# 1nc r1 HWL

## Off

### 1-Extra-T

#### 1] Interp – Unjust refers to a negative action – it means contrary.

Black Laws No Date "What is Unjust?" <https://thelawdictionary.org/unjust/> //Elmer

Contrary to right and justice, or to the enjoyment of his rights by another, or to the standards of conduct furnished by the laws.

#### 2] Violation – The Aff is a positive action – it creates a new concept for Space i.e. the treating of Space as a “Global Commons”.

#### 3] Standards –

#### a] Limits – making the topic bi-directional explodes predictability – it means that Aff’s can both increase non-exist property regimes in space AND decrease appropriation by private actors – makes the topic untenable.

#### b] Ground – wrecks Neg Generics – we can’t say appropriation good since the 1AC can create new views on Outer Space Property Rights that circumvent our Links since they can say “Global Commons” approach solves.

#### 4] TVA – just defend that space appropriation is bad.

#### a] Topicality is Drop the Debater – it’s a fundamental baseline for debate-ability.

#### b] Use Competing Interps – 1] Topicality is a yes/no question, you can’t be reasonably topical and 2] Reasonability invites arbitrary judge intervention and a race to the bottom of questionable argumentation.

### 2 – T-Private

#### Interpretation- Debaters must defend the resolution resolved: The Appropriation of outer space by private entities is unjust.

#### Violation- their actor is governments- cross and the internals of the goehring card proves- they’ll say they don’t say governments in the plan text but all of their evidence is in the context of governments doing more regulation in space

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Normally this distinction between morality and justice does not matter very much. But this resolution is different. Why? Because most LD resolutions that use ‘justice’ as the evaluative term focus on government actions. Here are some examples from the last decade: • Resolved: Predictive policing is unjust. • Resolved: The United States’ use of targeted killing in foreign countries is unjust. • Resolved: Placing political conditions on humanitarian aid to foreign countries is unjust. This is significant. There is a sense of the word ‘justice’ where it just describes the proper ordering of government and society. This is the sense of the word that John Rawls uses in his famous quote: “Justice is the first virtue of social institutions, as truth is of systems of thought. A theory however elegant and economical must be rejected or revised if it is untrue; likewise laws and institutions no matter how efficient and well‑arranged must be reformed or abolished if they are unjust.” But even if the difference between justice and morality is blurred when we talk about government action, it is quite clear (philosophically) when we talk about individual action. And this resolution is about whether the action of an individual is unjust. The resolution is not asking ‘should governments ban the private appropriation of outer space.’ Rather, it is asking if individuals commit an injustice in appropriating outer space. At camp, when teaching this resolution, some people read cases about how countries should ban the appropriation of outer space, or about how international law should prohibit such appropriation. But those cases did not actually affirm the resolution. Just because the government should make something illegal, that does not mean the act is unjust before the government passes a law. It was a good idea for the government to ban driving on the left side of the road. But before the government passed a law one way or the other, there was nothing unjust about driving on the left. Similarly, it might be that the government should raise taxes. But that does not mean I’m doing anything unjust by not sending my untaxed income to the state. To say an act is unjust is not the same thing as saying an act should be prohibited. It can be a good idea to pass laws against just acts 11 1 Topic Analysis by Marshall Bierson (like many driving regulations), and it can be a bad idea to pass laws against unjust acts (it is unjust to cheat on one’s spouse, but the government probably should not outlaw infidelity). While legality is connected with justice, it is not the same thing as justice. So, cases that say appropriation should be illegal, are not actually affirming the resolution. They don’t show that appropriation is unjust. 1.2.3 Arguments that Don’t Work This also means that many of the arguments people make on the resolution do not actu‑ ally affirm or negate. For example, I saw many debaters at camp read cases about how the appropriation of outer space resources will contribute to inequality. The basic idea is that only the rich can spend money to acquire resources from outer space, and so such appropriation will mean that the rich get richer. But how does that show the appropriation of outer space resources is unjust? It might well give governments a reason to regulate, or even ban, the appropriation of outer space. But it does not seem to show the appropriation itself is unjust. Rather, what’s unjust is either the rich hoarding resources, or else the government allowing the rich a leg up over everyone else. Either way, it’s not the appropriation itself that is a problem. For example, imagine that Bill Gates goes and appropriate a meteor, and then sets it up so that the proceeds of the meteor fund a charitable trust that redistributes resources to the global poor. If the objection to appropriation was income inequality, then clearly this act of appropriation is fine. What this shows is that it was not the appropriation of outer space resources that was unjust, rather it is the excessive concentration of wealth. Another common argument I saw at camp was the argument that people appropriating outer space resources might lead to an arms race in space. Now, I think there are lots of problems with this argument, but the most fundamental problem is that even if it’s true, it’s not clear that it shows that anyone acts unjustly when appropriating outer space resources. Suppose I know that if I get a good job, it will make my neighbor jealous such that they will begin stealing. Do I act unjustly in getting a good job? No, my neighbor does. But generally, just because my behavior leads someone else to act unjustly, that does not mean that my act itself is unjust. As many philosophers have argued, justice is not a consequentialist value. Indeed, many philosophers have argued that justice is fundamen‑ tally incompatible with utilitarianism. (The Stanford Encyclopedia of Philosophy article on 12 1 Topic Analysis by Marshall Bierson “Justice” has a whole subsection titled: 4.2 Utilitarian theories of justice: three prob‑ lems.) There might, indeed, be utilitarian reasons to think it’s a bad idea to appropriate resources from outer space. But even if such utilitarian reasons show that such appro‑ priation is immoral, they don’t show its unjust. Why? Because those arguments don’t show that the act of appropriation itself wrongs anyone or violates any rights.

**1] Semantics outweigh:**

**A] Topicality is a constitutive rule of the activity and a basic aff burden, they agreed to debate the topic when they came to the tournament**

**B] Jurisdiction -- you can’t vote affirmative if they haven’t affirmed**

**C] It’s the only stasis point we know before the round so it controls the internal link to engagement, and there’s no way to use ground if debaters aren’t prepared to defend it.**

**2] Limits:**

**A] Quantitative – there are tens of of thousands of affs because they can call anything that makes it harder for companies in space as turning away from appropriation**

**B] Qualitative – they take away generic turns like appropriations good and functionally jettison "private entities" from the topic, which shifts away from the core topic lit – also means there is no universal DA to spec affs**

#### Cross apply paradigm issues and TVA

### 3 – Asteroid DA

#### Recent moves by NASA put Asteroid Mining solely in the hands of the private sector.

**Glester 18**, Andrew. [Andrew Glester is the host of the Physics World podcast and the Cosmic Shed podcast, which explores the way science and storytelling collide. He is also the co-ordinator of the Space Universities Network] “The Asteroid Trillionaires.” *PhysicsWorld*, 11 June 2018, <https://physicsworld.com/a/the-asteroid-trillionaires/>. [GHS-AA]

“I’ll make a prediction right now. The first trillionaire will be made in space.” So said Texas senator Ted Cruz, shortly after a bill was signed to increase NASA’s budget for 2018. To untrained ears, his claim would have sounded extraordinary. It might even have stretched credulity for those familiar with the challenges of space. But on closer inspection, Cruz was not being that revolutionary. Peter Diamandis – founder of the X Prize competition to encourage tech developments – made the same prediction back in 2008 and expanded on the theme in his 2015 book Bold. As for how those trillionaires will make their riches from space, both he and Neil DeGrasse Tyson – the US astrophysicist and TV host – reckon it will be done by mining asteroids. Progress is already under way. The first asteroid company, Planetary Resources, was founded in 2012 by Diamandis, Chris Lewicki and others in Washington. Within a year the US company Deep Space Industries was set up by Rick Tumlinson, Stephen Cover and a host of others. A handful more firms have since been established, and while some are admittedly are less serious than others, the race to the riches of space is on. Despite the existence of such firms and Cruz’s declaration, however, Donald Trump’s 2018 NASA budget cancelled the Asteroid Redirect Mission (ARM), which planned to bring an asteroid into an orbit around Earth where it could be studied and mined a lot more easily than one in the asteroid belt. A NASA spokesperson told me the ARM team is ensuring that the key knowledge from the mission so far is not lost, but NASA pulling out has left the asteroid-mining community without a valuable learning tool and places asteroid mining firmly in the realm of the private space sector. Nevertheless, the investment bank Goldman Sachs has reassured its clients about the financial benefits of investing in asteroid-mining companies. “The psychological barrier to mining asteroids is high, the actual financial and technological barriers are far lower,” it said in a report published last year. A Caltech study put the cost of an asteroid-mining mission at $2.6bn – perhaps not surprisingly the same estimated cost of NASA’s erstwhile ARM. It might sound a lot, but a rare-earth-metal mine has comparable set-up costs of up to $1bn and a football-field-sized asteroid could contain as much as $50bn of platinum.

