billionaires and their associates for now](https://apnews.com/article/jeff-bezos-space-e0afeaa813ff0bdf23c37fe16fd34265), if this technology is to follow the arc of many other advancements previously reserved for the rich ([cell phones](http://www.cnn.com/2010/TECH/mobile/07/09/cooper.cell.phone.inventor/index.html) and [air travel](https://www.travelandleisure.com/airlines-airports/history-of-flight-costs), for example), eventually there may come a time in the future where space tourism is a realistic financial goal for those of more restricted means. As humanity broaches this great commercial frontier, it will have to clear the great and neglected hurdle of “space junk,” and current trends appear to indicate that industry will shape not only the technology designed to solve the problem, but the policy as well. As satellites and other projectiles blast into orbit, upon collision they can disintegrate into shards, sometimes just centimeters wide, that remain in orbit, risking further collision. Hollywood captured the potential perils of fairly large pieces of space debris in the opening minutes of the 2013 film [Gravity](https://www.warnerbros.com/movies/gravity), where space junk threatens the lives of astronauts on a mission.

Outside the realms of fictional space-thrillers, even the smallest pieces of space junk can present real danger. In 2016, a tiny piece of space junk, believed to be a paint chip or a piece of metal no more than a few thousandths of a millimeter across, [cracked the window of the International Space Station](https://www.popsci.com/paint-chip-likely-caused-window-damage-on-space-station/). In May 2021, a piece of space debris [punctured](https://www.nbcnews.com/science/space/space-junk-damages-international-space-stations-robotic-arm-rcna1067) the robotic arm of the International Space Station. This is seriously concerning, as, [according to the European Space Agency](https://www.esa.int/Safety_Security/Clean_Space/How_many_space_debris_objects_are_currently_in_orbit), there are 670,000 pieces of space debris larger than 1cm and 170,000,000 between 1mm and 1cm in width. Unfortunately, public action and policy struggles to keep up with these risks. International law affords little clarity on the problem, as its control is a novel, [emerging field](https://www.technologyreview.com/2021/08/23/1032386/space-traffic-maritime-law-ruth-stilwell/) with many technical [tracking](https://www.space.com/space-situational-awareness-house-hearing-february-2020.html) and [removal](https://www.scientificamerican.com/article/space-junk-removal-is-not-going-smoothly/#:~:text=There%20is%20no%20doubt%20that,antisatellite%20weapon%2C%E2%80%9D%20she%20says.) challenges. **None** of the existing space treaties [directly tackle the issue](https://oxfordre.com/planetaryscience/view/10.1093/acrefore/9780190647926.001.0001/acrefore-9780190647926-e-70), rendering [responsibility for it](https://scholarship.law.upenn.edu/jil/vol41/iss1/6/) ambiguous. Absent such responsibility, [legal incentives are non-existent](https://www.courthousenews.com/lack-of-space-law-complicates-growing-debris-problem/). [Guidelines are occasionally issued](https://www.unoosa.org/pdf/limited/l/AC105_2014_CRP14E.pdf) by international governing bodies, but provide little legal significance and are [more targeted at the practicalities of tracking and removal](https://scholarship.law.upenn.edu/jil/vol41/iss1/6/). The nation best positioned to notify space actors of collision risks is the United States, and the burden of that task currently falls on the [Department of Defense](https://www.govexec.com/media/d1-mission-space.pdf). However, the Trump administration issued a [directive in 2018](https://www.cnbc.com/2018/06/18/national-space-council-trump-signs-space-debris-directive.html), shifting the responsibility from the DoD to the Department of Commerce, and the [transition has yet to materialize](https://www.govexec.com/media/d1-mission-space.pdf), leaving DoD struggling to keep pace [with increasing commercial activity](https://www.mckinsey.com/industries/aerospace-and-defense/our-insights/look-out-below-what-will-happen-to-the-space-debris-in-orbit). In the face of public paralysis, addressing the problem through industry looks more and more attractive. This has led some to call for a new legal order that still leaves room for government, but reframes who the rules exist to serve. Rather than our current, rudimentary treaty regime designed to [prevent international conflict](https://www.theverge.com/2017/1/27/14398492/outer-space-treaty-50-anniversary-exploration-guidelines), [commentators](https://space.nss.org/wp-content/uploads/NSS-Position-Paper-Space-Debris-Removal-2019.pdf) have called for an additional regime resembling [maritime law](https://www.technologyreview.com/2021/08/23/1032386/space-traffic-maritime-law-ruth-stilwell/) that preserves the interests of a more diverse set of stakeholders, including those in the future that can bring technology and interests to space that may not yet exist. These commentators shun the common conception that space regulation should resemble air-traffic control, which is suited to a narrower set of uses (transport). Under such a “maritime” regime, the light touch of central regulatory bodies, and perhaps their non-existence, is preferred, just as it has been on the seas. This way, individual nations have a degree of flexibility in instituting controls they see fit while leaving room for industry to address problems and introduce new uses for space.

