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## 1

#### Space policies are all grounded on representations of outer space and rely on a virtual relationship to space itself produced by mediated technological simulations — this virtual relationship erases territory as threat and risk becomes ubiquitous and requires a drive towards certainty that makes weaponization and conflict inevitable

Bormann 9 (Natalie Bormann – Teaching Professor at Northeastern University. “The lost dimension? A spatial reading of US weaponisation of space” Ch. 5 in *Securing Outer Space: International Relations Theory and the Politics of Space* (2009) pgs. 81-89. <https://books.google.com/books?id=xHt8AgAAQBAJ&pg=PA78&lpg=PA78&dq=virilio+and+%22outer+space%22&source=bl&ots=stoPb9axPg&sig=ACfU3U1kOc7P7ncw4EeHZ-k5I0XgAK6jbw&hl=en&sa=X&ved=2ahUKEwj9isOt_6XjAhWpxVkKHY5SB0MQ6AEwCXoECAkQAQ#v=onepage&q=virilio%20and%20%22outer%20space%22&f=false>, DOA: 8/1/19,)

The representation of a ‘battlefield’ and combat in and through space is certainly contingent in our reading of key documents; for instance, in 2001, the US Space Commission evoked the powerful image that the US is an ‘attractive candidate for another Pearl Harbor’ in space, making the case that weapons in space were needed to counter perceived US vulnerabilities in form of an attack on a virtual US territory and habitat in space. Further examples for the ways in which claims to spatiality are deeply implicated in the forging of US space weaponisation abound; they range from mapping outer space as a ‘final frontier’, the ‘ultimate high ground’, or a space that follows ‘the rules of the road’ for which there is a ‘space road map’. One finds these discourses generally embedded within the logic of the our/their space nexus coupled with the attributes of defending our space versus an offending other that allow for the drawing of the boundaries around space. In 2004, US Strategic Command (2004) contemplated that the first step in space control is identifying exactly what’s in orbit around the Earth, who it belongs to, and its mission. It goes on to claim that space control involves the ability to ‘ensure our use of space while denying the use to our adversaries. And lastly, the US National Space Policy of 1996 narrates a story along similar lines when it proposes the need to assure that ‘hostile forces cannot prevent our use of space’.

How does this matter? I argue that the task of tracing these constructions of spatiality, the meaning-giving of the ‘material’ as reality, is vital for the direction space policies have taken (and will continue to take). There is no spatiality – as produced in the aforementioned examples – that is not organised by the determination of frontiers and boundaries that in turn determine the space ‘inside’ these drawn lines. The virtual function of space weapons is what has allowed for the process of ‘drawing’ and mapping around ‘our space’, and has allowed for ‘stationing’ weapons to control, patrol and defend along a virtual territory with virtual frontiers (the extend of which has been determined by the reach of technology). The construction of a space of a certain kind, and the protection of its ‘new’ frontiers, is what precedes its weaponisation; it is what renders it meaningful. If we assume the construction of space, as opposed to the notion that space can be explored, then we need to ask: what has informed this process? What turns space into a battlefield?

‘[War] now takes place in “aero-electro-magnetic space”. It is equivalent to the birth of a new type of flotilla, a home fleet, of a new type of naval power, but in orbital space’ (Virilio 2000b). What should be clear by now is that material space is pre-constructed. According to Virilio, it is the technical that precedes the spatial. The possibility of new military technology underpins the ways we invent and organise our environment, geographies and landscapes. And it is the effects of technology which produces outer space as a place and authorises contingent action in support of weaponisation. This is not to suggest that technologies have an existence of and on their own and independent of social practice; of course, technology cannot be studied in isolation (see Bourdieu 1992).

The new technologies that allow us to penetrate outer space are producing new domains of experience and new modes of representations and perception. Now, that technology is deeply infatuated with current policies in outer space comes to no surprise, and we find ourselves amidst visions of ‘hyper-spectral imagery’, ‘advanced electro-optical warning sensors’ and ‘space-based radars and lasers’. While I am interested in these technologies of, and soon in, space I am even more interested in the ways in which they augment spatiality and accelerate claims to, and over, spatial authority. Thus, how do these technologies relate to space? Virilio is clear on this: to begin with, and to strip these technologies of their obfuscation, they shrink the planet (and space outwith the planet, the exoatmospheric); and they do so in two ways. First, Virilio insists that technologies lead to a doing away of spatial distance and the geo-strategic reference points that go with it. As the Rumsfeld Commission put it quite aptly, ‘Space enters homes, businesses, schools, hospitals and government offices’ (US Space Commission 2001). To take this notion further and to include the idea of a space-based laser as an example, from any given spot in outer space we will be able to strike and destroy each other at any given point and at any given time. Space stops to matter. The author contends that technologies therefore lead space to suffer from ‘torsion and distortion, in which the most elementary reference points disappear one by one’ (Virilio 1991: 30). The foreseeable deployment of a space-based laser, or, of a kinetic energy interceptor missile (designed to ‘hit and kill’ an incoming hostile missile) are testament to this sense of distortions insofar as space-based weapons would overcome the ‘location problem’ and the need of proximity close to target. As a recent study put it aptly, ‘interceptors fired from orbiting satellites could in principle defend the United States against ICBMs launched from anywhere on Earth [. . .]. Their coverage would not be constraint by geography’. The Transformation Study Report of 27 April 2001, reflects similar sentiments, claiming that ‘Space capabilities are inherently global, unaffected by territorial boundaries or jurisdirectional limitations’ [emphasis added]. It follows from here that, second, technologies ‘reduce-distance-reduce-reaction-time’ – or, as Virilio puts it much more eloquently: not only does technology deterritorialise space it also de-personalises it (and us in our relation to space). No doubt, outer space plays a key role in the ‘real-time’ enhancement of military operations on a global scale. Satellites are not only used to spot targets as they emerge and transmit data but they also allow us to offset weapons that meet these targets anywhere and at any time – instantly. The swiftness blurs if not erases the assumed (and familiar) distinction between offence and defence, which affects our views on spatiality insofar as the image of the battlefield can now become ubiquitous: ‘Every place becomes the front line’ (Virilio 1991: 132). Virilio further clarifies this for us; whereas in the past there was a sense that the ‘front’ is where the tanks are, now, he suggests, we assume that ‘where we find the satellites there is the fourth front’ (Virilio 2002: 3). This is furthered and amplified by the US Air Force vision that calls for ‘prompt global strike space systems with the capability to directly apply force from or through Space against terrestrial targets’ (US Air Force Space Command 2003). And fast forward to the present, the Quadrennial Defense Review of 2006 is clear in its visualisation for Intelligence, Surveillance and Reconnaissance in which it seeks to establish what it aptly terms an ‘unblinking eye’ over the ‘battlespace’ that suggests the instant, constant and ‘persistent surveillance’ of US space in outer space (Quadrennial Defense Review 2006: 55). For Virilio, this process of de-materialisation of space in outer space along these lines can turn into a de-realisation of the objectives of fighting and destruction, and as suggested by the problematic of proximity that this chapter addresses. There is no time left for reflecting on, and responding to, warfare and its mode of targeting, hitting, destruction and killing and, subsequently, no time to invent space differently. The author expresses this as the ‘dematerialization of armaments, de-personalisation of command, de-realisation of the aims of war’ (Virilio 2000: 87).

In an attempt to close the circle to the start of this chapter and draw the line back to the notion of an imagination of outer space as a battlefield – yet devoid of matter – consider the following: creating, fabricating, moulding and representing a field of combat in outer space, ubiquitous and instant in its ability to project modes of destruction and killing, in fact determines, reproduces and locks in the very existence and rationale of the need to defend space against an other, colonise space before a competitor can do so, and divide space into ‘ours’ and ‘theirs’. Put differently, the invention of outer space as a battlefield with the above ‘qualities’ assumes a notion of vulnerability and threat to that space – at any time and from anywhere – before it in fact becomes one. Thus, outer space as a sphere of permanent crisis in effect constitutes and constructs the very reality that it purports to counter. I am referring here to Carol Cohn’s (1987) argument that military projects pre-empt threats and threatening intentions. In the context of past US/Soviet rivalry she contends that, if one asks what the Soviets ‘can’ do, one quickly comes to assume that ‘that is what they intend to do’. In other words, strategic planning and the logic of worst-case-scenarios commit us to assume something will happen. Foucault’s notion of ‘technologies of normalization’ springs to mind by way of summary, and by which the author depicts technology as an essential component in the systematic creation, classification and control of space, habitat and its claim to contingent action drawn from that control over that space.

I began this chapter by implicitly suggesting that the ‘problem’ of outer space lies in the fact that – unlike the ‘blue sky above us’ or the ‘Azure Coast’ in the Virilio quote at the outset – we cannot ‘see’ outer space; unlike the tanks, guns, and soldiers, on ground and air, we cannot ‘see’ the satellites, anti-satellite weapons and space-based lasers. Both the place of outer space and its reference points for space-based weapons are presented to us through that which we can know about them – a particular reality, a certain landscape, and as organised in a meaningful and common-sensical way. This is not to suggest, however, that what we ‘see’ (again, ‘the blue sky’) is not equally dependent on that which we can know about it. According to Virilio, there is ‘little’ physicality in our geographical vision; most of what we ‘see’ is achieved through certain modes of representation, technology, narrating, and so forth. In this sense, this chapter was interested in that which we cannot look at on, and from, Earth and in the distance – yet, which is always-already ‘Earth-bound’ and locally embedded. It was interested in the landscapes and geographies of outer space which we cannot ‘see’ and visualise – yet, which are presented to us and narrated as spatially contingent. And it was concerned with the military technologies in outer space which are ‘Earth-bound, locally embedded, and close to us’ – yet, which provide for the possibility of a mode of war fighting and destruction ‘from the distance’, clean and sanitised, instant and with no time left for reflection.