#### Asteroid mining is key to solving water crises

Tillman 19 (Nola Taylor Tillman is a Freelance Science Writer at Redd Infinity. Graduate of Agnes Scott College.), “Tons of Water in Asteroids Could Fuel Satellites, Space Exploration”, Space, 9-29-19, <https://www.space.com/water-rich-asteroids-space-exploration-fuel.html> NT

When it comes to mining space for water, the best target may not be the moon: Entrepreneurs' richest options are likely to be asteroids that are larger and closer to Earth. **A recent study suggested that roughly 1,000 water-rich, or hydrated, asteroids near our planet are easier to reach than the lunar surface is.** While most of these space rocks are only a few feet in size, more than 25 of them should be large enough to each provide significant water. Altogether, the water locked in these asteroids should be enough to fill somewhere around 320,000 Olympics-size swimming pools — significantly more than the amount of water locked up at the lunar poles, the new research suggested. **Because asteroids are small, they have less gravity than Earth or the moon do, which makes them easier destinations to land on and lift off from**. If engineers can figure out how to mine water from these space rocks, they could produce a source of ready fuel in space that would allow spacecraft designers to build refuelable models for the next generation of satellites. Asteroid mining could also fuel human exploration, saving the expense of launching fuel from Earth. In both cases, would-be space-rock miners will need to figure out how to free the water trapped in hydrated minerals on these asteroids. "Most of the hydrated material in the near-Earth population is contained in the largest few hydrated objects," Andrew Rivkin, an asteroid researcher at Johns Hopkins University Applied Physics Research Laboratory in Maryland, told Space.com. Rivkin is the lead author on the paper, which estimated that near Earth asteroids could contain more easily accessible water than the lunar poles. "A sure thing" According to the United Nations Office for Outer Space Affairs, more than 5,200 of the objects launched into space are still in orbit today. While some continue to function, the bulk of them buzz uselessly over our heads every day. They carry fuel on board, and when they run out, they are either lowered into destructive orbits or left to become space junk, useless debris with the potential to cause enormous problems for working satellites. Refueling satellites in space could change that model, replacing it with long-lived, productive orbiters. "It's easier to bring fuel from asteroids to geosynchronous orbit than from the surface of the Earth," Rivkin said. "If such a supply line could be established, it could make asteroid mining very profitable." Hunting for space water from the surface of the Earth is challenging because the planet's atmosphere blocks the wavelength of light where water can be observed. The asteroid warming as it draws closer to the sun can also complicate measurements. Instead, Rivkin and his colleagues turned to a class of space rocks called Ch asteroids. Although these asteroids don't directly exhibit a watery fingerprint, they carry the telltale signal of oxidized iron seen only on asteroids with signatures of water-rich minerals, which means the authors felt confident assuming that all Ch asteroids carry this rocky water. Based on meteorite falls, a previous study estimated that Ch asteroids could make up nearly 10% of the near-Earth objects (NEOs). With this information, the researchers determined that there are between 26 and 80 such objects that are hydrated and larger than 0.62 miles (1 km) across. Right now, only three NEOs have been classified as Ch asteroids, although others have been spotted in the asteroid belt. Most NEOs are discovered and observed at wavelengths too short to reveal the iron band that marks the class. Carbon-rich asteroids, which include Ch asteroids and other flavors, are also darker than the more common stony asteroids, making them more challenging to observe. Although **Ch asteroids definitely contain water-rich minerals**, that doesn’t necessarily mean that they will always be the best bet for space mining. It comes down to risk. Would an asteroid-mining company rather visit a smaller asteroid that definitely has a moderate amount of water, or a larger one that could yield a larger payday but could also come up dry? "Whether getting sure things with no false positives, like the Ch asteroids, is more important or if a greater range of possibilities is acceptable with the understanding that some asteroids will be duds is something the miners will have to decide," Rivkin said.

#### Water Wars cause:

#### a] Indo-Pak War – goes Nuclear

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Interstate conflict over water might occur, the ICA indicated, when several states rely on a shared river system for much of their water supply and one or more of the riparian states sought to maximize the river’s flow for their own benefit at the expense of other states in the basin, amplifying any scarcities already present there. “We judge that as water shortages become more acute beyond the next ten years, water in shared basins will increasingly be used as leverage,” the ICA stated. An upstream state enjoying superior control over a river’s flow might exploit its advantage, say, to extract advantage in international negotiations or to attract international aid for infrastructure projects. As the ICA further noted, “…we assess that states will also use their inherent ability to construct and support major water projects to obtain regional influence or preserve their water interests.”16

The utilization of a state’s superior position in a shared river system to extract political or economic advantage can prove especially destabilizing, the ICA suggested, when weaker states in the system (typically the downstream countries) are especially vulnerable to water scarcity because of long-standing social, economic, and political conditions. Without identifying any particular states by name, the study suggested that this could occur when downstream states suffer from endemic corruption, poor water management practices, and systemic favoritism when it comes to the allocation of scarce water supplies. In such cases, any reduction in the flow of water by an upstream country could easily combine with internal factors in a downstream country to provoke widespread unrest and conflict. “Water shortages, and government failures to manage them, are likely to lead to social disruptions, pressure on national and local leaders, and potentially political instability,” the report noted.17

Although most discussion of the climate and water security nexus has continued to emphasize the risk of internal conflict arising from warming-related water scarcities, some analysts have pursued the line of inquiry introduced by the 2012 ICA, focusing on interstate tensions arising within shared river basins. This was a prominent theme, for example, of a 2013 study conducted by the National Research Council (NRC) on behalf of the IC. Entitled Climate and Social Stress: Implications for Security Analysis, the 2013 NRC report sought to better identify the links between global warming, pre-existing social vulnerabilities, and the likelihood of conflict. While it echoed earlier studies by the CNA and NIC in identifying internal factors like poverty, ethnic discord, and governmental ineptitude as likely pre-conditions for climate-related conflict, it also examined dangers arising from dependence on shared river systems, especially in cases where cooperation among the riparian powers in managing the system is limited and global warming is expected to reduce future water flows.18

For the NRC, the river systems of greatest concern in this respect were those that originate in the Himalayan Mountains and depend, for a significant share of the annual flow, on meltwater from the Himalayan glaciers. These glaciers are an important source of meltwater for many of Asia’s major rivers, including the Indus, Ganges, Brahmaputra, and

Mekong Rivers. These rivers originate in China but travel through India, Pakistan, Nepal, Bangladesh, Laos, Cambodia, Thailand, and Vietnam—countries with a combined population of over 3.4 billion people, or approximately 44 percent of the world’s total population.19 A large share of the population in these countries depends on agriculture for its livelihood, so ensuring access to adequate supplies of water is a prime local and national priority. During the monsoon season, heavy rains provide these rivers with abundant water, but during dry seasons they are dependent on glacial meltwater—and, with the rise in global temperatures, the Himalayan glaciers are melting, jeopardizing future water availability in these river basins. Given a history of ethnic and social discord within many of these countries and long-standing tensions among them, analysts fear that such shortages could aggravate both internal and external tensions and ignite interstate as well as intrastate conflict.20

As was the case of previous IC-initiated studies, the authors of the 2013 NRC report were reluctant to identify specific countries in their findings, referring again to “countries of security concern” or other such euphemisms. However, they did select one of these countries in particular: Pakistan. They chose that country for special analysis, the report indicated, because “Pakistan presents a clear example of a country where social dynamics and susceptibility to harm from climate events combine to create a potentially unstable situation.”21 Pakistan was said to suffer from multiple risk factors: Its economy is largely dependent on agriculture; much of the water used for irrigation purposes comes from just one source, the Indus River; control over the allocation of irrigation waters is often exercised by privileged elites, leaving millions of Pakistanis vulnerable to water shortages; and much of the water flowing into the Indus comes from China or from tributaries originating in India, leaving Pakistan in an unfavorable (downstream) position in the system. These conditions have led, in the past, to internal squabbles over water rights and to tensions with India over control of the Indus; now, with the likelihood of diminished meltwater from the Himalayan glaciers, the risk of water scarcity triggering violent conflict of one sort or another becomes that much greater.22

Pakistan, the Indus, and U.S. Security

There is no doubt that Pakistan is considered by U.S. security analysts as a “state important to U.S. national security interests,” the term used by the Defense Intelligence Agency to describe countries of concern in the 2012 ICA on water. Not only is Pakistan a critical—if not always wholehearted—partner in the global war on terror, but it also possesses a substantial arsenal of nuclear weapons whose security is a matter of enormous concern to American leaders.23 Should those munitions wind up with rogue elements of the Pakistani military (some of whose members are believed to maintain clandestine links to radical Islamic organizations), or even worse, should Pakistan descend into civil war and the weapons fall into untrustworthy or hostile hands, the safety of India and other US allies—as well as of American forces deployed in the region—would be at grave risk.24 Ensuring Pakistan’s stability therefore, has long been a major U.S. security objective, prompting regular deliveries of American arms and other military aid. Yet, despite billions of dollars in American aid, Pakistan remains vulnerable to social and ethnic internal strife.25

As noted, farming is the principal economic activity in Pakistan, and ensuring access to water is an overarching public and government concern. This means, above all, managing the use of the Indus—the country’s main source of water for irrigation and its major source of power for electricity generation. Pakistan’s rising population and growing cities, with their rings of factories, are placing an immense strain on the Indus, leading to competition between farmers, industrialists, and urban consumers. With water and power shortages becoming an increasingly frequent aspect of daily life, public protests—sometimes turning violent—have erupted across the country. In one particularly intense bout of rioting, following a prolonged power outage in June 2012, protestors burned trains, blocked roads, looted shops, and damaged banks and gas stations.26

However bad things might be in Pakistan today, climate change is likely to make conditions far worse in the years ahead. Prolonged droughts, climate scientists believe, will occur with increasing regularity, posing a severe threat to the nation’s agricultural sector and further reducing the supply of hydroelectric power. At the same time, warming is expected to increase the intensity of monsoon downpours, resulting in massive flooding (as occurred in 2010) and the loss of valuable topsoil, further adding to Pakistan’s woes. As the Himalayan glaciers melt, moreover, water flow through the Indus will diminish.27 With the competition for land and water resources bound to increase and with Pakistan already divided along ethnic and religious lines, widespread civil strife will become ever more likely, possibly jeopardizing the survival of the state.