Furthermore, governments seem ready and willing to construct the legal and incentive framework in concert with such private action. [In a joint statement this summer](https://www.gov.uk/government/news/g7-nations-commit-to-the-safe-and-sustainable-use-of-space), G7 members expressed **openness** to resolving the technical aspects of the debris problem with private institutions, and there is some **promising progress**. Apple co-founder [Steve Wozniak](https://www.space.com/apple-cofounder-steve-wozniak-space-junk-company) signaled his plans to address the problem through a new company with a telling name: Privateer Space. Astroscale, a UK-based company, successfully launched a pair of satellites in the Spring of 2021 [that will remove certain space debris from orbit](https://astroscale.com/astroscale-celebrates-successful-launch-of-elsa-d/). Astroscale also [stated their desire](https://astroscale.com/space-sustainability/) to work with governments and international governing bodies to craft policy with private efforts to control the problem top of mind. In light of public policy’s silence on space debris, the initiative of actors like Astroscale involving themselves in policy may be advised, as it could [promote further private investment](https://docs.google.com/document/d/1NCO5Vvjf-kgoZLNfgaOn4bDj_CAfyD1Qhz2oW3TrcHc/edit) in technology for space debris removal. A popular [policy recommendation](https://reason.org/policy-brief/u-s-space-traffic-management-and-orbital-debris-policy/) among experts is the establishment of public-private partnerships, and Astroscale has entered several such agreements including with [Japan](https://www.satellitetoday.com/in-space-services/2021/07/27/space-clean-up-company-astroscale-signs-partnerships-with-mhi-and-japanese-government/) and the [European Space Agency](https://spacenews.com/astroscale-clearspace-aim-to-make-a-bundle-removing-debris/).

### 1NC Corporate Colonialism

#### 1. No spillover- establishing a commons in space does not result in a commons on Earth. You don’t solve the reasons for cap on earth – can’t solve link chain

#### 2. Turn - Capitalism is self-correcting and sustainable---war and environmental destruction are not profitable and innovation solves their impacts

Kaletsky 11 – (Anatole, editor-at-large of *The Times* of London, where he writes weekly columns on economics, politics, and international relations and on the governing board of the New York-based Institute for New Economic Theory (INET), a nonprofit created after the 2007-2009 crisis to promote and finance academic research in economics, Capitalism 4.0: The Birth of a New Economy in the Aftermath of Crisis, p. 19-21 /DOA: 6/28/2018)//JDi

Democratic capitalism is a system built for survival. It has adapted successfully to shocks of every kind, to upheavals in technology and economics, to political revolutions and world wars. Capitalism has been able to do this because, unlike communism or socialism or feudalism, it has an inner dynamic akin to a living thing. It can adapt and refine itself in response to the changing environment. And it will evolve into a new species of the same capitalist genus if that is what it takes to survive. In the panic of 2008—09, many politicians, businesses, and pundits forgot about the astonishing adaptability of the capitalist system. Predictions of global collapse were based on static views of the world that extrapolated a few months of admittedly terrifying financial chaos into the indefinite future. The self-correcting mechanisms that market economies and democratic societies have evolved over several centuries were either forgotten or assumed defunct. The language of biology has been applied to politics and economics, but rarely to the way they interact. Democratic capitalism’s equivalent of the biological survival instinct is a built-in capacity for solving social problems and meeting material needs.