#### Technological control of outer space is what designs and upholds contemporary imperialism — the United States’ overwhelming satellite infrastructure generates unfettered economic and military domination of the world by means of arranging legal regimes and manufacturing emergencies to secure its role as the benevolent colonizer

Jason Beery, 2016, Ph.D. in Human Geography from University of Manchester, “Terrestrial Geographies in and of Outer Space”, Ch.1 in *The Palgrave handbook of society, culture and outer space*, Eds. Peter Dickens and James S. Ormrod, pgs. 64-67 [entire chapter pgs. 47-70]

While the legal regime was being negotiated, technological developments made human activity in outer space possible. Improved geophysical knowledge of the mechanics of Earth in space and of Earth's orbits brought with it speculation about how these orbits, and outer space more broadly, could be used to facilitate and improved existing activities on Earth, such as military reconnaissance, communication, navigation, scientific research, and weather forecasting. Much of the technological developments came in the form of artificial satellites. As scientific satellites recorded more measurements about the geophysical characteristics of Earth and the orbital environment, satellites were improved, even more potential uses and benefits imagined, and orbits were made into vital resources for terrestrial activities. In turn, these satellite technologies, made possible by the scientific and legal production of outer space, have been central tools in the production of contemporary terrestrial geographies. Over the last several decades, some geographers have employed satellite technology in their research, while others have examined how space technologies have been deployed, (re)shaped economic landscapes and often (re)produced the social relations under which they were developed.

Satellite technology has facilitated scientists' (geographers included) knowledge of terrestrial nature. Through various forms of photographic reconnaissance and measurement, remote sensing satellites have provided vast amounts of information about a wide variety of human and environmental spatial relations and processes, ranging from identifying hazardous environmental risk and impact areas, types vegetation covers, geological formations, water drainage patterns, fisheries, and fertile soils, to monitoring non-human animal movements, human movements, pollution, and land cover change, and to measuring sea-level rise, temperature changes, wind patterns, polar ice coverage, and other meteorological phenomena. Many geographers rely on and create such information in their own research. These images, measurements, and other scientific representations of Earth are contemporary constructions of terrestrial natures. Geographers and others, as demonstrated in this volume, through the creation, interpretation, or application of such representations, have contributed to the production of Earth. In addition, these representations of terrestrial natures have been performed in the spatial practice of many terrestrial activities, as highlighted in the introduction to this chapter, including environmental management, agriculture, urban planning, weather forecasting, military incursions, and resource extraction, all of which have reshaped terrestrial geographies by affecting how terrestrial spaces and natures are organized and incorporated (and by whom) into wider flows and processes.

Just like in previous centuries, these constructions of terrestrial space(s) and nature(s) are tied to existing political, economic, social, and environmental contexts and relations. In this context, satellite technology and outer space are means through which these relations themselves are reproduced. As Warf Observes, 'Although satellites circulate in outer space, their origins and impacts Occur very much on the ground' (2007, p. 385). Warf explains that satellite technologies have reflected terrestrial power relations (i) through large, longstanding imbalances in the number of satellites, especially communications and reconnaissance ones, and in the number of Earth stations between industrialized and developing countries, (ii) through imbalances again between industrialized and developing countries in participation in international satellite organizations, (iii) through re-regulation, neoliberalization, and privatization of major satellite networks such as Intelsat, which are primarily based in industrialized countries, and (iv) through the commodification of satellite-based and enabled products, such as photo imagery. 'Satellites', he argues, 'do not simply reflect the world's geopolitics, they are simultaneously constitutive of it, blurring the boundaries between earth and space' (2007, p. 395). Such imbalances, though, were always part of the outer space project. Even before the first satellites were launched, the US government envisioned potential military and commercial uses for satellite technology and sought to ensure, during the negotiation of the international legal regime, its ability to use orbits and satellites to their maximum political and economic advantage (Beery, 2011).

The US government's political and economic ambitions have played out through the geo-positioning and reconnaissance capabilities of satellites, which have aided the ability to extend and exert power across Earth. For example, the US military utilized these capabilities to carry out anti-terrorism operations in Afghanistan in the early 2000s (Beck, 2003), as it did again to locate and monitor the capture of Osama bin Laden (Whitlock & Gellman, 2013). These technologies offer (the US mostly) an Apollonian view-from-above (Cosgrove, 1994; MacDonald, 2007) that normalizes geopolitical activity through constant surveillance from orbit (MacDonald, 2007, p. 601). This view is also beneficial to the extension of corporate power and profits through the sale of vast numbers of routinely used products that use and rely on geo-positioning and navigation (MacDonald, 2007). Importantly, as MacDonald emphasizes, the use of this powerful satellite gaze to pursue US geopolitical and geoeconomic power is neither happenstance nor a mere Cold War artifact: some US government policy-makers and officials actively sought during the Cold War, and still seek today, to use space technologies to establish US dominance in outer space to dominate Earth (2007).

The gaze of non-military satellites, too, has been implicated in the perpetuation and extension of power and uneven social relations. Despite notions of the neutrality and objectivity of remote sensing and the communication of remotely sensed images, questions of power and control abound. Dodge and Perkins (2009, p. 48) point out, 'resolution and specifications vary, and despite apparent democratisation of access, "shutter control" remains firmly in the hands of powerful government institutions and unaccountable corporations. Beyond questions of what sites should be sensed and with what resolution, the satellite images must be 'grounded — that is, read, decoded, and contextualized — in order to signify anything other than its orbital perspective, to even remotely make sense' (Parks, 2005, p. 113). By 'grounding' images in this way, the ‘neutrality' of the image becomes inseparable from the multiple discourses that surround the sensed object, whether those discourses be ones of race, gender, class, colonialism, power, or some combination of these and others. Even when this remote sensing imagery in the hands of individuals, it may reflect and re-inscribe existing race and class divisions on a cyberlandscape, as was the case in the social online mapping of New Orleans after Hurricane Katrina hit the city in 2005 (Crutcher & Zook, 2009).

Although the production of outer space as a space free of sovereign claims, to which all countries should have access, and in which activities should be conducted for the benefit of humankind suggests equal access, use, and benefit, it has enabled economically developed countries to access outer space when and where they please. As such, they have placed large numbers of satellites in orbit, which have been fundamental in terrestrial political-economic infrastructures, flows and processes dominated by industrialized countries and their private companies over the last 50 years. By enabling military and civilian surveillance, establishing high-speed, long-distance communications networks, aiding navigation of goods and missiles, and forecasting weather for agricultural speculation, these infrastructures, flows, and processes have integrated and reshaped terrestrial geographies this last half-century. Although some developing countries have launched their own satellites into orbit, they have not done so at nearly the same magnitude, nor have they benefitted economically to the same degree (Beery, 2011). In these ways, outer space has been a means to contemporary imperial practices on Earth (Dickens & Ormrod, 2007). Indeed, the production of outer space has been central to the production of terrestrial uneven development over the past 50 years (Beery, 2011). The production of outer space and Earth remains tethered to the reification of terrestrial social relations and hierarchies of power.

## 2

#### The Committee on the Peaceful use of Outer Space ought to:

* **establish an application system for property rights on celestial bodies. Applications and approval of property rights should be granted upon the condition of**
* **open disclosure of data gathered in the exploration of a celestial body**
* **Applications must be publicly announced**
* **Property Rights will be made tradeable between private entities**
* **Property Rights will be set to expire on the conclusion of a successful extraction mission**
* **Private Entities will only be allowed one property right grant per celestial body and cannot have more than one grant at a time**
* **Ban the militarization of outer space**

#### Space-faring nations including but not limited to the United States, the People’s Republic of China, and the Russian Federation should comply to a Code of Conduct that prohibits harmful interference against human-made space objects and reduces practices that contribute to the weaponization of space.

#### Code of conduct plank solves weaponization and space wars – International norms, verification, SSA transparency

Krepon, Hitchens, and Katz-Hyman 11 [February 2011, Michael Krepon is the President of the Henry L. Stimson Center, Theresa Hitchens is Director of the United Nations Institute for Disarmament Research, and Michael Katz-Hyman is a Research Associate at the Henry L. Stimson Center on the Space Security and South Asia Projects “Preserving Freedom of Action in Space: Realizing the Potential and Limits of U.S. Spacepower”, Chapter 20 in “Towards a Theory of Spacepower: Selected Essays”, SM]