It is impossible to predict exactly how the United States might respond to a systemic breakdown of state governance in Pakistan. One thing is clear, however: At the earliest sign that the country’s nuclear weapons are at risk of falling into the hands of hostile parties, the American military would respond with decisive force. In fact, research conducted by the nonpartisan Nuclear Threat Initiative (NTI) has revealed that the Joint Special Operations Command (JSOC) and specialized Army units have been training for such contingencies for some time and have deployed all the necessary gear to the region. In the event of a coup or crisis, the NTI revealed, “U.S. forces would rush into the country, crossing borders, rappelling down from helicopters, and parachuting out of airplanes, so they can secure known or suspected nuclear-storage sites.” Recognizing that any such actions by American forces could trigger widespread resistance by the Pakistani army and/or various jihadist groups, the U.S. Central Command, which has authority over all American forces in the region, has developed plans for backing up JSOC personnel with full-scale military support.28

Another scenario that has some analysts worried is the possibility that a time of sharply reduced water flow through the Indus will coincide with efforts by India to exploit its advantageous position as the upper riparian on three key tributaries of the Indus—the Ravi, the Beas, and the Sutlej—to divert water for its own use, thereby depriving downstream Pakistan of vital supplies and provoking a war between these two countries. India was granted control over the three tributaries under the Indus Water Treaty of 1960, and various Indian leaders have threatened at times to dam the rivers or otherwise reduce their flow into Pakistan as a reprisal for Pakistani attacks on Indian bases in the disputed territory of Kashmir (through which the tributaries flow); this, in turn, has provoked counter-threats from Pakistani leaders.29 What analysts fear most, in such a situation, is that India, possessing superior conventional forces, would overpower Pakistan’s equivalent armies, leading Pakistan’s leaders to order the use of nuclear weapons against India, igniting a regional nuclear war. Such a conflict, scientists have calculated, would result in 50 to 125 million fatalities, and produce a dust cloud covering much of the Earth, decimating global agriculture—an outcome with enormous implications for American national security.30

### 4 - CP

#### Nations ought to establish a treaty which

#### coordinates travel and limits traffic in busy orbits,

#### limits the creation of debris,

#### prohibits deployment and testing of weapons in space

#### creates an independent international agency to review and approve mining and space colonies

Ramin **Skibba 7/22**<https://undark.org/2021/07/22/its-time-for-a-new-international-space-treaty/> (Ramin Skibba is an astrophysicist turned science writer and freelance journalist who is based in San Diego. He has written for The Atlantic organization, Slate, Scientific American, and Nature, among other publications.) [AB]

The Biden administration has so far focused its space policy not on treaties but on “norms,” non-legally binding principles that they hope will evolve into international agreements with teeth. But it’s hard to imagine that enforceable international space policies will be adopted unless Biden explicitly and enthusiastically calls for them, while urging Russian and Chinese leaders to do the same. More likely, whatever endeavors the space industry and military decide to pursue will retroactively become policy. This is already playing out in debates about the private harvesting of resources from the moon and asteroids, the types of spacecraft companies can put in orbit, and the kinds of space and anti-satellite weapons militaries can develop. **More than half a century after humans first set foot on the moon, there remains no clearly established, agreed-upon rules governing space activity.** **If we were to design a new space treaty that would preserve space primarily as a place for exploration and collaboration rather than for war and commercial gain, what would it look like? It would coordinate travel and limit traffic in busy orbits in the atmosphere while also taking steps to limit the creation of space debris. (Cleaning up the mess already clogging low-Earth orbit is another story entirely.) It would also build on the Moon Agreement, prohibiting the deployment and testing of weapons — including electronic weapons — in the atmosphere. And it would prohibit deploying and testing any weapons in space, not just on the moon or other celestial bodies. It would create an independent, international organization to review proposals for mining resources and establishing colonies on the moon, Mars, and beyond. This sounds ambitious — and it is — but it’s achievable**. The Antarctic Treaty of 1961 enshrines many of the same principles for activity on Antarctica, and it still works six decades later. **Public opinion on space seems to be shifting, too, with growing calls to jettison colonialist views of space exploration in favor of more egalitarian approaches.** If scientists, non-governmental groups, space environmentalists, and other stakeholders put pressure on the Biden administration, it could become politically feasible for the president to take a stand and jumpstart space diplomacy with the U.S.’s rivals. **To the extent that it would help make space exploration sustainable, peaceful, and beneficial to all humanity, it would be worth the cost in political capital.** We only have one atmosphere, one moon, and one night sky to cherish.

#### All planks solve the aff

## Case

### 1NC – AT: Solvency

#### Normal means has the plan implemented through the *Committee on the Peaceful use of Outer Space.*

Halstead 10—(B.S., Psychology, The University of Alabama; J.D., The University of Alabama School of Law; LL.M., Institute of Air and Space Law, McGill University; Lieutenant Colonel, U.S. Air Force Judge Advocate General's Corps). C. Brandon Halstead. 2010. "Prometheus Unbound - Proposal for a New Legal Paradigm for Air Law and Space Law: Orbit Law," Journal of Space Law 36, no. 1, 143-206

The debate on how to distinguish airspace from outer space is as old as the space age itself. The problems emerging from space exploration first entered the agenda of the United Nations in 1957, and were later placed on the agenda before the General Assembly through the establishment of an Ad Hoc Committee on the Peaceful Uses of Outer Space (COPUOS) in 1958.' Although this Committee initially focused on the debate of disarmament, its status was later made permanent in 1961 while its charter was expanded to include examination of all issues relating to the field of exploration and use of outer space by governmental and non-governmental organizations.16 In 1962 the Scientific and Technical Sub-Committee and Legal Sub-Committee began their true substantive work and became the main center of international cooperation and coordination for exploration of peaceful uses of outer space." Successive sessions focused on general and specific issues of space law, including the establishment of a frontier between outer space and atmospheric space18.

#### OST Fails

**Evanoff 17** [Kyle Evanoff, Kyle is a research associate in international economics and U.S. foreign policy at the Council on Foreign Relations 10/10/17, "The Outer Space Treaty’s Midlife Funk," Council on Foreign Relations [https://www.cfr.org/blog/outer-space-treatys-midlife-funk accessed 12/11/2021](https://www.cfr.org/blog/outer-space-treatys-midlife-funk%20accessed%2012/11/2021)] Adam

Half a century later, however, the Outer Space Treaty has entered something of a funk. Despite the universal aspirations of the UN Committee on the Peaceful Uses of Outer Space, which molded the document into its completed form, many of the principles enshrined within the text are less suited to the present than they were to their native Cold War milieu. While the anachronism has not reached crisis levels, current and foreseeable developments do present challenges for the treaty, heightening the potential for disputes. At the crux of the matter is the ongoing democratization of space. During the 1950s and ‘60s, when the fundamental principles of international space law took shape, only large national governments could afford the enormous outlays required for creating and maintaining a successful space program. In more recent decades, technological advances and new business models have broadened the range of spacefaring actors. Thanks to innovations such as reusable rockets, micro- and nanosatellites, and inflatable space station modules, costs are decreasing and private companies are crowding into the sector. This flurry of activity, known as New Space, promises nothing less than a complete transformation of the way that humans interact with space. Asteroid mining, for example, could eliminate the need to launch many essential materials from Earth, lowering logistical hurdles and enabling largescale in-space fabrication. Companies like Planetary Resources and Deep Space Industries, by extracting and selling useful resources in situ, could help to jumpstart a sustainable space economy. They might also profit from selling valuable commodities back on terra firma. As a recent (bullish) Goldman Sachs report noted, a single football-field-sized asteroid could contain $25 to $50 billion worth of platinum—enough to upend the terrestrial market. With astronomical sums at stake and the commercial sector kicking into high gear, legal questions are becoming a major concern. Many of these questions focus on Article II of the Outer Space Treaty, which prohibits national appropriation of space and the celestial bodies. Since another provision (Article VI) requires nongovernmental entities to operate under a national flag, some experts have suggested that asteroid mining, which would require a period of exclusive use, may violate the agreement. Others, however, contend that companies can claim ownership of extracted resources without claiming ownership of the asteroids themselves. They cite the lunar samples returned to Earth during the Apollo program as a precedent. Hoping to promote American space commerce, Congress formalized this more charitable legal interpretation in Title IV of the 2015 U.S. Commercial Space Launch Competitiveness Act. Luxembourg, which announced a €200 million asteroid mining fund last year, followed suit with its own law in August. Controversies like the one surrounding asteroid mining are par for the course when it comes to the Outer Space Treaty. The agreement’s insistence that space be used “for peaceful purposes” has long been the subject of intense debate. During the treaty-making process, Soviet jurists argued that peaceful meant “non-military” and that spy satellites were illegal; Americans, who enjoyed an early lead in orbital reconnaissance, interpreted peaceful to mean “non-aggressive” and came to the opposite conclusion. Decades later, the precise meaning of the phrase remains a matter of contention. While the Outer Space Treaty has survived past disputes intact, some experts and policymakers believe that an update is in order. Senator Ted Cruz (R-TX), for instance, worries that legal ambiguity could undermine the nascent commercial space sector—a justifiable concern. Russia and Brazil, among other countries, hold asteroid mining operations to constitute de facto national appropriation. And while there are plenty of asteroids to go around for now (NASA has catalogued nearly 8,000 near earth objects larger than 140 meters in diameter), more supply-side saturation could lead to conflicts over choice space rocks. The absence of clear property rights makes this prospect all the more likely. Plans to establish outposts on the moon and Mars present a bigger challenge still. Last week, prior to the first meeting of the revived National Space Council, Vice President Mike Pence described the need for “a renewed American presence on the moon, a vital strategic goal” in an op-ed for the Wall Street Journal. His piece came on the heels of SpaceX Founder and Chief Executive Officer Elon Musk’s announcement at the 2017 International Astronautical Congress of a revised plan to colonize the red planet, with the first human missions slated for 2024. Musk hopes for the colony to house one million inhabitants within the next fifty years. While mining might require only temporary use of the celestial bodies, full-fledged colonies would necessarily be more permanent affairs. With some national governments arguing that mining operations would constitute territorial claims, lunar and Martian bases are almost certain to enter the legal crosshairs. And, even under the favorable U.S. interpretation of the Outer Space Treaty, states and private companies would need to avoid making territorial claims. If viable colony locations are relatively few and far between, fierce competition could make asserting control a practical necessity. Even so, policymakers should avoid hasty attempts to overhaul the Outer Space Treaty. The uncertainties associated with altering the fundamental principles of international space law are greater than any existing ambiguities. Commercial spacefaring already entails high levels of risk; adding new regulatory hazards to the mix would jeopardize investment and could slow progress in the sector. While the current property rights regime may be untenable over longer timelines, it remains workable for now.