#### 3. Turn - Asteroid mining causes resource abundance that solves the transition to a post-scarcity economy – and makes currency worthless

Williams 20 Matthew S Williams is an author, a writer for Universe Today, and the curator of their Guide to Space section. His works include sci-fi/mystery The Cronian Incident and his articles have been featured in Phys.org, HeroX, Popular Mechanics, Business Insider, Gizmodo, and IO9, ScienceAlert, Knowridge Science Report, and Real Clear Science, with topics ranging from astronomy and Earth sciences to technological innovation and environmental issues. “Asteroid Mining to Shape the Future of Our Wealth” Nov 06, 2020. [Quality Control]

These recommendations address another important issue, which is the impact that the influx of all these resources would have on Earth's economy. By tapping resources that are far more abundant than what exists at home, humanity will be able to transcend its current economic models.

For as long as human beings have conducted trade and businesses, scarcity has been a crucial element. By having abundant sources of necessary resources, humanity could effectively become a post-scarcity species. At the same time, if supply should suddenly exceed demand, then the value of these resources will drop considerably, and all the wealth that is measured using them will also suffer.

As such, it is much more likely that asteroid mining - rather than being a savior to Earth's economy - will be one of the means through which humanity expands into space. Saving planet Earth could very well happen as a result, but only in the long run.

#### 4. Space’s lack of inhabitants and ecological problems solves the vast majority of their criticism – but it segregates the capitalists from ruining Earth and generates enough resources to make the planet’s surface into a Communist utopia

Taylor 19 Chris Taylor is a veteran journalist. Previously senior news writer for Time.com a year later. In 2000, he was named San Francisco bureau chief for Time magazine. He has served as senior editor for Business 2.0, West Coast editor for Fortune Small Business and West Coast web editor for Fast Company. Chris is a graduate of Merton College, Oxford and the Columbia University Graduate School of Journalism. "How asteroid mining will save the Earth — and mint trillionaires." Mashable, 2019, mashable.com/feature/asteroid-mining-space-economy. [Quality Control]

All in all, it’s starting to sound a damn sight more beneficial to the human race than the internet economy is. Not a moment too soon. I’ve written encouragingly about asteroid mining several times before, each time touting the massive potential wealth that seems likely to be made. And each time there’s been a sense of disquiet among my readers, a sense that we’re taking our rapacious capitalist ways and exploiting space.

Whereas the truth is, this is exactly the version of capitalism humanity has needed all along: the kind where there is no ecosystem to destroy, no marginalized group to make miserable. A safe, dead space where capitalism’s most enthusiastic pioneers can go nuts to their hearts’ content, so long as they clean up their space junk.

(Space junk is a real problem in orbital space because it has thousands of vulnerable satellites clustered closely together around our little blue rock. The vast emptiness of cislunar space, not so much.)

And because they’re up there making all the wealth on their commodities market, we down here on Earth can certainly afford to focus less on growing our stock market. Maybe even, whisper it low, we can afford a fully functioning social safety net, plus free healthcare and free education for everyone on the planet.

## SOLVENCY

### 1NC Appropriation Key

#### The “commons” cannot capture any negative impact- ONLY appropriation is key

#### 1. Property rights are key to effective space development- it creates the most efficient system for the development of space

Reinstein, 99 -- JD, Associate, Kirkland & Ellis

[Ezra J., Owning Outer Space, 20 Nw. J. Int'l L. & Bus. 59, 1999, <https://scholarlycommons.law.northwestern.edu/njilb/vol20/iss1/7>, accessed 7-10-21]

IV. PROPOSAL: APPROPRJATIVE OWNERSHIP OF REAL PROPERTY

The ideal legal regime should create maximum incentives for efficient development of space, in recognition of the fact that the potential wealth in space will not drop into our laps.

But as much as commercial development of space would benefit all mankind, it is just as important that the development be controlled. We must learn from mistakes of the past. Any legal regime should guard against inefficient exploitation, waste, and environmental despoliation. Furthermore, space should not become the next Wild West. Destruction and sabotage must be discouraged.