We view a code of conduct for responsible spacefaring nations as a necessary complement to a hedging strategy and as an essential element of a space posture that provides for the preservation and growth of U.S. space capabilities. A code of conduct makes sense because, with the increased utilization and importance of space for national and economic security, there is increased need for space operators and spacefaring nations to act responsibly. While some rules and treaty obligations exist, there are many gaps in coverage, including how best to avoid collisions and harmful interference, appropriate uses of lasers, and notifications related to potentially dangerous maneuvers. Because the increased utilization of space for security and economic purposes could lead to friction and diminished space assurance, it serves the interests of all responsible spacefaring nations to establish rules of the road to help prevent misunderstandings, catastrophic actions in space, and grievances. Another reason for pursuing rules of the road is that interactive hedging strategies could generate actions in space that diminish space security by nations concerned about the import of technology demonstrations and flight tests. We have therefore argued that hedging strategies are best accompanied by diplomatic initiatives to set norms that increase the safety and security of satellites vital to U.S. national and economic security. A code of conduct would serve these purposes. No codes of conduct or rules of the road are self-enforcing. Despite traffic laws, some drivers still speed. But having rules of the road reduces the incidence of misbehavior and facilitates action against reckless drivers. We acknowledge that there are no traffic courts for misbehavior in space, but we nonetheless argue that having agreed rules of the road in this domain will also reduce the incidence of misbehavior, while facilitating the isolation of the miscreant as well as the application of necessary remedies. Without rules, there are no rule breakers. Traditional arms control was devised to prevent arms racing between the superpowers. With the demise of the Soviet Union, concerns over arms racing have been replaced by concerns over proliferation and nuclear terrorism. Cooperative threat reduction initiatives have been designed to deal with contemporary threats. These arrangements have taken myriad forms, including rules of the road to prevent proliferation. Since the flight-testing, deployment, and use of weapons in space would increase security concerns, and since security concerns are drivers for proliferation, agreed rules of the road for space could supplement other codes of conduct that seek to prevent proliferation. Codes of conduct supplement, but differ from, traditional arms control remedies. Skeptics of new arms control treaties to prevent ASAT tests and space-based weapons argue that it would be difficult to arrive at an agreed definition of space weapons, and that even if this were possible, it would be hard to monitor compliance with treaty obligations. A code of conduct would focus on responsible and irresponsible activities in space that, in turn, would obviate the need for an agreed definition of space weapons. For example, a code of conduct might seek to prohibit the deliberate creation of persistent space debris. Again, our focus is on behavior, not an agreed definition of space weapons. Moreover, the deliberate creation of persistent space debris is very hard to hide and can be monitored by existing technical means. The United States has championed codes of conduct governing militaries operating in close proximity at sea in the 1972 Incidents at Sea Agreement, as well as in the air and on the ground, in the 1989 Dangerous Military Practices Agreement. More recently, the United States has championed codes of conduct to reduce proliferation threats, including The Hague Code of Conduct (2002) and the Proliferation Security Initiative (2003). The 2001 Space Commission Report chaired by Donald Rumsfeld also endorsed rules of the road for space. 8 Codes of conduct typically take the form of executive agreements in the United States. They can begin as bilateral or multilateral compacts and they can expand with subsequent membership. Codes of conduct are either an alternative to, or a way station toward, more formal treaty-based constraints that often take extended effort. 9 Some rules of the road, formal agreements, and elements of a code of conduct already exist for space. The foundation document that defines the responsibilities of spacefaring nations is the Outer Space Treaty (1967). Other key international agreements and institutions include the Liability Convention and the International Telecommunications Union. There is growing sentiment among space operators to develop and implement several key elements of a code of conduct, including improved data sharing on space situational awareness; debris mitigation measures; and improved space traffic management to avoid unintentional interference or collisions in increasingly crowded orbits. A more comprehensive code of conduct might include elements such as notification and consultation measures; provisions for special caution areas; constraints against the harmful use of lasers; and measures that increase the safety, and reduce the likelihood, of damaging actions against manmade space objects, such as harmful interference against satellites that create persistent space debris. Key elements of a code of conduct are useful individually, but they are even more useful when drawn together as a coherent regime. Situational Awareness Space situational awareness (SSA)—the ability to monitor and understand the constantly changing environment in space—is one of the most important factors in ensuring the safety and security of all operational satellites and spacecraft. SSA provides individual actors with the ability to monitor the health of their own assets, as well as an awareness of the actions of others in space. Transparency measures can be particularly helpful in providing early warning of troubling developments and in dampening threat perceptions. One measure of U.S. spacepower and space prowess is America's unparalleled space situational awareness capabilities. Thus, the United States is in a position to become a leader in building space transparency, which is the foundation stone of norm setting and rules of the road in space.

#### First counterplan plank establishes international norms for safe extraction of resources on celestial bodies while increasing R&D in outer space.

**Steffen 21** [Olaf Steffen, Olaf is a scientist at the Institute of Composite Structures and Adaptive Sytems at the German Aerospace Center. 12-2-2021, "Explore to Exploit: A Data-Centred Approach to Space Mining Regulation," Institute of Composite Structures and Adaptive Systems, German Aerospace Center, [https://www.sciencedirect.com/science/article/pii/S0265964621000515 accessed 12/12/21](https://www.sciencedirect.com/science/article/pii/S0265964621000515%20accessed%2012/12/21)] Adam

4. The data-centred approach to space mining regulation

4.1. Core description of the regulatory regime and mining rights acquisition process

The data gathered in the exploration of a [celestial body](https://www.sciencedirect.com/topics/social-sciences/astronomical-systems) is not only of value for space mining companies for informing them whether, where and how to exploit resources from the body in question, but also for science. The irretrievability of information relating to the solar system contained in the body that will be lost during resource exploitation carries a value for humanity and future generations and can thus be assigned the characteristic of a common heritage for all mankind as invoked in the Moon Agreement. This characteristic makes exploration data an exceptional and unique candidate for use in a mechanism for acquiring mining rights because its preservation is of public interest and its disclosure in exchange for exclusive mining rights does not place any additional burden on the mining company. The following principles would form the cornerstones of the proposed regulatory regime and rights acquisition mechanism based on exploration data:

Without preconditions, no entity has a right to mine the resources of a celestial body.

An international regulatory body administers the existing rights of companies for mining a specific celestial body.

Mining rights to such bodies can be applied for from this international regulatory body, with applications made public. The application expires after a pre-set period.

Mining rights are granted on the provision and disclosure of exploration data on the celestial body within the pre-set period, proposedly gathered in situ, characterising this body and its resources in a pre-defined manner.

The explorer's mining right to the resources of the celestial body is published by the regulatory body in a mining rights grant.

The data concerning the celestial body are made public as part of the rights grant within the domain of all participating members of the regulatory regime.

The exclusive mining rights to any specific body are tradeable.

The scope of the regulatory body with respect to the granting of mining rights is not revenue-oriented.

The international regulatory body would thus act as a curator of a rights register and an attached database of exploration data. The concept is superficially comparable to patent law, where exclusive rights are granted following the disclosure of an invention to incentivise the efforts made in the development process. In the following section, the characteristics of such a regulatory regime are further discussed with respect to the formation of [monopolies](https://www.sciencedirect.com/topics/social-sciences/monopolies), market dynamics, conflict avoidance, inclusivity towards less developed countries and the viability of implementation.

4.2. Discussion and means of implementation

The proposed regulatory mechanism has advantages both from a business/investor and society perspective. First, it prevents already highly capitalised companies from acquiring exploitation rights in bulk to deny competitors those objects that are easiest to exploit or most valuable, which would otherwise be possible in any kind of pay-for-right mechanism and could result in preventing market access to smaller, emerging companies. Thus, early monopoly formation can be avoided.

The use of data disclosure for the granting of mining rights ensures the scientific community has access to this invaluable source of information. In this way, space mining prospecting missions can lead to a boost in research on small celestial bodies at a speed unmatchable by pure government/agency funded science probes. This usefulness to the scientific community could lead to sustained partnerships between prospecting companies and scientific institutions and could even provide a source of funding for the companies through R&D grants and public-private partnerships. The results of the exploration efforts contribute to research on the formation of planets and the history of the solar system and provide valuable insight for space defence against asteroids. The transition of exploration from a tailored mission profile with a purpose-built spacecraft to a standard task in space flight would also lead to a cost reduction of the respective exploration spacecraft through [economies of scale](https://www.sciencedirect.com/topics/social-sciences/economies-of-scale). This describes the very benefits Elvis [[24](https://www.sciencedirect.com/science/article/pii/S0265964621000515#bib24)] and Crawford [[25](https://www.sciencedirect.com/science/article/pii/S0265964621000515#bib25)] imagined as possible effects of a space economy. Thus, there is an immediate return for society from the exploitation rights grant. It also reconciles the adverse interests of space development and [space science](https://www.sciencedirect.com/topics/social-sciences/space-sciences) as laid out by Schwartz [[26](https://www.sciencedirect.com/science/article/pii/S0265964621000515#bib26)]. It ensures that, by exploitation, information contained in celestial bodies is not lost for future generations.The application period should not be set in a manner that creates a situation that can be abused through the potential for stockpiling inventory rights. Rather, it is intended to prevent conflict in the phase before exploration data gathered by a mission, as a prerequisite to the mining rights grant, is available. In other words, only one exploration effort at a time can be permitted for a specific body. The time frame between the application and the granting of mining rights (meaning: availability of the required exploration data set) should be tight and should only consider necessary exploration time on site, transit time and possibly a reasonable launch preparation and data processing markup. These contributors to the application period make it clear that the time frame could be dynamic and individualistic, depending on the exploration target (transit time and duration of exploration) and the technology of the exploration probe (transit time). After the expiration of the application period, applications for the exploration target would again be permissible. To prevent the previously mentioned stockpiling of inventory rights, credible proof of an imminent exploration intention would need to be part of the application process, for example, a fixed launch contract or the advanced build status of the exploration probe. Such a mechanism would not contradict the statement in the OST that outer space shall be free for both exploration and scientific investigation. Applications would not apply to purely scientific exploration. An application would only be necessary as a prerequisite for mining. Even resource prospecting could take place without an application (for whatever reason), with a subsequent application comprising in situ data already gathered. For such cases, the application process would need to provide a short period for objections to enable the secretive explorer to make their efforts public. The publication of the application for the mining rights, which is nothing more than a statement of intention to explore, thus provides a strong measure for avoiding conflict.

The transparency of where exploration spacecraft are located and, at a later stage, where mining activities take place, provides additional benefits for the sustainable use of space, trust building and deterrence against malign misuse of mining technology. Involuntary spacecraft collisions of competitors in deep space are prevented by the reduction of exploration efforts at the same destination through the application for mining rights by one applicant at a time. As pointed out by Newman and Williamson [[20](https://www.sciencedirect.com/science/article/pii/S0265964621000515#bib20)], this is relevant because space debris does not de-orbit in deep space as in the case of LEO. Deep space may be vast, but the velocities involved mean that small debris particles are no less dangerous. Considering NEO mining with fleets of small spacecraft, malfunctions and/or destructive events could create debris clouds crossing Earth's orbit around the sun on a regular basis, presenting another danger to satellites in Earth's own orbit. Thus, by effectively preventing the collision of two spacecraft, one source of debris creation can be mitigated through this regulation mechanism. With respect to Deudney's [[11](https://www.sciencedirect.com/science/article/pii/S0265964621000515#bib11)] scepticism of asteroid mining and the dual-use character of technology to manipulate orbits of celestial bodies, it has to be stated that this potential is truly inherent to asteroid mining. An asteroid redirect mission for scientific purposes was pursued by NASA [[49](https://www.sciencedirect.com/science/article/pii/S0265964621000515#bib49)] before reorientation towards a manned lunar mission. In one way or another, each type of asteroid mining will require the delivery of the targeted resource to a destination via a comparable technology as formerly envisioned by NASA, be it as a raw material or a useable resource processed in situ, even if this is not necessarily done through redirecting the whole asteroid and placing it in a lunar orbit. However, to be misused as a weapon, space mined resources would have to surpass a certain mass threshold to survive atmospheric entry at the target. This seems unfeasible for currently discussed mining concepts using small-scale spacecraft as described in this article. Redirecting larger masses or whole asteroids would require far more powerful mining vessels or small amounts of thrust over long periods of time. The continuous, (for a mining activity) untypical change in the orbit of an asteroid would make a redirect attempt with hostile intent easily identifiable, effectively deterring such an activity in the first place by ensuring the identification of the aggressor long before the projectile hits its target. The proposed database would provide a catalogue of asteroids with exploration and mining activities in place that should be tracked more closely because of their interaction with spacecraft. This would, in fact, be necessary per se as a precaution to avoid catastrophic mishaps, such as the accidental change of a NEO's orbit to intercept Earth by changing its mass through mining.