#### All your solvency advocates assume the aff creates legal institutions and frameworks to create sustainable use of outer space – but you haven’t read an internal link that says simply the declaration of outer space as a global commons does that

#### Russia and China say no, or the plan gets watered down.

**Bahney and Pearl 19** [Benjamin Bahney and Jonathan Pearl, 3-26-2019, "Why Creating a Space Force Changes Nothing," BENJAMIN BAHNEY and JONATHAN PEARL are Senior Fellows at the Lawrence Livermore National Laboratory’s Center for Global Security Research and contributing authors to [Cross Domain Deterrence: Strategy in an Era of Complexity](https://archive.md/o/Hlbi1/https:/www.amazon.com/Cross-Domain-Deterrence-Strategy-Era-Complexity/dp/0190908653). Foreign Affairs, [https://www.foreignaffairs.com/articles/space/2019-03-26/why-creating-space-force-changes-nothing accessed 12/10/21](https://www.foreignaffairs.com/articles/space/2019-03-26/why-creating-space-force-changes-nothing%20accessed%2012/10/21)] Adam

As Russia and China continue to push forward, U.S. policymakers may be tempted to use treaties and diplomacy to head off their efforts entirely. This option, although alluring on paper, is simply not feasible. Existing treaties designed to limit military competition in space have had little success in actually doing so. The 1967 Outer Space Treaty bans parties from placing nuclear weapons or other weapons of mass destruction in space, on the moon, or on other celestial bodies, but it has no formal mechanism for verifying compliance, and places no restrictions on the development or deployment in space of conventional antisatellite weapons. Even if it were possible to convince Moscow and Beijing of the benefits of comprehensive space arms control, existing technology makes it extremely difficult to verify compliance with the necessary treaty provisions—and without comprehensive and reliable verification, treaties are toothless. Moreover, regulating the development and deployment of antisatellite weapons is extremely difficult, both because they include such a broad and diverse range of technologies and because many types of antisatellite weapons can be concealed or explained away as having some other use. Unsurprisingly, Russia and China’s draft Treaty on the Prevention of Placement of Weapons in Space, which they have been pushing for several years now, has an unenforceable definition of what constitutes a “weapon” and does nothing at all to address ground-based antisatellite weapons development.

### 1NC - AT: Debris

#### No debris cascades, but even a worst case is confined to low LEO with no impact

Daniel Von Fange 17. Web Application Engineer, Founder and Owner of LeanCoder, Full Stack, Polyglot Web Developer, “Kessler Syndrome is Over Hyped”, 5/21/2017, http://braino.org/essays/kessler\_syndrome\_is\_over\_hyped/

Kessler Syndrome is overhyped. A chorus of online commenters great any news of upcoming low earth orbit satellites with worry that humanity will to lose access to space. I now think they are wrong. What is Kessler Syndrome? Here’s the popular view on Kessler Syndrome. Every once in a while, a piece of junk in space hits a satellite. This single impact destroys the satellite, and breaks off several thousand additional pieces. These new pieces now fly around space looking for other satellites to hit, and so exponentially multiply themselves over time, like a nuclear reaction, until a sphere of man-made debris surrounds the earth, and humanity no longer has access to space nor the benefits of satellites. It is a dark picture. Is Kessler Syndrome likely to happen? I had to stop everything and spend an afternoon doing back-of-the-napkin math to know how big the threat is. To estimate, we need to know where the stuff in space is, how much mass is there, and how long it would take to deorbit. The orbital area around earth can be broken down into four regions. Low LEO - Up to about 400km. Things that orbit here burn up in the earth’s atmosphere quickly - between a few months to two years. The space station operates at the high end of this range. It loses about a kilometer of altitude a month and if not pushed higher every few months, would soon burn up. For all practical purposes, Low LEO doesn’t matter for Kessler Syndrome. If Low LEO was ever full of space junk, we’d just wait a year and a half, and the problem would be over. High LEO - 400km to 2000km. This where most heavy satellites and most space junk orbits. The air is thin enough here that satellites only go down slowly, and they have a much farther distance to fall. It can take 50 years for stuff here to get down. This is where Kessler Syndrome could be an issue. Mid Orbit - GPS satellites and other navigation satellites travel here in lonely, long lives. The volume of space is so huge, and the number of satellites so few, that we don’t need to worry about Kessler here. GEO - If you put a satellite far enough out from earth, the speed that the satellite travels around the earth will match the speed of the surface of the earth rotating under it. From the ground, the satellite will appear to hang motionless. Usually the geostationary orbit is used by big weather satellites and big TV broadcasting satellites. (This apparent motionlessness is why satellite TV dishes can be mounted pointing in a fixed direction. You can find approximate south just by looking around at the dishes in your northern hemisphere neighborhood.) For Kessler purposes, GEO orbit is roughly a ring 384,400 km around. However, all the satellites here are moving the same direction at the same speed - debris doesn’t get free velocity from the speed of the satellites. Also, it’s quite expensive to get a satellite here, and so there aren’t many, only about one satellite per 1000km of the ring. Kessler is not a problem here. How bad could Kessler Syndrome in High LEO be? Let’s imagine a worst case scenario. An evil alien intelligence chops up everything in High LEO, turning it into 1cm cubes of death orbiting at 1000km, spread as evenly across the surface of this sphere as orbital mechanics would allow. Is humanity cut off from space? I’m guessing the world has launched about 10,000 tons of satellites total. For guessing purposes, I’ll assume 2,500 tons of satellites and junk currently in High LEO. If satellites are made of aluminum, with a density of 2.70 g/cm3, then that’s 839,985,870 1cm cubes. A sphere for an orbit of 1,000km has a surface area of 682,752,000 square KM. So there would be one cube of junk per .81 square KM. If a rocket traveled through that, its odds of hitting that cube are tiny - less than 1 in 10,000. So even in the worst case, we don’t lose access to space. Now though you can travel through the debris, you couldn’t keep a satellite alive for long in this orbit of death. Kessler Syndrome at its worst just prevents us from putting satellites in certain orbits. In real life, there’s a lot of factors that make Kessler syndrome even less of a problem than our worst case though experiment. Debris would be spread over a volume of space, not a single orbital surface, making collisions orders of magnitudes less likely. Most impact debris will have a slower orbital velocity than either of its original pieces - this makes it deorbit much sooner. Any collision will create large and small objects. Small objects are much more affected by atmospheric drag and deorbit faster, even in a few months from high LEO. Larger objects can be tracked by earth based radar and avoided. The planned big new constellations are not in High LEO, but in Low LEO for faster communications with the earth. They aren’t an issue for Kessler. Most importantly, all new satellite launches since the 1990’s are required to include a plan to get rid of the satellite at the end of its useful life (usually by deorbiting) So the realistic worst case is that insurance premiums on satellites go up a bit. Given the current trend toward much smaller, cheaper micro satellites, this wouldn’t even have a huge effect. I’m removing Kessler Syndrome from my list of things to worry about.

#### No collisions---takes centuries and mitigation checks.

Hugh Lewis 15. Senior Lecturer in Aerospace Engineering at the University of Southampton, “Space debris, Kessler Syndrome, and the unreasonable expectation of certainty.” Room, <https://room.eu.com/article/Space_debris_Kessler_Syndrome_and_the_unreasonable_expectation_of_certainty>

There is now widespread awareness of the space debris problem amongst policymakers, scientists, engineers and the public. Thanks to pivotal work by J.C. Liou and Nicholas Johnson in 2006 we now understand that the continued growth of the debris population is likely in the future even if all launch activity is halted. The reason for this sustained growth, and for the concern of many satellite operators who are forced to act to protect their assets, are collisions that are expected to occur between objects – satellites and rocket stages – already in orbit. In spite of several commentators warning that these collisions are just the start of a collision cascade that will render access to low Earth orbit all but impossible – a process commonly referred to as the ‘Kessler Syndrome’ after the debris scientist Donald Kessler – the reality is not likely to be on the scale of these predictions or the events depicted in the film Gravity. Indeed, results presented by the Inter-Agency Space Debris Coordination Committee (IADC) at the Sixth European Conference on Space Debris show an expected increase in the debris population of only 30% after 200 years with continued launch activity. Collisions are still predicted to occur, but this is far from the catastrophic scenario feared by some. Constraining the population increase to a modest level can be achieved, the IADC suggested, through widespread and good compliance with existing space debris mitigation guidelines, especially those relating to passivation (whereby all sources of stored energy on a satellite are depleted at the end of its mission) and post-mission disposal, such as de-orbiting the satellite or re-orbiting it to a graveyard orbit. Nevertheless, the anticipated growth of the debris population in spite of these robust efforts merits the investigation of additional measures to address the debris threat, according to the IADC.