My proposal, which will be developed throughout this essay, is to maximize incentives by giving developers comprehensive property rights. Humanity's welfare demands that we alter the current law to allow real estate ownership -- not just usufructary rights -- to those who would best develop land in space.7 The potential wealth of outer space, in the form of minerals, energy, living space, etc., doesn't do us any good unless we are able to harness it. And, as Jeffrey Kargel, a planetary scientist at the U.S. Geological Survey, has written, "if you want to cross the bridge into the 21st century of space [development], then space must pay its way and give private investors a handsome early return on investment.' 75

What do we mean by "ownership?" Property is commonly recognized as being a "bundle" of disparate rights regulating relations between people with respect to things. The bundle of rights can be unpacked. It includes: the right to possess, the right to use, the right to exclude, and the right to transfer.76 These rights are not on/off affairs; they can each be limited or expanded along a continuum. I use the term "ownership" to describe a state of affairs wherein a person has all four of these rights to their maximum extent with respect to a piece of property.

Current space law ostensibly respects the right to use real property in space and to collect and own its fruits. Historically, this has been known as the usufructary right.77 But the current law doesn't even provide this right freely; it seems to be limited by several clauses of the Outer Space Treaty (e.g. use "for the benefit...of all countries").78

Nor does the OST recognize the right to exclude, as is evidenced by article I's prohibition on appropriating what it recognizes as being "the province of all mankind," the guarantee in the same article of "free access to all areas of celestial bodies," and article XII's requirement that "[a]ll stations [and] installations...shall be open to representatives of other States Parties to the Treaty on a basis of reciprocity." Likewise, as illuminated in the SpaceCorp hypothetical, the prohibition on appropriation seems to negate a long-term right of possession. Without the right to exclude or pos- sess, of course, a legal system need not provide the right to transfer real estate. Anyone else may simply help themselves. In sum, the OST demands that "[n]o State can obtain such possessions as will entitle it to claim ownership or sovereignty over them... There can be no exclusive appro- priation of [celestial bodies] and any part thereof as a result of their 'use'..." 79 Under current law, space cannot be owned.

A new law of space real property must enliven and support all four rights that comprise ownership.

First, there must be a right to permanent possession: barring some ex- traordinary circumstance or the enforcement of a judgment, no one should face dispossession of his real estate on Earth or in space. This rule supplies a needed measure of certainty, in two ways: (1) it's a definite rule and almost any such rule is better than the fogginess of the current regime, and (2) it moves the presumption away from public conversion of private lands, and therefore makes it clear that the OST's statement, that space development must be "for the benefit...of all countries," is a moral exhortation and not a loophole through which the United Nations can dispossess a private party of his site.

Second, I suggest that the right to use be unlimited, except by environmental regulations and the developer's domestic law. This rule is a recognition that humanity's fortune is best enhanced not by a centralized command-and-control system, but by private development making market driven decisions.

Like the right to perpetual possession, the third right -- the right to exclude -- creates the certainty vital to an optimal investment environment. As noted, the current system precludes such a right, for it would certainly run afoul of the prohibition on appropriation and the requirement that there be "free access to all areas of celestial bodies. 80 Without the right to exclude, however, pioneer investors would be at the mercy of free riders. After investing countless hours in (or paying someone else for) a survey of the real estate, after setting up a mining colony at great expense, the pioneer would have no recourse if another party took advantage of the pioneer's research and began a copycat mine on the very same site. So the right to exclude must form a part of the new legal system.

Finally, the right to transfer must accompany the rights of exclusion and perpetual possession. The Coase Theorem of economics tells us that, in a legal environment supportive of bargaining, property rights will be allocated to the party who values them most, i.e. the most efficient user of the property.81 When transaction costs are high enough to prevent bargaining, property rights only end up in the most productively efficient hands if the law happens to initially assign them that way.82 Without any right to transfer, transaction costs are infinite, and no bargaining can occur. In order to avoid the inevitably inefficient solutions of a command-and-control regime of property usage, the right to transfer -- alienability -- must be a part of our system.83

All these rights together -- possession, use, exclusion, and transfer -- make up ownership. And it is ownership that the modem law of space real property needs.