#### Space mining fails now due to profitability and unsafe tech which only the cp solves

**Steffen 21** [Olaf Steffen, Olaf is a scientist at the Institute of Composite Structures and Adaptive Sytems at the German Aerospace Center. 12-2-2021, "Explore to Exploit: A Data-Centred Approach to Space Mining Regulation," Institute of Composite Structures and Adaptive Systems, German Aerospace Center, [https://www.sciencedirect.com/science/article/pii/S0265964621000515 accessed 12/12/21](https://www.sciencedirect.com/science/article/pii/S0265964621000515%20accessed%2012/12/21)] Adam

* answers timeframe deficits
* creates solvency vs inequality/developing nation affs

The data-driven mechanism also addresses another potential risk of an emerging space-based resource economy: the reinforcing of the incontestable market positions of the market leaders based on an advantage in knowledge unattainable by new competitors. Explorations of celestial bodies will have a likelihood of failing from the perspective of the actual value of the explored object vs. the expected value. In this case, the costs of exploration would be a loss for the company, which could be significant and possibly ruinous considering the budgets needed for contemporary space agency-led exploration missions. Sanchez and McInnes [[5](https://www.sciencedirect.com/science/article/pii/S0265964621000515#bib5)] explicitly mention the uncertainties in object distribution models used in their asteroid distribution study and for the conclusions drawn concerning reachable object masses with certain delta-v capabilities of spacecraft. With an increasing number of exploration missions led by a company, the data collected may lead to better in-house models and a higher probability of exploring the ‘right’ body for the value/resources aimed at. This may even provide information on the best spacecraft designs for matching the targeted objects’ orbit distribution. This risk is known from the digital platform economy, where the companies that are now leading have an uncatchable advantage in user data compared with market newcomers, translatable to a more refined and comfortable user experience, attracting additional users and thus offering superior services to business customers. This also holds true for space mining companies. Through their lack of legacy mission data, market newcomers would have a higher risk of misallocating exploration missions, making investments in those companies riskier than in established companies. To avoid the preferred investment in a single or a few companies, the risk of the investment in emerging companies is reduced by the proposed mechanism by ensuring the equal access to data for market newcomers and established companies alike. From a prospecting risk perspective, the market entrance of a new company becomes progressively less risky for investors with increasing amounts of publicly available exploration data, promoting progressive and dynamic development.

The long lead times of asteroid mining ventures coincide with a long time frame for an ROI. The exclusive mining rights granted after the exploration phase give investors security half-way into their space mining endeavours. The proposed tradability of the rights offers an early chance of gaining investment proceeds. It also offers the possibility of new business models: the classical asteroid mining system concept, as shown by Andrews et al. [[43](https://www.sciencedirect.com/science/article/pii/S0265964621000515#bib43)], for example, covers exploration, exploitation and resource transfer. This maximises the investment needed to develop the technologies required for the entire process chain. Giving exploration a value could lead to a division of labour. Dedicated prospecting companies could emerge, providing mining companies with the data and mining rights to a body with the specific resource profile they are seeking. In this way, the investment needed for a successful mining endeavour is divided between different specialised companies. This considerably reduces the risk for investors as well as the investment needed for a company to meet their business goals, which are now aimed at just a particular part of the overall space mining endeavour. Third-party applications for mining rights should be possible to allow a mining company to subcontract to exploration companies. Such a regulatory mechanism design would also be more easily inclusive of less developed countries. They could simply contract exploration missions made affordable through economies of scale to become part of the emerging space mining economy as holders of tradeable mining rights. Through a wise selection of such missions’ targets, they could gain powerful positions of influence.

#### Creating clear rules of the road now prevents China from normalizing space militias

Adam Routh 17, Routh is a research associate with the Defense Strategies and Assessments Program at the Center for a New American Security. Before that, he served with the U.S. Army’s 75th Ranger Regiment, “Op-ed | Is the U.S. ready for China’s ‘space militias’?,” Space News, 11/20/17, https://spacenews.com/is-the-u-s-ready-for-chinas-space-militias/

Economic interests in space continue to rise. In 2016 the global space economy represented $329 billion, and 76 percent of the total was produced through commercial efforts. With some of the most lucrative endeavors like asteroid mining, space tourism, micro satellites, and space colonies still in the early stages of development and application, it’s no wonder economic projections estimate the space sector will grow to $2.7 trillion over the next three decades.

Nations’ militaries will continue to protect vital economic interests, and outer space will be no exception. But how will it happen? Will the United States see peer competitor militaries expand more aggressively into outer space? The answer lies in gray zone tactics and space militias.

The operational complexities of the space environment coupled with poorly defined international norms and laws will likely encourage U.S. adversaries to use gray zone tactics. Chinese maritime militias provide a likely model.

Maritime militias are merchant and commercial vessels that, when called upon, support roles similar to those found in law enforcement, disaster relief, and the military. Maritime militias are rather common around the world and often serve useful missions. There are also maritime militias, however, that do more than serve peacefully.

Aside from Vietnam, China’s maritime militia is the only such organization that routinely harasses law abiding foreign vessels, among other aggressive activities. For example, in 2012 Chinese maritime militias participated in China’s seizure of the Scarborough Shoal from the Philippines. In 2015, when the USS Lassen sailed by Subi Reef, China used maritime militias to communicate Chinese opposition. These militias have become increasingly professionalized while still maintaining an ambiguous civilian affiliation, and herein lies the problem. The civilian nature of these militias provides Beijing the ability to deny involvement while making any sort of response from the United States, or others, very difficult. Even worse still, the use of maritime militias in this way allows China to undermine international law and begin to set legal precedence in their favor. Given the proven success of this tactic, the United States should anticipate similar approaches via space militias.

Space militias could operate much in the same way maritime militias act currently. Space militias will be commercial (or at least appear to be commercial) spacecraft supporting commercial activities but when directed by their government will quickly adjust and adopt a more military or law enforcement like role. The United States should expect these space militias to defend territory, provide situational awareness, and even attack other spacecraft through a variety of anti-satellite systems, but instead of people, these commercial spacecraft will rely on automation and artificial intelligence for basic operations. Without human life at stake risk tolerance will surely increase.

The complex environment of space will make this tactic very appealing. The vast distances between asteroids, planets and orbits means communications, situational awareness, and replacing or reinforcing spacecraft will be time consuming. This environment provides ample reason for states unconcerned with the separation of civilian and military entities to employ commercial platforms to achieve military objectives in a well-integrated and organized way.

To the benefit of those who would employ the gray zone tactics described above, laws and norms about the commercial and military use of space remain unsettled. While the 1967 Outer Space Treaty prohibits claims of sovereignty over celestial bodies, it doesn’t say anything about owning the resources extracted from said bodies. The treaty does require a nation-state to supervise its public or private organizations operating in space, but it doesn’t detail what constitutes adequate oversight. Outside the 1967 Outer Space Treaty, international space law is poorly defined and understood. Making matters worse, there isn’t any international organization designed to address commercial space activities. The lack of rules and regulatory bodies creates an ideal situation for space militias.

While the United States currently has a significant advantage in commercial space ventures, China is catching up quickly. Before China develops and normalizes the use space militias, the United States should pursue international agreements with partners nations that create clear laws, regulations, and norms that govern commercial activities in space. These agreements should not replace the 1967 Outer Space Treaty but, instead, supplement it. They should address commercial rights including definitions for demarcating claims and their operational zones, identification requirements differentiating civilian and military spacecraft and operations, and the creation of earth-bound organizations which serve as regulatory and legal forums for the creation of space customs and handling of space disputes. U.S. adversaries will deploy offensive military capabilities in space to defend their economic interest. The U.S. must proactively establish rules of the road before peer competitors gain the advantage by normalizing space militias.

#### International cooperation over mining prevents weaponization of asteroids

Jakub Drmola and Miroslav Mareš 15, both have a PhD in Political Science from Masaryk University, “Revisiting the deflection dilemma,” Astronomy & Geophysics, Volume 56, Issue 5, October 2015, Pages 5.15–5.18, https://doi.org/10.1093/astrogeo/atv167

The risks of mining asteroids

There are two basic ways to go about moving the resources contained within a given asteroid to the Earth. They can be extracted from the asteroid during its natural orbit and then transported to the Earth, or the entire asteroid might be moved closer to a more convenient location before starting mining. Thus repositioned, it might even be used as a shielded habitat, once hollowed out (Ostro 1999). There are different speculative costs and benefits associated with either option, which would vary with the size, orbit and composition of the asteroid. But, crucially, the second option would entail putting asteroids into orbit around the Earth, the Moon or possibly at one of the Earth's Lagrangian points. Indeed, NASA has already planned a mission to capture a small asteroid and place it in a high cislunar orbit, where it would serve as a destination for future manned missions and experiments. This “Asteroid Redirect Mission” is to take place in the next decade and is being pitched mainly as a stepping stone towards a future mission to Mars (see box “NASA's Asteroid Redirect Mission”; Brophy et al. 2012, Burchell 2014, Gates et al. 2015).

Programmes to redirect asteroids and, especially, plans to mine asteroids on an industrial scale essentially resurrect the deflection dilemma. But it is no longer a matter of superpowers intentionally misusing technology designed to prevent dangerous impacts. It becomes an issue of proliferation among private entities. Once private mining companies acquire the technical ability to redirect suitable NEOs (Baoyin et al. 2011) in order to extract platinum or water from them, perilous inflections become more likely.