### --- AT: Wood 20

#### Wood’s claim is not reverse causal and the satellites causing the problem are already in-orbit and non-operational --- stockdale reads green.

Therese **Wood, 20** - ("Who owns our orbit: Just how many satellites are there in space?," World Economic Forum, 10-23-2020, 12-8-2021, https://www.weforum.org/agenda/2020/10/visualizing-easrth-satellites-sapce-spacex)//AW

There are nearly 6,000 satellites circling the Earth, but only 40% are operational. Satellites are a vital part of our infrastructure, helping us to use GPS, access the internet and support studies of the Earth. Out of the 2,666 operational satellites circling the globe in April 2020, 1,007 were for communication services. 446 are used for observing the Earth and 97 for navigation/ GPS purposes. Over half of satellites in space are non-operational. For centuries, humans have looked to space and the stars for answers. The fascination is more than philosophical—it’s coupled with the need to solve problems here on Earth. Today, there are seemingly countless benefits and applications of space technology. Satellites, for instance, are becoming critical for everything from internet connectivity and precision agriculture, to border security and archaeological study. Right now, there are nearly 6,000 satellites circling our tiny planet. About 60% of those are defunct satellites—space junk—and roughly 40% are operational. As highlighted in the chart above, The Union of Concerned Scientists (UCS), determined that 2,666 operational satellites circled the globe in April of 2020. Over the coming decade, it’s estimated by Euroconsult that 990 satellites will be launched every year. This means that by 2028, there could be 15,000 satellites in orbit. Nearly 10,000 satellites will be launched form 2019-2028. Image: Visual Capitalist With SpaceX’s planned Starlink constellation of 12,000 satellites and Amazon’s proposed constellation in the works, the new space race continues its acceleration. Let’s take a closer look at who operates those satellites and how they apply their technology. Technology with a purpose Humans have long used space for navigation. While sailors once relied on the stars, today we use satellites for GPS, navigation, and various other applications. More than half of Earth’s operational satellites are launched for commercial purposes. About 61% of those provide communications, including everything from satellite TV and Internet of Things (IoT) connectivity to global internet. Over 1,000 satellites are for communication purposes. Image: Visual Capitalist Second to communications, 27% of commercial satellites have been launched for Earth Observation (EO) purposes, including environmental monitoring and border security. Commercial satellites, however, can serve multiple purposes. One week, a satellite may be ‘tasked’ to image a contested border. It could later be tasked to monitor the reclamation of a mining site or even the aftermath of a natural disaster. 54% of operational satellites are for commercial use. Image: Visual Capitalist Government and civil purposes make up 21% of all of Earth’s operational satellites, and military purposes come in at 13%. Who owns Earth’s orbit? Space operators SpaceX—founded by Elon Musk—is not only a disruptive launch provider for missions to the International Space Station (saving NASA millions). It’s also the largest commercial operator of satellites on the planet. With 358 satellites launched as of April, part of SpaceX’s mission is to boost navigation capabilities and supply the world with space-based internet. While the company operated 22% of the world’s operational satellites as of April, it went on to launch an additional 175 satellites in the span of one month, from August to September 2020.

#### And says the vast-majority are state owned even if they’re for commercial purposes --- stockdale finishes the article.

Therese **Wood, 20** - ("Who owns our orbit: Just how many satellites are there in space?," World Economic Forum, 10-23-2020, 12-8-2021, https://www.weforum.org/agenda/2020/10/visualizing-easrth-satellites-sapce-spacex)//AW

Nations that dominate Earth’s orbit It may be no surprise that the United States, China, and Russia top the list of countries with operational satellites. The U.S. and Russia (then the USSR) piloted the space race throughout the 1950s and 1960s. Both nations are found in the top three of current satellite operators, with the U.S. operating nearly half of all satellites—1,308 as of April 2020. China trails the U.S. with approximately 356 satellites. Taking third spot, Russia has 167 satellites in operation, and the UK comes in at a close fourth with 130 satellites. Space satellites orbit Earth U.S. UK Russia China China owns 356 operational satellites. Image: Visual Capitalist Collectively, the above five countries operate roughly 76% of the world’s satellites. The new space race Where the original space race was a nationalistic competition between Cold War rivals, the new space race is collaborative and commercialized. Today, international cooperation allows for the deployment of satellites, as well as space-based science. Before SpaceX, NASA and the other space agencies that operate the International Space Station had been reliant on Russian Soyuz rockets for hundreds of missions. With the success of its famed reusable rockets, SpaceX is on track to reduce launch costs by as much as US$6 million per flight—which is likely to support the proliferation of satellites in the coming years. With improved technology and commercial partnerships, all signs point to a crowded orbit.

#### 86% of debris owned publically

Wright 12 — David Wright (Received his PhD in physics from Cornell University in 1983 and worked for five years as a research physicist, SSRC-MacArthur Foundation Fellow in International Peace and Security in the Center for Science and International Affairs in the Kennedy School of Government at Harvard, and a Senior Analyst at the Federation of American Scientists), 2012, “Who Owns the Most Space Debris? Depends What You Measure”. <https://allthingsnuclear.org/dwright/who-owns-the-most-space-debris-depends-what-you>.

The number of debris particles in orbit is a concern since if these particles collide with a satellite they can damage or destroy it. The plot on the right shows that the US and Russia together own more than 85% of the debris mass in LEO, while China owns a small slice. This is because these two countries have many more large-mass objects in orbit, like defunct satellites and the rocket stages used to put them in orbit. These large-mass objects are a concern because they are the potential sources of large amounts of debris in the future, since in a collision these objects could fragment into enormous clouds of debris. As a result, these are the objects you most want to remove from orbit to reduce the likelihood of large future increases of debris. Removing these objects can be thought of as pulling down large amounts of debris that are currently all in one place. Figuring out how to remove the large objects in a safe and affordable way is an area of active research. What the plot on the right makes clear is that despite the 2007 Chinese ASAT test, the responsibility for debris remediation—i.e., removing the most problematic debris already in space—is overwhelmingly a US-Russian issue.

### --- AT: Munoz-Patchen 19

#### Tipping points are thumped, no one follows the guidelines, and new space-faring nations are an alt cause --- stock reads green.

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

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

### --- AT: Johnson 13

#### Don’t powertag --- no nuke war, alt causes, and thumped. stock reads green.

Les Johnson 13, Deputy Manager for NASA's Advanced Concepts Office at the Marshall Space Flight Center, Co-Investigator for the JAXA T-Rex Space Tether Experiment and PI of NASA's ProSEDS Experiment, Master's Degree in Physics from Vanderbilt University, Popular Science Writer, and NASA Technologist, Frequent Contributor to the Journal of the British Interplanetary Sodety and Member of the American Institute of Aeronautics and Astronautics, National Space Society, the World Future Society, and MENSA, Sky Alert!: When Satellites Fail, p. 9-12 [language modified]