#### 2. Ownership both reduces wasteful use and allows firms to internalize its positive externalities- AND private ownership is the best way to fulfill the common heritage principle

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A. Three Arguments for Ownership

Space is an international zone, and so is, in a sense, the heritage of all humanity. We must not forget, when considering the governance of outer space, that the rules should first and foremost attempt to maximize the benefit to all humankind. So, ideally, celestial bodies should be put to the uses most beneficial to humanity. This is guaranteed by a system that puts land in the hands of those for whom the territory is most profitable. It is a matter of elementary economic theory. Whoever can use a site to humanity's greatest benefit will be the one who can profit most from the site; whoever can profit most from the site will be the one for whom the site is most valuable. Thus the person who can put a site to humanity's greatest benefit will be the one willing to spend the most to own the site.84 This is the bargain theory of economics, and will form the basis for all that follows.

1. Ownership will reduce wasteful use

Ownership, and the attendant right of alienability, would promote the efficient use of space resources.

Again, a hypothetical will help illustrate: a Martian site has been identified as being rich with manganese and silicon. Manganese Mining Co. ("M.M.Co."), interested in the manganese and the manganese alone, decides to send up a team of miners. They begin operations, develop shipping routes, and build a sustainable mining colony.

Without the right of ownership, M.M.Co. has no reason not to blast through and obliterate silicon deposits in order to more quickly uncover the manganese. Furthermore, once the manganese is depleted, there is no reason for them to leave the colony's structures and life support systems intact.

If, on the other hand, space law grants ownership to M.M.Co., then M.M.Co. has incentive to act with greater over-all efficiency. There is incentive to preserve the silicon deposits, because silicon will increase the amount for which Silicon Mining Co. ("S.M.Co.") is willing to purchase the site from M.M.Co. Along similar lines, there is also incentive to preserve the shipping routes and the colony structures and life support systems.

So M.M.Co. receives the benefit of the manganese deposits, and is further rewarded for developing the mining colony and transportation routes, and for preserving the silicon deposits and the colony itself when it sells the site. Because M.M.Co. owned the site, there would be reason for it to prospect for silicon and advertise its presence to interested parties, even though M.M.Co. did not itself have an interest in mining the silicon. Thus S.M.Co. receives the benefit of M.M.Co.'s mineralogical research. S.M.Co. also need not waste resources setting up new routes, mines, and colonies; it could purchase them intact.

Under such a system, people are better rewarded for pioneering efforts and pioneers have incentive to research and preserve that which they find and build. The second-comers receive the benefit of the pioneers' efforts; they need not reinvent the wheel. And, in the end, people on Earth receive the benefit of plentiful manganese and silicon, instead of, as would result in a non-ownership system, just manganese.

2. The right to transfer (alienability) would compensate for positive externalities, thereby creating added incentive to productively develop space

Another advantage of an ownership regime over a use regime can be found in the following hypothetical situation. Suppose the bark of a tree found only deep in the Amazon has cancer-curing properties. Whoever first attempts to harvest the tree bark would be required to build a road to the grove, at tremendous expense. All subsequent pharmaceutical harvesters would have use of the road and consequently be able to turn a much larger profit on the harvested bark. The problem arises, then, that no company would want to make the costly first trek.

What problem does this situation present? Because, since no company would rationally sacrifice itself in the quest for bark, the rest of us will have to do without this life-saving cure. The cause of the problem is an uncompensated positive externality. The right of use does not, by itself, reward the first company for the positive externality it produces, i.e., the road.

One way of rewarding that first company's pioneering effort would be to grant it ownership of the grove. So if company A made the first trek to the grove, the right of ownership would let them decide whether to utilize their exclusive rights to the trees in perpetuity, or to sell the grove to company B for a price that accounts for the expense of building the road. Either way, ownership allows company A to internalize the positive externality.

The same problem exists in space development. The early developers will encounter huge costs, many of which will produce positive externalities (e.g. improved site assaying techniques). In space, as in the jungle, ownership rights can help a company internalize its positive external effects.

#### 3. Ownership also solves their environmentalism offense

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A. Problem: Would additional incentive to develop space unleash environmental havoc?