The probability of accidents will rise with the number of asteroids whose trajectories we decide to manipulate. Such accidents might be very unlikely, but even a tiny technical or human error in the execution of an inflection meant to place an asteroid into the lunar or geocentric orbit might send it crashing into the Earth with potentially devastating consequences. And while we might find solace in the low probabilities associated with such an accident, even contemporary industries which are considered very safe suffer from unlikely tragedies. Despite being dependable and reliable, airliners do crash; there are a lot of them flying and very improbable accidents do happen if the dice are rolled often enough. Undoubtedly, we will not be steering as many asteroids as we steer planes any time soon, but industries tend to be more accident-prone during their infancy. Furthermore, a single asteroid can do a lot more damage than a single plane. And who is to say how much metal or water we are going to need in space over the course of the 21st century, or the next?

The second source of risk is the intentional misuse, similar to the original deflection dilemma. But the entry barrier for asteroid weaponization gets much lower if mining them and moving them around becomes a common industrial activity. This is in stark contrast to the original scenario which envisioned this technology to be used solely for planetary defence and under control of a very small number of the most powerful countries (Morrison 2010). If such a powerful technology becomes widely and commercially available, even rogue states and well-funded terrorist groups might be tempted to use it for an unexpected and devastating attack. In addition, an active asteroid mining industry would make it more difficult to detect any hostile inflection attempts among the number of legitimate and benign ones.

Policy implications

Considering these possible future dangers, it seems prudent to consider what to do about them sooner rather than later. The most obvious “solution” would be a blanket ban on the development of any technology that might lead to artificially inflected asteroids crashing into the Earth. However, such a ban would be incompatible with the dream of increased presence of humans in the solar system. It would stymie both scientific exploration and economic development here on Earth, which is increasingly dependent on precious metals and space-based technologies. Furthermore, this approach would leave us more vulnerable to natural impacts which, in the long view, seems less than desirable.

Another approach might be similar to the current regime of non-proliferation of nuclear weapons, aiming to support peaceful civilian use of nuclear power while at the same time prohibiting the spread of weapons of mass destruction. The regime mostly works (with caveats, see Wood et al. 2008) because these applications require different infrastructures and fissile materials enriched to different levels of purity. This makes it possible, at least in principle, to tell apart operations meant for the production of electricity and those designed to create weapons. Unfortunately, the difference between legitimate and hostile trajectory modification would lie only in the acceleration imparted on the asteroid and not in the technical means to do it. As the spacecraft launched with the intent to cause impact with the Earth might be identical to those sent off to retrieve resources, telling them apart would be nearly impossible, until it was too late. And this approach makes no difference to the chances of an industrial accident.

If monitoring equipment on Earth is unhelpful, the focus changes to space. In other words, all asteroid movement missions should be constantly monitored. For an attacker, it would make most sense to delay the final course adjustment for as long as possible in order to give the least warning and make the timeframe for reaction as short as possible. So an asteroid might head towards a safe orbit fit for resource extraction for most of its altered flight time, but be further accelerated at the last possible moment onto an impact trajectory, perhaps mere days before it hits a major city.

Our current programmes cataloguing NEOs (such as CSS or Pan-STARRS), which look for new, previously unknown objects, are not ideally suited for the task of constantly tracking a number of different, already known asteroids. New instruments would be needed to track them in order to immediately detect any hazardous inflection, whether intentional or accidental. Once such a detection is made, emergency measures to evacuate the population or, preferably, to “re-deflect” the incoming object can be executed right away, regardless of the cause. Accidents and hostilities could be treated the same way and countered by the same system (initially, at least). Such a system would be more akin to an air traffic control than a non-proliferation regulation, offering security through vigilance, rather than absence. Additionally, development of a system able to deflect incoming objects at relatively short notice would be beneficial in case of an impending natural impact.

## Case

#### VOTE NEG ON PRESUMPTION – Tronchetti 7 ev says they defend OST as normal maens and then Macwhorter 16 says treaties like OST can’t enforce compliance meaning the aff doesn’t solve

**The private sector is essential for asteroid mining – competition is key and government development is not effective, efficient, or cheap enough. Thiessen 21:**

Marc Thiessen, 6-1, 21, Washington Post, Opinion: SpaceX’s success is one small step for man, one giant leap for capitalism, https://www.washingtonpost.com/opinions/2020/06/01/spacexs-success-is-one-small-step-man-one-giant-leap-capitalism/

It was one small step for man, one giant leap for capitalism. Only three countries have ever launched human beings into orbit. This past weekend, SpaceX became the first private company ever to do so, when it sent its Crew Dragon capsule into space aboard its Falcon 9 rocket and docked with the International Space Station. This was accomplished by a company Elon Musk started in 2002 in a California strip mall warehouse with just a dozen employees and a mariachi band. At a time when our nation is debating the merits of socialism, SpaceX has given us an **incredible testament to the power of American free enterprise.** While the left is advocating unprecedented government intervention in almost every sector of the U.S. economy, from health care to energy, **today Americans are celebrating the successful privatization of space travel.** If you want to see the difference between what government and private enterprise can do, consider: It took a private company to give us the first space vehicle with touch-screen controls instead of antiquated knobs and buttons. It took a private company to give us a capsule that can fly entirely autonomously from launch to landing — including docking — without any participation by its human crew. It also took a private company to invent a reusable rocket that can not only take off but land as well. When the Apollo 11 crew reached the moon on July 20, 1969, Neil Armstrong declared “the Eagle has landed.” On Saturday, SpaceX was able to declare that the Falcon had landed when its rocket settled down on a barge in the Atlantic Ocean — ready to be used again. That last development will save the taxpayers incredible amounts of money. The cost to NASA for launching a man into space on the space shuttle orbiter was **$170 million per seat, compared with just $60 million** to $67 million on the Dragon capsule. The cost for the space shuttle to send a kilogram of cargo into to space was $54,500; with the Falcon rocket, the cost is just $2,720 — **a decrease of 95 percent.** And while the space shuttle cost $27.4 billion to develop, the Crew Dragon was designed and built for just $1.7 **billion — making it the lowest-cost spacecraft developed in six decades.** SpaceX did it in six years — far faster than the time it took to develop the space shuttle. ***The private sector does it better, cheaper, faster and more efficiently than government***. **Why? Competition.** Today, SpaceX has to compete with a constellation of private companies — including legacy aerospace firms such as Orbital ATK and United Launch Alliance and innovative start-ups such as Blue Origin (which is designing a Mars lander and whose owner, Jeff Bezos, also owns The Post) and Virgin Orbit (which is developing rockets than can launch satellites into space from the underside of a 747, avoiding the kinds of weather that delayed the Dragon launch). In the race to put the first privately launched man into orbit, upstart SpaceX had to beat aerospace behemoth Boeing and its Starliner capsule to the punch. It did so — for more than $1 billion less than its competitor. **That spirit of competition and innovation will revolutionize space travel in the years ahead.** Indeed, Musk has his sights set far beyond Earth orbit. Already, SpaceX is working on a much larger version of the Falcon 9 reusable rocket called Super Heavy that will carry a deep-space capsule named Starship capable of carrying up to 100 people to the moon and eventually to Mars. Musk’s goal — the reason he founded SpaceX — is to colonize Mars and make humanity a multiplanetary species. He has set a goal of founding a million-person city on Mars by 2050 complete with iron foundries and pizza joints. Can it be done? Who knows. But this much is certain: **Private-sector innovation is opening the door to a new era of space exploration**. Wouldn’t it be ironic if, just as capitalism is allowing us to explore the farthest reaches of our solar system, Americans decided to embrace socialism back here on Earth?

#### Asteroid mining is only possible by private, commercial actors appropriating space – mining asteroids makes space exploration sustainable and solves environmental destruction on Earth

Britt, 2021

Hugo Britt, Ph.D. Doctor of Philosophy in English Literature University of Melbourne, is a freelance content writer who believes that every topic is fascinating if you dig deeply enough. Hugo is the co-founder of content marketing agency Discontent. “Companies Are Preparing for Space Mining”, Aug 19, 2021, <https://www.thomasnet.com/insights/companies-are-preparing-for-space-mining/>, accessed 1/10/21, sb