Whatever the initial cause, the result may be the same. A satellite destroyed in orbit will break apart into thousands of pieces, each traveling at over 8 km/sec. This virtual shotgun blast, with pellets traveling 20 times faster than a bullet, will quickly spread out, with each pellet now following its own orbit around the Earth. With over 300,000 other pieces of junk already there, the tipping point is crossed and a runaway series of collisions begins. A few orbits later, two of the new debris pieces strike other satellites, causing them to explode into thousands more pieces of debris. The rate of collisions increases, now with more spacecraft being destroyed. Called the "Kessler Effect", after the NASA scientist who first warned of its dangers, these debris objects, now numbering in the millions, cascade around the Earth, destroying every satellite in low Earth orbit. Without an atmosphere to slow them down, thus allowing debris pieces to bum up, most debris (perhaps numbering in the millions) will remain in space for hundreds or thousands of years. Any new satellite will be threatened by destruction as soon as it enters space, effectively rendering many Earth orbits unusable. But what about us on the ground? How will this affect us? Imagine a world that suddenly loses all of its space technology. If you are like most people, then you would probably have a few fleeting thoughts about the Apollo-era missions to the Moon, perhaps a vision of the Space Shuttle launching astronauts into space for a visit to the International Space Station (ISS), or you might fondly recall the "wow" images taken by the orbiting Hubble Space Telescope. In short, you would know that things important to science would be lost, but you would likely not assume that their loss would have any impact on your daily life. Now imagine a world that suddenly loses network and cable television, accurate weather forecasts, Global Positioning System (GPS) navigation, some cellular phone networks, on-time delivery of food and medical supplies via truck and train to stores and hospitals in virtually every community in America, as well as science useful in monitoring such things as climate change and agricultural sustainability. Add to this the [disabling] ~~crippling~~ of the US military who now depend upon spy satellites, space-based communications systems, and GPS to know where their troops and supplies are located at all times and anywhere in the world. The result is a nightmarish world, one step away from nuclear war, economic disaster, and potential mass starvation. This is the world in which we are now perilously close to living. Space satellites now touch our lives in many ways. And, unfortunately, these satellites are extremely vulnerable to risks arising from a half-century of carelessness regarding protecting the space environment around the Earth as well as from potential adversaries such as China, North Korea, and Iran. No government policy has put us at risk. It has not been the result of a conspiracy. No, we are dependent upon them simply because they offer capabilities that are simply unavailable any other way. Individuals, corporations, and governments found ways to use the unique environment of space to provide services, make money, and better defend the country. In fact, only a few space visionaries and futurists could have foreseen where the advent of rocketry and space technology would take us a mere 50 years since those first satellites orbited the Earth. It was the slow progression of capability followed by dependence that puts us at risk. The exploration and use of space began in 1957 with the launch of Sputnik 1 by the Soviet Union. The United States soon followed with Explorer 1. Since then, the nations of the world have launched over 8,000 spacecraft. Of these, several hundred are still providing information and services to the global economy and the world's governments. Over time, nations, corporations, and individuals have grown accustomed to the services these spacecraft provide and many are dependent upon them. Commercial aviation, shipping, emergency services, vehicle fleet tracking, financial transactions, and agriculture are areas of the economy that are increasingly reliant on space. Telestar 1, launched into space in the year of my birth, 1962, relayed the world's first live transatlantic news feed and showed that space satellites can be used to relay television signals, telephone calls, and data. The modern telecommunications age was born. We've come a long way since Telstar; most television networks now distribute most, if not ali, of their programming via satellite. Cable television signals are received by local providers from satellite relays before being sent to our homes and businesses using cables. With 65% of US households relying on cable television and a growing percentage using satellite dishes to receive signals from direct-to-home satellite television providers, a large number of people would be cut off from vital information in an emergency should these satellites be destroyed. And communications satellites relay more than television signals. They serve as hosts to corporate video conferences and convey business, banking, and other commercial information to and from all areas of the planet. The first successful weather satellite was TIROS. Launched in 1960, TIROS operated for only 78 days but it served as the precursor for today's much more long-lived weather satellites, which provide continuous monitoring of weather conditions around the world. Without them, providing accurate weather forecasts for virtually any place on the globe more than a day in advance would be nearly impossible. Figure !.1 shows a satellite image of Hurricane Ivan approaching the Alabama Gulf coast in 2004. Without this type of information, evacuation warnings would have to be given more generally, resulting in needless evacuations and lost economic activity (from areas that avoid landfall) and potentially increasing loss of life in areas that may be unexpectedly hit. The formerly top-secret Corona spy satellites began operation in 1959 and provided critical information about the Soviet Union's military and industrial capabilities to a nervous West in a time of unprecedented paranoia and nuclear risk. With these satellites, US military planners were able to understand and assess the real military threat posed by the Soviet Union. They used information provided by spy satellites to help avert potential military confrontations on numerous occasions. Conversely, the Soviet Union's spy satellites were able to observe the United States and its allies, with similar results. It is nearly impossible to move an army and hide it from multiple eyes in the sky. Satellite information is critical to all aspects of US intelligence and military planning. Spy satellites are used to monitor compliance with international arms treaties and to assess the military activities of countries such as China, Russia, Iran, and North Korea. Figure 1.2 shows the capability of modem unclassified space-based imaging. The capability of the classified systems is presumed to be significantly better, providing much more detail. Losing these satellites would place global militaries on high alert and have them operating, literally, in the blind. Our military would suddenly become vulnerable in other areas as well. GPS, a network of 24-32 satellites in medium-Earth orbit, was developed to provide precise position information to the military, and it is now in common use by individuals and industry. The network, which became fully operational in 1993, allows our armed forces to know their exact locations anywhere in the world. It is used to guide bombs to their targets with unprecedented accuracy, requiring that only one bomb be used to destroy a target that would have previously required perhaps hundreds of bombs to destroy in the pre-GPS world (which, incidentally, has resulted in us reducing our stockpile of non-GPS-guided munitions dramatically). It allows soldiers to navigate in the dark or in adverse weather or sandstorms. Without GPS, our military advantage over potential adversaries would be dramatically reduced or eliminated.

### 1NC - Space Col Good

#### Colonization of outer space is essential to humanity – 5 warrants

Orwig 15 [(Jessica, a senior editor at Insider. She has a Master of Science in science and technology journalism from Texas A&M University and a Bachelor of Science in astronomy and physics from The Ohio State University. Before NY she spent time as an intern at: American Physical Society in MD International Center for Theoretical Physics in Italy Fermi National Accelerator Laboratory in IL American Geophysical Union in DC), “5 undeniable reasons humans need to colonize Mars — even though it's going to cost billions,” Slate, 4/21/2015, https://www.businessinsider.com/5-undeniable-reasons-why-humans-should-go-to-mars-2015-4] MN

Establishing a permanent colony of humans on Mars is not an option. It's a necessity. At least, that's what some of the most innovative, intelligent minds of our age — Buzz Aldrin, Stephen Hawking, Elon Musk, Bill Nye, and Neil deGrasse Tyson — are saying. Of course, it's extremely difficult to foresee how manned missions to Mars that would cost hundreds of billions of dollars each, could benefit mankind. It's easier to imagine how that kind of money could immediately help in the fight against cancer or world hunger. That's because humans tend to be short-sighted. We're focused on what's happening tomorrow instead of 100 years from now. "If the human race is to continue for another million years, we will have to boldly go where no one has gone before," Hawking said in 2008 at a lecture series for NASA's 50th anniversary. That brings us to the first reason humans must colonize Mars: 1. Ensuring the survival of our species The only home humans have ever known is Earth. But history shows that surviving as a species on this tiny blue dot in the vacuum of space is tough and by no means guaranteed. The dinosaurs are a classic example: They roamed the planet for 165 million years, but the only trace of them today are their fossilized remains. A colossal asteroid wiped them out. Putting humans on more than one planet would better ensure our existence thousands if not millions of years from now. "Humans need to be a multiplanet species," Musk recently told astronomer and Slate science blogger Phil Plait. Musk founded the space transport company SpaceX to help make this happen. Mars is an ideal target because it has a day about the same length as Earth's and water ice on its surface. Moreover, it's the best available option: Venus and Mercury are too hot, and the Moon has no atmosphere to protect residents from destructive meteor impacts. 2. Discovering life on Mars Nye, the CEO of The Planetary Society, said during an episode of StarTalk Radio in March that humanity should focus on sending humans instead of robots to Mars because humans could make discoveries 10,000 times as fast as the best spacecraft explorers we have today. Though he was hesitant to say humans should live on Mars, he agreed there were many more discoveries to be made there. One monumental discovery scientists could make is determining whether life currently exists on Mars. If we're going to do that, we'll most likely have to dig much deeper than NASA's rovers can. The theory there is that life was spawned not from the swamps on adolescent Earth, but from watery chasms on Mars. The Mars life theory suggests that rocks rich with microorganisms could have been ejected off the planet's surface from a powerful impact, eventually making their way through space to Earth. It's not a stretch to imagine, because Martian rocks can be found on Earth. None of those, however, have shown signs of life. "You cannot rule out the fact that a Mars rock with life in it landing on the Earth kicked off terrestrial life, and you can only really test that by finding life on Mars," Christopher Impey, a British astronomer and author of over a dozen books in astronomy and popular science, told Business Insider. 3. Improving the quality of life on Earth "Only by pushing mankind to its limits, to the bottoms of the ocean and into space, will we make discoveries in science and technology that can be adapted to improve life on Earth." British doctor Alexander Kumar wrote that in a 2012 article for BBC News where he explored the pros and cons of sending humans to Mars. At the time, Kumar was living in the most Mars-like place on Earth, Antarctica, to test how he adapted to the extreme conditions both physiologically and psychologically. To better understand his poignant remark, let's look at an example: During its first three years in space, NASA's prized Hubble Space Telescope snapped blurry pictures because of a flaw in its engineering. The problem was fixed in 1993, but to try to make use of the blurry images during those initial years, astronomers developed a computer algorithm to better extract information from the images. It turns out the algorithm was eventually shared with a medical doctor who applied it to the X-ray images he was taking to detect breast cancer. The algorithm did a better job at detecting early stages of breast cancer than the conventional method, which at the time was the naked eye. "You can't script that. That happens all the time — this cross pollination of fields, innovation in one, stimulating revolutionary changes in another," Tyson, the StarTalk radio host, explained during an interview with Fareed Zakaria in 2012. It's impossible to predict how cutting-edge technologies used to develop manned missions to Mars and habitats on Mars will benefit other fields like medicine or agriculture. But we'll figure that out only by "pushing humankind to its limits" and boldy going where we've never been before. 4. Growing as a species Another reason we should go to Mars, according to Tyson, is to inspire the next generation of space explorers. When asked in 2013 whether we should go to Mars, he answered: "Yes, if it galvanizes an entire generation of students in the educational pipeline to want to become scientists, engineers, technologists, and mathematicians," he said. "The next generation of astronauts to land on Mars are in middle school now." Humanity's aspirations to explore space are what drive us toward more advanced technological innovations that will undoubtedly benefit mankind in one way or another. "Space is like a proxy for a lot of what else goes on in society, including your urge to innovate," Tyson said during his interview with Zakaria. He added: "There's nothing that drives ambitions the way NASA does." 5. Demonstrating political and economic leadership At a February 24 hearing, Aldrin told the US Senate's Subcommittee on Space, Science and Competitiveness that getting to Mars was a necessity not only for science, but also for policy. "In my opinion, there is no more convincing way to demonstrate American leadership for the remainder of this century than to commit to a permanent presence on Mars," he said. If Americans do not go to Mars, someone else will. And that spells political and economic benefit for whoever succeeds. "If you lose your space edge," Tyson said during his interview with Zakaria, "my deep concern is that you lose everything else about society that enables you to compete economically."