The current space law governing environmental responsibilities is well-meaning, but not effective enough. It is composed of OST article VII and the Convention on International Liability for Damage Caused by Space Objects (the "Liability Convention"). Article VII of the OST asserts that

[e]ach State Party to the Treaty that launches or procures the launching of an object into outer space is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object...

The Liability Convention limits liability to "fault."

Space environmental law, as it stands under these two treaties, is deeply flawed. The Liability Convention supplies no definition of fault. Both treaties refer only to harms caused by launched objects; while these might be interpreted to include harms caused by unlaunched installations constructed on celestial bodies, such an interpretation is by no means certain. 6 A detailed dispute resolution procedure neither has been described nor has arisen.87 Even if the liability standards fashioned by these two treaties can remedy localized and evidentiarily attributable injuries, they cannot redress those harms which are communal or otherwise unattributable.88

One reason for the inadequacy of the current law might be that its formulators did not correctly foresee the course space development would take. The approach taken by the OST and Liability Convention resonates with the expectation that space activity would remain limited to periodic governmental exploratory missions.89 I suggest two ways to bring space environmental law into the modem space age of ubiquitous commercial activity.

First of all, an approval process, overseen by an international organi- zation, must precede any actual development. This would be similar in function to the International Telecommunications Union ("ITU"), an organization whose most essential duty is to certify that proposed communications satellites will not interfere with each other.90 Any party wishing to engage in the development of space would first present a proposal to the overseeing organization. The organization would then only grant project approval after an environmental review, ensuring that the project complies with environmental standards agreed to by COPUOS.

Making approval dependent on environmental compliance does not destroy the dual goals of efficient usage and wealth maximization. Far from it. Environmental safeguards embody the recognition that environmental degradation harms humanity in very real ways: it can endanger our health and lives, and can ruin a site's utility. It doesn't bear belaboring this point; an example should suffice. Without environmental precautions, a mining corporation might dirty a distant planet's lone water supply, forever deadening a world that might have grown into a great and productive colony. Similar has happened on Earth many times. It can happen in space.

Another way to solve the problem of space environmental ruination is by accepting the right of ownership into our system of space law. It would be a simple but effective step in the right direction. As Lawrence Roberts has written, the current law "is rather damaging from an environmental perspective," because "without a means to secure control of a resource in the ground," i.e. without ownership, "each individual developer will seek to maximize his or her own gain by extracting as much value as quickly as possible without regard to the effect on the communal resource. 9 '

Ownership creates a strong incentive to act with an environmentalist ethos. As owner of a site, SpaceCorp would want to maximize the site's value. This self-interest protects the environment in two related ways. First, because SpaceCorp is not just a squatter on a plot of celestial territory, because it will have more than an expiring usufructary interest, SpaceCorp will avoid wanton despoliation of the land. Despoliation would reduce the value of the property to a purchaser, and thus SpaceCorp's potential revenue. Poor land management might also harm SpaceCorp's current interests, if its actions contaminate its own site to the point that its settlement loses viability. Second, SpaceCorp will avoid ripping through the site; instead, it will either preserve materials it does not use to maximize the site's resale value, or it will itself use the site as fully and efficiently as possible. SpaceCorp will either use the site with preservationist techniques, sparing the site from wasteful destruction, or it will use the site as a conservationist, i.e. wholly and completely, sparing other sites from exploitation. The incentive to use space non-wastefully, discussed above in the context of economic efficiency, clearly has positive environmental repercussions. An owner has an interest in keeping his own site clean, as well as using it with minimal waste and maximum efficiency, because if he wants to eventually sell the property, any despoliation will devalue it. This carrot, because it is self-executing, is better than any stick.

Of course, the right of ownership would not make an environmental violation whose harm extends onto another site less likely -- but it wouldn't make it more likely, either. As under the current system, lawsuits should still be available to remedy harms. Hopefully the requirement of environmental review would act as a prior restraint to prevent these harms. And ownership, by creating an incentive to care about one's own property, protects the interests of others: both those nearby (who instantly feel the effects of more care given to, e.g., waste disposal and water management), and those who come later.