When LA-based blues and rock band Canned Heat wrote “Poor Moon” in the same year Neil Armstrong took his famous giant leap, their lyrics reflected the Cold-War-era concern that spacefaring nations would one day scar the moon by testing a bomb on its surface. While this, thankfully, hasn’t yet happened, the moon — along with all the other planets, moons, and asteroids in the solar system — could one day be mined for resources to meet Earth’s ever-growing needs. Why Mine Off-Earth? Space Exploration Is Expensive While the price tag involved in establishing a human colony on the Moon or Mars is mind-boggling, the costs of sustaining off-Earth colonies and keeping them resupplied indefinitely are even more so — unless the settlements can somehow pay for themselves. Mining for much-needed metals and sending them back to Earth could change the game for space exploration, transforming off-world ventures from prohibitively expensive to financially viable. That being said, bringing a heavy payload of minerals down through Earth’s atmosphere is not currently feasible. Futurists believe that instead, minerals mined in space will be used in space as humanity spreads outwards. Rare Earth Materials Are Abundant There are around two million near-earth asteroids brimming with rare earth minerals, precious metals, iron, and nickel. The Moon contains helium-3, yttrium, samarium, and lanthanum, while Mars contains an abundance of magnesium, aluminum, titanium, iron, chromium, and trace amounts of lithium, cobalt, tungsten, and other metals. Importantly, many planetary bodies contain water, which through hydrolysis can be used as rocket fuel. It Helps with Sustainability Earth’s resources are finite. Non-renewable metal resources are inherently unsustainable, and mining causes environmental degradation all over the world. The answer is to source our minerals off-world. Off-world minerals are exhaustible as well, but the argument is that mining lifeless rocks such as the Moon or asteroids is infinitely preferable to continuing to damage Earth’s fragile biosphere. Discoveries May Be Made Opening space to commercial mining does not mean that science takes a back seat. Space-mining interests could drive scientific advancement by discovering extremely rare or unknown minerals on other planetary bodies. Robotics Would Do the Work While countless lives have been lost on Earth over the centuries due to mining accidents and disasters, it is likely that humans will not have to risk their lives by traveling in-person to off-world mining sites. Regolith-sampling probes are already in use and provide an early glimpse of what a scaled-up robotic mining craft may one day look like. Off-Earth Mining and Space Law The 1967 Outer Space Treaty is unclear in terms of whether any country — or private company — can claim mineral rights in space. It states that “exploration and use of outer space shall be carried out for the benefit and in the interests of all countries and shall be the province of all mankind.” The 1979 Moon Treaty was an attempt to declare the Moon and its natural resources to be CHM (Common Heritage of Mankind). Significantly, it called for “an equitable sharing [by all countries] in the benefits derived from these resources.” Most nations, including the U.S., did not ratify this treaty. Recently, the U.S. has accelerated its efforts to create a legal framework for the exploitation of resources in space. The Obama administration signed the U.S. Commercial Space Launch Competitiveness Act of 2015, allowing U.S. citizens to “engage in the commercial exploration and exploitation of space resources.” In April 2020, the Trump administration issued an executive order supporting U.S. mining on the Moon and asteroids. In May 2020, NASA unveiled the Artemis Accords, which included the development of safety zones around lunar mining sites. Former NASA administrator Jim Bridenstine said: “It’s time to establish the regulatory certainty to extract and trade space resources,” and clarified in a separate statement that: “We do believe we can extract and utilize the resources of the moon, just as we can extract and utilize tuna from the ocean.” NASA planned an Asteroid Redirect Mission which involved collecting a multi-ton boulder from an asteroid and redirecting it into a stable orbit around the moon, but the mission was canceled in 2017. What Companies Are Preparing for a Future of Space Mining? One thing that is becoming clear is that off-earth mining is unlikely to be a state-run activity. Instead, several private companies are jockeying to be first in line to access minerals in space. iSpace (Japan) has a mission to “help companies access new business opportunities on the moon,” including the extraction of water and mineral resources to spearhead a space-based economy. Planetary Resources (defunct) was founded in 2009 with the goal of developing a robotic asteroid mining industry. Despite having high-profile founding investors including Alphabet’s Larry Page, Eric Schmidt, and Virgin Group founder Richard Branson, Planetary ran into financial trouble in 2018 and was gone by 2020. Deep Space Industries (defunct) was another early mover that intended to explore, examine, sample, and harvest minerals from asteroids. DSI was acquired by Bradford Space in 2019. Offworld is an AI company building “universal industrial robots to do the heavy lifting [including mining] on Earth, the Moon, asteroids, and Mars.” The Asteroid Mining Corporation (UK) is a venture currently crowdfunding for a 2023 satellite mission called “El Dorado,” which will conduct a spectral survey of 5,000 asteroids to identify the most valuable for mining. Alongside the U.S., the tiny European nation of Luxembourg has also developed a space mining framework and has subsequently emerged as a European hub for the fledgling industry.

#### Space habitation solves every existential threat -- failure makes human extinction inevitable

**Kaku 18** Dr. Michio Kaku (Professor of theoretical physics in the City College of New York and CUNY Graduate Center, Co-Inventor of String Field Theory, PhD from UC Berkeley). The Future of Humanity: Terraforming Mars, Interstellar Travel, Immortality, and Our Destiny Beyond. Doubleday Publishing. 2018. pp 25-33. Recut apark [I disagree with the author’s use of the word “pioneer”]

It is as inescapable as the laws of physics that humanity will one day confront some type of **extinction-level event**. But will we, like our ancestors, have the drive and determination to survive and even flourish? If we scan all the life-forms that have ever existed on the Earth, from microscopic bacteria to towering forests, lumbering dinosaurs, and enterprising humans, we find that more than 99.9 percent of them eventually became extinct. This means that extinction is the norm, that the odds are already **stacked heavily against us**. When we dig beneath our feet into the soil to unearth the fossil record, we see evidence of many ancient life-forms. Yet only the smallest handful survive today. Millions of species have appeared before us; they had their day in the sun, and then they withered and died. That is the story of life. No matter how much we may treasure the sight of dramatic, romantic sunsets, the smell of fresh ocean breezes, and the warmth of a summer’s day, one day it will all end, and the planet will **become inhospitable to human life**. Nature will eventually turn on us, as it did to all those extinct life-forms. The grand history of life on Earth shows that, faced with a hostile environment, organisms inevitably meet one of three fates. They can leave that environment, they can adapt to it, or they will die. But if we look far enough into the future, we will eventually face a disaster **so great that adaptation will be virtually impossible**. Either **we must leave the Earth or we will perish**. There is no other way. These disasters have happened repeatedly in the past, and they will inevitably happen in the future. The Earth has already sustained five major extinction cycles, in which up to 90 percent of all life-forms vanished from the Earth. As sure as day follows night, there will be more to come. On a scale of decades, we face threats that are not natural but are largely self-inflicted, due to our own folly and shortsightedness. We face the danger of global warming, when the atmosphere of the Earth itself turns against us. We face the danger of modern warfare, as nuclear weapons proliferate in some of the most unstable regions of the globe. We face the danger of weaponized microbes, such as airborne AIDS or Ebola, which can be transmitted by a simple cough or sneeze. This could wipe out upward of 98 percent of the human race. Furthermore, we face an expanding population that consumes resources at a furious rate. We may exceed the carrying capacity of Earth at some point and find ourselves in an ecological Armageddon, vying for the planet’s last remaining supplies. In addition to calamities that we create ourselves, there are also natural disasters over which we have little control. **On a scale of thousands of years,** we face the onset of another ice age. For the past one hundred thousand years, much of Earth’s surface was blanketed by up to a half mile of solid ice. The bleak frozen landscape drove many animals to extinction. Then, ten thousand years ago, there was a thaw in the weather. This brief warming spell led to the sudden rise of modern civilization, and humans have taken advantage of it to spread and thrive. But this flowering has occurred during an interglacial period, meaning we will likely meet another ice age within the next ten thousand years. When it comes, our cities will disappear under mountains of snow and civilization will be crushed under the ice. We also face the possibility that the supervolcano under Yellowstone National Park may awaken from its long slumber, tearing the United States apart and engulfing the Earth in a choking, poisonous cloud of soot and debris. Previous eruptions took place 630,000, 1.3 million, and 2.1 million years ago. Each event was separated by roughly 700,000 years; therefore, we may be due for another colossal eruption in the next 100,000 years. On a scale of millions of years, we face the threat of another meteor or cometary impact, similar to the one that helped to destroy the dinosaurs 65 million years ago. Back then, a rock about six miles across plunged into the Yucatán peninsula of Mexico, sending into the sky fiery debris that rained back on Earth. As with the explosion at Toba, only much larger, the ash clouds eventually darkened the sun and led temperatures to plunge globally. With the withering of vegetation, the food chain collapsed. Plant-eating dinosaurs starved to death, followed soon by their carnivorous cousins. In the end, 90 percent of all life-forms on Earth perished in the wake of this catastrophic event. For millennia, we have been blissfully ignorant of the reality that **the Earth is floating in a swarm of potentially deadly rocks**. Only within the last decade have scientists begun to quantify the real risk of a major impact. We now know that there are several thousand NEOs (near-Earth objects) that cross the orbit of the Earth and pose a danger to life on our planet. As of June 2017, 16,294 of these objects have been catalogued. But these are just the ones we’ve found. Astronomers estimate that there are perhaps several million uncharted objects in the solar system that pass by the Earth. I once interviewed the late astronomer Carl Sagan about this threat. He stressed to me that “we live in a cosmic shooting gallery,” surrounded by potential hazards. It is only a matter of time, he told me, before a large asteroid hits the Earth. If we could somehow illuminate these asteroids, we would see the night sky filled with thousands of menacing points of light. Even assuming we avoid all these dangers, there is another that dwarfs all the others. Five billion years from now, the sun will expand into a giant red star that fills the entire sky. The sun will be so gigantic that the orbit of the Earth will be inside its blazing atmosphere, and the blistering heat will make life impossible within this inferno. Unlike all other life-forms on this planet, which must passively await their fate, we humans are masters of our own destiny. Fortunately, we are now creating the tools that will defy the odds given to us by nature, so that we don’t become one of the 99.9 percent of life-forms destined for extinction. In this book, we will encounter the pioneers who have the energy, the vision, and the resources to change the fate of humanity. We will meet the dreamers who believe that humanity can live and thrive in outer space. We will analyze the revolutionary advances in technology that will make it possible to leave the Earth and to settle elsewhere in the solar system, and even beyond. But if there is one lesson we can learn from our history, it is that humanity, when faced with life-threatening crises, has risen to the challenge and has reached for even higher goals. In some sense, the spirit of exploration is in our genes and hardwired into our soul. But now we face perhaps the greatest challenge of all: to leave the confines of the Earth and soar into outer space. The laws of physics are clear; sooner or later we will face global crises that threaten our very existence. Life is too precious to be placed on a single planet, to be at the mercy of these planetary threats. **We need an insurance policy**, Sagan told me. He concluded that we should become a “two planet species.” In other words, we need a backup plan. In this book, we will explore the history, the challenges, and the possible solutions that lie before us. The path will not be easy, and there will be setbacks, but we have no choice.