#### Mining---colonizing space resources solves bioD loss and resource shortages

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Ram S. Jahku, “The Importance of Natural Resources from Space and Key Challenges,” *Space Mining and Its Regulation*, Published by Springer International Publishing, pp. 11-21. 2017

Coping with the Scale and Complexity Problem

The land area of the entire world is 148.94 million sq. km (or 57.506 million sq. miles), and its water area is 361.132 million sq. km (or 139.434 million sq. miles). About half of that land area is truly viable for year- round habitation when one eliminates most parts of Antarctica, the Arctic north, Siberia, the most dangerous mountain ranges and the most arid desert regions. Rising sea levels will further decrease available land areas. When one divides about 75 million sq. km by 10 billion people (or about 133 people people/sq. km) it becomes clear that rising global population and shrinking land areas and exhaustion of many types of natural resources—especially potable water— will be a growing problem.7 Figure 2.2 shows the volume of water in the world in comparison to the total volume of Earth. This graphic helps us to realize just how small the amount of potable water that is truly accessible today in comparison to a rising global population actually is.

Figure 2.2 underscores the issue of just how difficult it will be to continue to provide key resources especially to major urban centers as global population continues to grow. And this is not just a question of sustaining human needs for water and natural resources. It is also a matter of sustaining endangered species of flora and fauna. The United Nations had done an analysis that shows the loss of species since 1800 and projections for the future show a very disturbing trend.8

The graphs in Fig. 2.3 that come from the U. S. Geological Survey seem to show a relationship between the rapid growth of the global human population in recent times and the increasing rate of extinction on species. The future availability of petroleum products and water is most often mentioned in studies of future resource scarcity, but broader studies have shown that the world by the mid twenty-first century will have many shortages. The following results from a detailed Global Nonrenewal Natural Resources (NNR) study came up with the following results, as shown in Fig. 2.1. 9 Although these results might vary somewhat from year to year based on economic downturns or upturns, the overall trend toward increasing shortages is clear. The upward mobility of the populations in China, India, Indonesia, and other newly industrialized companies suggest that up to three times more consumer demand for products and energy will be present by the middle of the twenty-first century. Only recycling and new energy sources can meet the great bulk of this burgeoning demand. Meeting the demand for natural resources has been identified as a problem by many that have researched this problem. The projections of shortages in the future are presented in Fig. 2.4 and in even greater detail in Fig. 2.5 are certainly of concern. As Chris Clugston’s detailed analysis of this subject has concluded: “Global Non Renewable Natural Resource (NNR) scarcity will intensify going forward, as global economic activity levels, economic growth rates, and corresponding NNR demand return to their pre-recession levels; and global NNR supply levels continue to approach and reach their geological limits.”

Yet the prospect of space mining can provide new options. A modest nearEarth asteroid rich in platinum, approximately spherical in shape and 30 m in diameter would constitute a volume of 4500 cu. m and represent a mass of perhaps 5000 metric tons. If one assumed that this asteroid was 50% platinum, then its value at current world market prices would be on the order of $90 billion. Even if the asteroid recovery mission and refinement costs ran to $5 billion and even if some of the proceeds were to go into some sort of global commons development or ecological fund, just a single such mission would produce many billions of dollars in profits. This may represent an extreme example, but there are over a million PHAs that are on the order of 30 m. The key in the early days of space mining would be to identify high-value targets.

A 50-m PHA would be over 4.6 times more massive in volume and content and would be incredibly valuable if it contained precious metals or rare earth materials such as iridium, rhodium, ruthenium, palladium, or osmium. In contrast, the economics would be much more difficult in the case of PHAs with less valuable natural resource contents. An asteroid with 70% nickel and molybdenum content and 50 m in diameter would have something like a market value of only about $200 million based on current market prices of $13,000 a metric ton for molybdenum and $10,000 a metric ton for nickel. This much lower valuation would call for space mining transport equipment of the longer term future that could be used over and over again. It would also likely mean systems that ran off of solar and electric propulsion systems.

#### That averts resource wars.

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Michael T. Klare, “How Resource Scarcity and Climate Change Could Produce a Global Explosion,” *The Nation*, April 22, 2013. <https://www.thenation.com/article/how-resource-scarcity-and-climate-change-could-produce-global-explosion/>

Brace yourself. You may not be able to tell yet, but according to global experts and the US intelligence community, the earth is already shifting under you. Whether you know it or not, you’re on a new planet, a resource-shock world of a sort humanity has never before experienced.

Two nightmare scenarios—a global scarcity of vital resources and the onset of extreme climate change—are already beginning to converge and in the coming decades are likely to produce a tidal wave of unrest, rebellion, competition and conflict. Just what this tsunami of disaster will look like may, as yet, be hard to discern, but experts warn of “water wars” over contested river systems, global food riots sparked by soaring prices for life’s basics, mass migrations of climate refugees (with resulting anti-migrant violence) and the breakdown of social order or the collapse of states. At first, such mayhem is likely to arise largely in Africa, Central Asia and other areas of the underdeveloped South, but in time, all regions of the planet will be affected.

#### Space exploration and habituation is good ---

#### 1] Extinction from asteroids and warming

Kovic 18 (Marko Kovic, co-founder and president of the thinktank [ZIPAR](https://kovic.ch/zipar/), the Zurich Institute of Public Affairs Research. He is also co-founder and CEO of the consulting firm [ars cognitionis](https://kovic.ch/consulting-ars-cognitionis/),. He has a PhD in political communication, University of Zurich.)(“Why space colonization is so important”, Nov 10, 2018, https://medium.com/@marko\_kovic/space-colonization-why-nothing-else-matters-a877723f77d4)

Should humankind exist in the future? Should the future existence of humankind be as good as possible in as many ways as possible?

If your answer to these two questions is Yes, then there is a topic that you should care about a lot: Space colonization.

Why, you might wonder, does space colonization matter, possibly more than anything else, as the title of this article claims? Because the future of humankind directly and completely dependent on whether and how we manage to colonize space.

Space colonization is a double-edged sword. On one hand, the creation of permanent and self-sustainable human habitats beyond Earth is unavoidable if humankind is to exist in the long-term future. On the other hand, however, space colonization could bring about a catastrophically bad future if we colonize space in a bad way. That future that might be worse than one in which humankind does not exist.

Space or bust: Why we must reach for the stars

Why should we pursue space colonization in the first place? Don’t we have more pressing problems today, on Earth?

Yes, we do have many problems on Earth today, and we should try to solve them. But space colonization is just that: A strategy for dealing with certain problems. An the problems that space colonization would be dealing with are, arguably, among the greatest problems of them all: Existential risks; risks that might lead to the extinction of humankind [1]. Currently, all of our proverbial existential eggs are in the same basket. If a natural existential risk strikes (for example, a large asteroid colliding with Earth) or if a man-made existential risk results in a catastrophic outcome (for example, runaway global warming [2, 3]), all of humankind is at risk because humankind is currently limited to planet Earth. If, however, there are self-sustainable human habitats beyond Earth, then the probability of an irreversibly catastrophic outcome for all of humankind is drastically reduced.

Investing in space colonization today could therefore have immense future benefits. Using resources today in order to make space colonization possible in the medium-term future is not a waste, but a very profitable investment. If humankind stays limited to Earth and if we go extinct as a consequence of doing so, then we will all the billions of life years and billions of humans who might have come to exist — and who would have experienced happiness and contributed to humankind’s continued epistemic and moral progress.

Taking space colonization more seriously today does not, of course, mean that we should only pursue space colonization and ignore everything else that is bad in the world. We should continue dealing with current global problems and, at the same time, invest greater resources into space colonization. At this point in our history and our technological development, even modest amounts of resources directed at space colonization would go a long way, such as public funding of basic research. Additionally, it is very likely that technological advances in the domain of space colonization would improve our lives in other ways as well thanks to technology transfer [4] — investing in space colonization today would probably be a win-win situation.

So the situation seems clear: We must pursue space colonization and try to spread beyond Earth as fast as possible. Unfortunately, there is a catch: Yes, we must colonize space if humankind is to survive, but space colonization itself is very risky. So much so that bad outcomes of space colonization might be even worse for humankind than “merely” going extinct.

#### 2] Even if we don’t get there, working towards it builds spinoffs that resolves structural violence.

--drinking water

--elecricity

Comstock and Lockney 7

Douglas A. Comstock, Director, Innovative Partnerships Program; Senior Member, AIAA, NASA, and Daniel Lockney, NASA Center for AeroSpace Information (CASI), IAA SPACE 2007 Conference & Exposition, “NASA’s Legacy of Technology Transfer and Prospects for Future Benefits.”

NASA’s technologies have been transferred to many different areas that contribute to quality of life and safety of the public, as well as to economic growth. These areas include: Health and Medicine; Transportation; Public Safety; Consumer Goods; Environmental and Agricultural Resources; Computer Technology; and Industrial Productivity. A sampling of some well known historic examples, all of which can be accessed through the Spinoff database, include: 1978: Teflon-coated fiberglass developed in the 1970s as a new fabric for astronaut spacesuits has been used as a permanent roofing material for buildings and stadiums worldwide. 1982: Astronauts working on the surface of the Moon wore liquid-cooled garments under their space suits to protect them from lunar temperatures that often reached 250°F. Developed by NASA’s Ames Research Center, the technology is one of the most widely used spinoffs in NASA history. The technology has been adapted to portable cooling systems for treatment of medical ailments such as burning limb syndrome, multiple sclerosis, spinal injuries, and sports injuries. 1986: A joint National Bureau of Standards/NASA project directed by Johnson Space Center resulted in a light- weight breathing system including face mask, frame, harness, and air bottle for fire fighters. To this day, every major manufacturer of breathing apparatuses incorporates NASA technology in some form, and inhalation injuries have been significantly reduced. 1991: Employing three separate NASA-developed technologies in the design and testing of its school bus chas- sis, a Chicago-based company was able to mathematically analyze a design and predict how it will hold up under stress, monitor structural changes during fatigue testing, and develop a measurement of ride vibration and sound level. This testing contributed to the company’s creating of a safer, more reliable, advanced chassis and allowed the company to gain nearly half of the school bus chassis market within its first year of production. 1994: Using technologies created for servicing spacecraft, a Santa Barbara-based company developed a mechanical arm that enables surgeons performing laparoscopic surgery to operate three instruments simultaneously. The robot, AESOP (Automated Endoscopic System for Optimal Positioning), holds the laparoscope and moves it in response to a controller operated by the surgeon. In August of 2001, the first complete robotic surgical operation was performed, when a team of doctors in New York removed the gallbladder of a woman in France using the Com- puter Motion equipment. 1995: The Left Ventricular Assist Device (LVAD) is used to supplement the heart’s pumping capacity in the left ventricle. David Saucier of NASA’s Johnson Space Center teamed with Dr. Michael DeBakey of the Baylor College of Medicine to develop the device with tools and techniques used by NASA in spacecraft propulsion system compo- nent design. The device can maintain the heart in a stable condition in patients requiring a transplant until a donor is found, which can range from one month to one year. In some cases, the need for a transplant may be negated by permanent implantation of the LVAD. 2000: Internet-based Global Differential GPS (IGDG) was developed at Jet Propulsion Laboratory and won its inventors the “2000 NASA Software of the Year” award. The C-language package provides an end-to-end system capability for GPS-based real-time positioning and orbit determination. The software is being used to operate and control real-time GPS data streaming from NASA’s Global GPS Network. The Federal Aviation Administration (FAA) adopted its use into the Wide Area Augmentation System program that provides pilots in U.S. airspace with meter-level accurate knowledge of their positions in real-time. 2002: Three SBIR contracts with NASA’s Langley Research Center to research and develop a new, low cost, lightweight recovery system for aircraft in both civilian and military markets resulted in a unique ballistic parachute system that lowers an entire aircraft to the ground in the event of an emergency. These parachutes are designed to provide a safe landing for pilots and passengers while keeping them in their aircraft, and a uniquely effective safety technology in the event of engine failure, mid-air collision, pilot disorientation or incapacitation, unrecovered spin, extreme icing, and fuel exhaustion. To date, over 200 lives have been saved as a result of this parachute system. The uniqueness of living and working in space teaches us to think in new ways. The weightless environment can be very counter-intuitive, as things don’t fall when you drop them, and liquid doesn’t pour. A key example of this is what was learned from a sintering experiment on Shuttle, which led to improved manufacturing here on earth. Liq- uid-phase sintering is an industrial process of heating and compacting materials used to manufacture many products such as cutting tools and automotive turbochargers. Experiments conducted in space showed exactly the opposite behavior relative to what was predicted: the sintered samples distorted more in microgravity. After analyzing the surprising behavior with NASA researchers, Kennametal, Inc., the North American market leader in the metal- cutting tool industry and second worldwide, with annual sales of $1.8 billion, changed their sintering process. Be- fore, grinding was required to bring the part into specification after sintering because the sintering process produced an imperfect shape. The cost of this extra production step was about 40% of the total manufacturing cost. Using the insight obtained from space research, it was possible to nearly eliminate the grinding step, and make parts more simply and at less cost. The importance of this Shuttle-based research was verified by independent experts of the National Research Council8. NASA technologies have been saving lives and improving the quality of life all over the globe. Advances re- cently featured in Spinoff include the use of a portable water filtration device that is a direct descendant of a technol- ogy developed for use on the ISS and space shuttle to provide clean drinking water to people in Pakistan, the Do- minican Republic, and Northern Iraq. Space suit technologies have been adapted to create a type of weather balloon that have been used as an affordable “satellite” for cell phone coverage in remote parts of Africa. A technique for diffusing landmines with surplus NASA rocket fuel is saving lives in Kosovo and Jordan. A device originally developed for monitoring astronaut health is now being used in networks of sensors for monitoring environmental changes, including monitoring water quality in Vietnam and tracking public health information in Ethiopia. The radiant barrier material popularized as the “space blanket” was shipped in mass quantities to Pakistan after the earthquakes in 2005. Techniques developed for groundwater remediation at Kennedy Space Center’s launch sites have been used to reclaim areas heavily contaminated with solvents and industrial byproducts. These are just a few of the many historic examples of how NASA technologies are helping people around the world, and exemplify the type of public benefits NASA seeks to document each year in Spinoff. While historic ex- amples are interesting, what has NASA done lately? To provide a sense of the current benefits NASA technology is providing, a few brief examples – that are fully documented in the soon-to-be-released 2007 edition of Spinoff – are summarized below. They are presented in seven major benefits categories.

#### 3] Food production---just the tech is enough to avert mass starvation

Pandya ‘9 S., University of Alberta, “From Orbit to OR: Space Solutions for Terrestrial Challenges in Medicine” P. Olla (ed.), Space Technologies for the Benefit of Human Society and Earth,

Nutrition in space is highly subject to a host of factors, including many of those dis- cussed above. Obviously, the weightless environment greatly influences one’s diet and eating habits based on mechanics alone, but proper nutrition may also impact cognitive function and cancer susceptibility after radiation exposure. Like the on- board atmosphere, however there is also the added limitation of being isolated from food sources and the need for contamination prevention. The challenge, therefore, lies in creating meals that are nutritionally sound, easily stored and packaged, have a long shelf life, and that are possibly regenerative. These stringent requirements for “astronaut food” therefore have many useful repercussions for the terrestrially- bound. By way of example, research from the Nutrition, Physical Fitness and Rehabil- itation Team at NSBRI suggests that up to one-third of all cancers may be linked to nutrition – and some foods actually help protect against specific cancers. One of the team’s initiatives is therefore concerned with designing a diet to protect against radiation-induced DNA damage and cancer. Other researchers are looking at the use of particular amino acids – alone or in combination with carbohydrates to target insulin secretion, thereby preventing diabetes and muscle-wasting. The po- tential halt in muscle wasting based on dietary measures alone would be extremely valuable, directly impacting the millions of people the world over who suffer from muscle wasting due to disease, injury or aging. (NSBRI 2008) In addition to dietary composition, issues of food storage, synthesis and sustain- ability have also led to relevant medical spinoffs. After all, one of the greatest threats to health on a global scale stems from access to adequate food and water. NASA has long since realized that any long-term Moon and Mars missions will need to be largely self-reliant and sustainable, with minimal reliance on outside supplies for reasons of cost, practicality and survivability. Plants are therefore key because of their ability to provide food, water and oxygen. More importantly, the lack of soil in space and other celestial bodies has spawned a large body of research on the use of hydroponics, or liquid nutrient solutions in lieu of soil to support plant growth (The Space Place 2004). In the face of growing food shortages, increasing population demands, decreasing agricultural land space, and variable soil quality from year to year, hydroponics will have a huge role to play in food supplementation and growth on Earth in the coming decades. NASA research has resulted in similar advances in the nutritional content of food. One research product, a microalgae-based vegetable-like oil dubbed “Formulaid,” has been developed for long-duration space travel, but has since been spun-off to create enriched baby food. Forumulaid contains two essential fatty acids vital for mental and visual development, typically found in breast milk but not in most other formulae. (The Space Place 2004) Global disease is also greatly impacted by contaminated water sources. The occurrence of a contaminated water supply aboard the ISS would be perilous for the crew. As such, NASA has put much time and effort into creating a compact, reliable water filtration system. Known as the Regenerable Biocidal Water Delivery Unit, this water filtration system relies on iodine instead of chlorine to kill bacteria and has also been made available in developing countries to ensure access to clean drinking water (The Space Place 2004). Also on the subject of contamination, the NSBRI Nutrition, Physical Fitness and Rehabilitation Team is currently exploring ways to extend the period for which food can be preserved, which will obviously be of interest to everyone from Emergency Rescue teams in natural disaster situations to grocers (NSBRI 2008). Related to the issue of food storage is that of delivery: research has shown that hospital in-patients’ appetites are related to a meal’s warmth (when it is supposed to be heated). To help address this issue, many hospitals now make use of the Food Service Sys- tem, initially designed for meal service aboard the 1966–7 Apollo missions, helping maintain patient well-being by providing warm meals (JAXA-b 2005).