#### Asteroid mining solves climate change, resource shortages, and environmental degradation

Hlimi 14 [Tina Hlimi, Canadian lawyer with a Bachelors and Masters Degrees in Environmental Sciences from McGill University, 2014, “THE NEXT FRONTIER: AN OVERVIEW OF THE LEGAL AND ENVIRONMENTAL IMPLICATIONS OF NEAR-EARTH ASTEROID MINING,” ANNALS OF AIR AND SPACE LAW, https://papers.ssrn.com/sol3/papers.cfm?abstract\_id=2546924]/Kankee

A. THE ENVIRONMENTAL BENEFITS OF NEAR EARTH ASTEROID HARVESTING Let us recapitulate what we have already found. Shortage of resources is not a fact; it is an illusion born of ignorance. Scientifically and technically feasible improvements in launch vehicles will make departure from Earth easy and inexpensive. Once we have a foothold in space, the mass of the asteroid belt will be at our disposal, permitting us to provide for the material needs of a million times as many people as Earth can hold. Solar power can provide all the energy needs of this vast civilisation (10,000,000 billion people) from now until the Sun expires. Using less than one percent of the helium-3 energy resources of Uranus and Neptune for fusion propulsion, we could send a billion interstellar arks, each containing a billion people, to the stars. There are about a billion Sun-like stars in our galaxy. We have the resources to colonise the entire Milky Way. 122 In addition to demystifying the legal doctrine governing outer space natural resource appropriation it is also necessary to weigh the benefits and detriments of space-faring activities. Foremost, States around the world are developing at unprecedented rates and the human population is mounting in conjunction with demand for natural resources to sustain the current and newly established western standard of living. One of the fastest growing nations, China, is experiencing unhindered growth facilitated by fossil fuel use from coal and extensive mining. This has caused substantial water, soil and air degradation. In the face of these troubles, NEA mining could be the key to preserving the Earth's bounty and replenishing contaminated water supplies. The influx of natural resources could thwart the burning of dirty coal and fossil fuels, thereby mitigating the effects of climate change, such as, rising sea level, atmospheric pollution, melting of sea ice and rising temperatures. NEA harvesting could also protect the ocean and the fragile and largely unexplored deep seabeds 123 from oil and gas drilling. It could furthermore protect ecosystems from rare-earth mineral mining predominantly used to fuel the electronics sector. 124 NEA mining is especially pertinent as China restricted its global exports of rare-earth minerals in 2009, incongruously citing the need to protect the environment. Unfortunately, the supply cuts have forced dependent States like Japan, the United States and South Korea to heighten rare-Earth mineral exploration. This accordingly led to Japan's 2011 discovery of rare-earth minerals in the ocean-bed deposits of the Pacific Exclusive Economic Zone (PEEZ) thereby necessitating risky, deep-sea mining techniques, which may result in marine pollution if not carefully designed and developed. Other States, which have joined the environmentally destructive rare-earth mineral exploration movement include India, Canada, Tanzania, Australia, Brazil and Vietnam., There is accordingly much competition and exploration for rare-earth minerals which could result in significant exploitation of untouched areas like the PEEZ seabed and Mongolia.125 Other regions which may soon be targeted for mineral and hydrological resources include Antarctica and the Arctic. With the advent of technological advances, environmentally destructive practices such as refining may soon occur in outer space, sparing the Earth of pollution. 126 Accordingly, NEA mining is a viable technology for preserving the Earth's environment by curbing atmospheric and marine pollution, enhancing water supply and quality and mitigating the effects of climate change; all while allowing humankind to maintain and even improve their standard of living through increased technologies, consumption and population growth. B. THE ENVIRONMENTAL CONSEQUENCES OF NEAR EARTH ASTEROID MINING

#### Earth mining kills the environment

Matthew S. Williams 19, writer at Universe Today, Aug 1 2019, "Asteroid Mining: What Will It Involve and Is This the Future of Wealth?", Interessting Engineering, https://interestingengineering.com/asteroid-mining-what-will-it-involve-and-is-this-the-future-of-wealth

Of course, this raises the obvious question: wouldn't it be really expensive to do all this mining? Why not simply continue to rely on Earth for sources of precious metals and resources and simply learn to use them better?

To put it simply, we are running out of resources. To be clear, learning to use our resources better and more sustainably is always a great idea. And while it is certainly true than Earth-based mining is far cheaper than going to space would be, that may not be the case indefinitely.

Aside from the fact that off-world minerals and ices would be of considerable value to Earth's economy, there is also the way that growing consumption is leading our reserves to become slowly exhausted.

In fact, according to some estimates, it is possible that our planet will run out of key elements that are needed for modern industry and food production within the next 50 to 60 years. This alone is a pretty good incentive to tap the virtually inexhaustible supply of elements located off-world.

Plus, there are a lot of benefits to expanding humanity's resource base beyond Earth. Here on Earth, mining takes a considerable toll on the natural environment. In fact, depending on the methods used, it can result in erosion, sinkholes, habitat destruction, and the destruction of native animal and plant life.

There's also the dangers of toxic runoff and the contamination of soil, groundwater, and surface water, which is a danger to humans, as well as to wildlife and the natural environment.

As for smelting, machining, and manufacturing, the environmental damage that results is well-documented. Combined with power generation, these industrial processes are one of the leading contributors to air, water, and pollution.

By shifting these burdens off-world, humanity could dramatically-reduce the impact it has on the natural environment.

#### Biod loss causes human extinction

Joe McCarthy 18, a Staff Writer at Global Citizen, Nov 8 2018, "Humans Could Face Extinction if We Don't Protect Biodiversity: UN", Global Citizen, <https://www.globalcitizen.org/en/content/biodiversity-loss-human-extinction/>

As the sixth mass extinction event accelerates around the world, engulfing thousands of animal and plant species, humans risk facing a similar fate unless drastic interventions are made, according to Cristiana Pașca Palmer, the United Nations biodiversity chief, who recently spoke with the Guardian.

Palmer said that within the next two years, countries have to develop an ambitious plan to conserve land, protect animals, and stop practices that are harming wildlife. This effort is equally as urgent as the Paris climate agreement’s goal of mitigating climate change, she said.

“The loss of biodiversity is a silent killer,” she told the Guardian. “It’s different from climate change, where people feel the impact in everyday life. With biodiversity, it is not so clear but by the time you feel what is happening, it may be too late.”

Next month, countries will meet in Sharm el Sheikh, Egypt, to begin mapping out what such a plan would like. Palmer hopes that a final version will be formalized in Beijing in 2020.

If a binding global treaty fails to materialize, then humanity faces an uncertain future, she said. Past efforts to stop the loss of biodiversity have not proved successful, according to the Guardian.

In recent years, evidence of this staggering loss has begun accumulating.

Wild animal populations have declined by 60% since 1970, more than 26,000 plants and animals are close to extinction, nearly two-thirds of the world’s wetlands and half of all rainforests have been destroyed, more than 87% of the world’s ocean area is dying, and the planet needs an estimated 5 million years to recover from the biodiversity loss it has already sustained.

“We are sleepwalking towards the edge of a cliff,” Mike Barrett, executive director of science and conservation at WWF, recently told the Guardian. “If there was a 60% decline in the human population, that would be equivalent to emptying North America, South America, Africa, Europe, China, and Oceania. That is the scale of what we have done.”

“This is far more than just being about losing the wonders of nature, desperately sad though that is,” he said. “This is actually now jeopardising the future of people. Nature is not a ‘nice to have’ — it is our life-support system.”

The benefits of biodiversity are hard to overstate. The food chain, climate systems, atmospheric conditions, natural resources, and much more depend on the delicately structured interactions of ecosystems around the world.

The truly wild places in the world, meanwhile, are crucial to generating, cleaning, and distributing water around the world, and could help to mitigate the looming water crisis. These landscapes and marine environments also clean the air and act as carbon sinks, stabilize the global environment, and protect countries from natural disasters.

In addition to climate change, the biggest threats to biodiversity are deforestation, agriculture, over-development, and industrial pollution.

While Palmer sounded an urgent alarm bell while speaking with the Guardian, she’s hopeful that countries will recognize the threat of biodiversity loss and begin to take action.

The UN is calling for at least 30% of all land and 15% of all marine environments to be protected by 2030 and for targets to be lifted in the following years.

“Things are moving. There is a lot of goodwill,” Palmer said. “We should be aware of the dangers but not paralysed by inaction. It’s still in our hands but the window for action is narrowing. We need higher levels of political and citizen will to support nature.”

#### Conflicts coming over water scarcity---extinction

Daniel Darling 19, senior international military markets analyst at Forecast International Incorporated, an aerospace and defense consulting firm located in Newtown, Connecticut, where he covers the Europe and Asia-Pacific markets, “The Coming Wars over Water,” The National Interest, 4/14/19, https://nationalinterest.org/blog/buzz/coming-wars-over-water-52147

But another looming issue confronting global leaders involves the earth’s most precious resource: water. In many regions of the globe—from Northern Africa to the Middle East to Central and South Asia—efforts to manage internal freshwater supplies or conserve transboundary water agreements are under strain as scarcity rises in parallel with population growth, consumption and warming temperatures. A World Bank study on the global water picture in 2016 noted that entire regions may see their gross domestic product decline by up to 6 percent by 2050 due to water-related losses in agriculture, health, income and property. The areas highlighted consist of many of the world’s largest population concentrations, regions with developing economies, intensive and unsustainable agricultural practices and high occurrences of drought. Dam-building and its downstream effects across national borders—as in the case of Ethiopia’s Grand Ethiopian Renaissance Dam and China’s water diversion project from the Yarlung Tsangpo River in southern Tibet—threaten to escalate tensions or redefine national claims over disputed regions. Such disputes could mushroom across the globe in the face of broader demographic and resource shifts. According to the Pacific Institute’s water conflict chronology database, eighteen water-related incidents occurred in 2018 alone, ranging from violence erupting at protests over water management to outright fighting between competing communities over access to water and herding rights. These incidents appear destined to become more a norm than an outlier as water resources are consumed faster than rainfall replenishment in some areas and limitations exacerbate longstanding tensions, be they ethnic, tribal or national-based. Delicate tradeoff systems between nations located upstream and downstream of major rivers threaten to be undone by disruptions, as in the case of Central Asian countries sharing parts of the Fergana Valley. In addition, scarcity issues may create internal security pressures by leading to radicalization amongst vulnerable population sectors. With water a vital and finite resource, the world’s industrialized nations are naturally protective of local supply and place a premium on water security in instances where water flows across shared borders. When mixed with political disputes or rivalries, resource pressures may act as a catalyst for armed conflict. Wars over water resources are not without precedent. The Six-Day War of 1967, for instance, was in part an Israeli military response to a Syrian attempt to dam the Yarmuk River, a tributary of the Jordan River, a crucial water source for Israel. Another potential flashpoint exists in one of the world’s most tense arenas: the border between India and Pakistan. There the potential repudiation of a water-sharing agreement brokered by the World Bank in 1960, the Indus Waters Treaty, would serve to further damage relations between Pakistan and India, potentially sending the two rivals spiraling into a conflict that might draw in other nations. The treaty remains in place despite two wars conducted over that time between the neighboring rivals. This is a credit to the cornerstone of the agreement: the rational self-interest of both signatories. With water at a premium for both, any war over it would threaten the supply of each actor, thus ostensibly negating the pretense for armed conflict. But with Pakistan facing declining water availability and blaming its situation on India's “water terrorism,” the potential for crisis increases. India, which plans for a presumptive “collusive threat” on both its northeast and northwest borders from China and Pakistan, must tread carefully in order to avoid reciprocity from Beijing should the latter turn its back on water rationality. While India holds an upstream riparian advantage over Pakistan in regards to the Sutlej, Beas and Ravi Rivers, so too does China as it relates to major rivers flowing into India from Tibet. Considering Pakistan’s water vulnerability—which involves exploding population growth, poor water utilization and infrastructure maintenance, and unsustainable usage patterns—any threat by India to abrogate the treaty or maximize its use of water from any of the rivers covered under the IWT would be seen by Islamabad as tantamount to an act of war. Factor in Pakistan’s strategic alignment with China and any outbreak of conflict might draw Beijing into the scrum, thereby resulting in India confronting the two-front war its planners most fear. Under this scenario, in which three nuclear-armed nations conduct military operations at some level of intensity, the rest of the world would be left scrambling to mediate the crisis at zero hour.

#### Space resource mining key to a sustainable space economy

Vidya Sagar Reddy Avuthu 17, Research Analyst at the Observer Research Foundation in New Delhi, “Commercial space mining: Economic and legal implications,” Observer Foundation Research, September 28 2017, https://www.orfonline.org/research/commercial-space-mining-economic-and-legal-implications/

The task of shifting these processes into outer space is daunting. Nevertheless, the current pace of population growth and dwindling resources make it imperative to support these initiatives. Resource conflicts are expected to multiply in the future and unlike the oil wars, they could well be over plain drinking water. The United Arab Emirates’ plans to diversify its economy, followed by similar attempts by Saudi Arabia, attests to this fact. Chris Lewicki, founder of Planetary Resources, is, however, optimistic about humanity’s survival. Much like the earlier explorers crossing the oceans and settling in new frontiers, he envisions millions of people working and living in the final frontier.[30] This could be the Moon, Mars, or even giant space stations orbiting celestial bodies. This new civilisation will be not merely about humanity’s survival but also about continuing its development. Lewicki asserts that space mining is not just about space, but a resources project to establish a new industrial economy in space.[31] The mining, transportation and manufacturing sectors, once refined and consolidated, will help build a space economy, much like the processes sustaining the current global economy. Most of these space projects are in design and testing phase, but with Moore’s Law doubling computing power approximately every 18 months, it is possible to develop new technologies and platforms faster than anticipated. Consider, for example, the decreasing time interval in which humanity migrated from horse carriages to cars, and then from cars to airplanes. Within the space age, the ongoing adoption of reusable launch vehicles is occurring within a much shorter timescale. Most importantly, the entrepreneurial spirit imbued in Western business practices cannot be undermined. Elon Musk himself stands as an example of this attitude, having successfully compelled traditional rocket companies to adapt to reusability. The current pace of development signals that the decade of the 2020s will unleash a new wave of technologies required for space mining. This new generation of environment-minded space entrepreneurs can build a sustainable future provided governments gives them the legal space to attract investments, develop technologies and profit from their innovations. Therefore, the NewSpace entrepreneurs have been proactively seeking regulations to avoid venturing into a “new Wild West” in outer space.

#### Commercial space economy solves disease

Dirk C. Gibson 12, Associate Professor at the University of New Mexico, Commercial Space Tourism: Impediments to Industrial Development and Strategic Communication Solutions, Bentham Books, Google Books

4. COMMERCIAL SPACE BENEFITS Four factors might justify commercial space development: I) Manufacturing benefits, 2) Mining opportunities, 3) Medical breakthroughs and 4) Astronomy advancements. Each will be described in detail. A. Manufacturing Benefits "The future also promises more commercial benefits. Much has been said about the potential for creating and manufacturing new materials in the microgravity environment of space," declared Edward L. Hudgins [10]. Taylor noted that "Certain manufacturing processes can be done better in the absence of gravitational fields, or in a vacuum which space offers" [23]. We will consider: I) General manufacturing, 2) Biotechnology and 3) Pharmaceutical production. General Manufacturing The microgravity environment of space appeals to manufacturers for a variety of reasons. According to Taylor, "Materials that will not mix on earth—oil and water, certain minerals—will mix in space. This space manufacturing could lead to the production of vastly improved products, more precise manufacturing of products, and new materials-processing techniques" [23]. O'Neill referred to "the advantages of zero gravity for the handling of massive objects, for the heating of materials to very high temperatures without the contamination of containing crucible walls, for the formation of uniform production of light and heavy materials" [24]. Biotechnology Biotechnology and medical research and development in particular would benefit from space manufacturing. A study for the Office of Space Commercialization in the Department of Commerce found that "The microgravity conditions of space enable the growth of large, superior quality crystals that could be the predecessors to synthesized proteins for fighting disease. Materials have been developed without the structural flaws that often accompany their production on Earth" [3J. Pharmaceutical Production Medicines may be improved substantially by research and production conducted in space. It is believed that the environmental characteristics of space would enhance pharmaceutical company operations. One study specified that because of space-based electrophesis, "New vaccines and drugs can be produced in volumes that could aid millions of people" [23]. Existing drugs could be improved and made more cheaply, including diabetes and hormone deficiency drugs, and antihemophiliac products, epidermal growth stimulants, antitrypsin products and interferon [23].

#### Extinction

Yaneer Bar-Yam 16, Founding President of the New England Complex Systems Institute, “Transition to extinction: Pandemics in a connected world,” NECSI (July 3, 2016), http://necsi.edu/research/social/pandemics/transition

Watch as one of the more aggressive—brighter red — strains rapidly expands. After a time it goes extinct leaving a black region. Why does it go extinct? The answer is that it spreads so rapidly that it kills the hosts around it. Without new hosts to infect it then dies out itself. That the rapidly spreading pathogens die out has important implications for evolutionary research which we have talked about elsewhere [1–7].¶ In the research I want to discuss here, what we were interested in is the effect of adding long range transportation [8]. This includes natural means of dispersal as well as unintentional dispersal by humans, like adding airplane routes, which is being done by real world airlines (Figure 2).¶ When we introduce long range transportation into the model, the success of more aggressive strains changes. They can use the long range transportation to find new hosts and escape local extinction. Figure 3 shows that the more transportation routes introduced into the model, the more higher aggressive pathogens are able to survive and spread.¶ As we add more long range transportation, there is a critical point at which pathogens become so aggressive that the entire host population dies. The pathogens die at the same time, but that is not exactly a consolation to the hosts. We call this the phase transition to extinction (Figure 4). With increasing levels of global transportation, human civilization may be approaching such a critical threshold.¶ In the paper we wrote in 2006 about the dangers of global transportation for pathogen evolution and pandemics [8], we mentioned the risk from Ebola. Ebola is a horrendous disease that was present only in isolated villages in Africa. It was far away from the rest of the world only because of that isolation. Since Africa was developing, it was only a matter of time before it reached population centers and airports. While the model is about evolution, it is really about which pathogens will be found in a system that is highly connected, and Ebola can spread in a highly connected world.¶ The traditional approach to public health uses historical evidence analyzed statistically to assess the potential impacts of a disease. As a result, many were surprised by the spread of Ebola through West Africa in 2014. As the connectivity of the world increases, past experience is not a good guide to future events.¶ A key point about the phase transition to extinction is its suddenness. Even a system that seems stable, can be destabilized by a few more long-range connections, and connectivity is continuing to increase.¶ So how close are we to the tipping point? We don’t know but it would be good to find out before it happens.¶ While Ebola ravaged three countries in West Africa, it only resulted in a handful of cases outside that region. One possible reason is that many of the airlines that fly to west Africa stopped or reduced flights during the epidemic [9]. In the absence of a clear connection, public health authorities who downplayed the dangers of the epidemic spreading to the West might seem to be vindicated.¶ As with the choice of airlines to stop flying to west Africa, our analysis didn’t take into consideration how people respond to epidemics. It does tell us what the outcome will be unless we respond fast enough and well enough to stop the spread of future diseases, which may not be the same as the ones we saw in the past. As the world becomes more connected, the dangers increase.¶ Are people in western countries safe because of higher quality health systems? Countries like the U.S. have highly skewed networks of social interactions with some very highly connected individuals that can be “superspreaders.” The chances of such an individual becoming infected may be low but events like a mass outbreak pose a much greater risk if they do happen. If a sick food service worker in an airport infects 100 passengers, or a contagion event happens in mass transportation, an outbreak could very well prove unstoppable.

#### Asteroid mining offsets terrestrial growth that ruins the environment and enables solar power satellites – both solve climate change,

Veteran Journalist Taylor elaborates for Mashable in 2019

**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]

The mission is essential, Joyce declares, to save Earth from its **major problems**. First of all, the fictional billionaire wheels in a fictional Nobel economist to demonstrate the actual truth that the entire global economy is sitting on a **mountain of debt**. It has to keep growing or it will **implode**, so we might as well take the majority of the **industrial growth off-world where it can’t do any more harm to the biosphere.**

Secondly, there’s the **climate change fix**. Suarez sees asteroid mining as the only way we’re going to build **solar power satellites.** Which, as you probably know, is a form of uninterrupted solar power collection that is theoretically more effective, inch for inch, than any solar panels on Earth at high noon, but operating 24/7. (In space, basically, **it’s always double high noon).**

The power collected is beamed back to large receptors on Earth with large, low-power microwaves, which researchers think will be harmless enough to let humans and animals pass through the beam. A space solar power array like the one China is said to be working on could reliably supply 2,000 gigawatts — or **over 1,000 times more power than the largest solar farm currently in existence.**

“We're looking at a 20-year window to **completely replace human civilization's power infrastructure,**” Suarez told me, citing the report of the Intergovernmental Panel on Climate Change on the coming catastrophe. Solar satellite technology “has existed since the 1970s. What we were missing is **millions of tons of construction materials** in orbit. **Asteroid mining can place it there.”**

The Earth-centric early 21st century can’t really wrap its brain around this, but the idea is not to bring all that building material and precious metals down into our gravity well. Far better to create a whole new commodities exchange in space. You mine the useful stuff of asteroids both near to Earth and far, thousands of them taking less energy to reach than the moon. That’s something else we’re still grasping, how relatively easy it is to ship stuff in zero-G environments.