# Framework

**I negate the resolution.**

**The standard is maximizing societal welfare.**

**This agrees with my opponent’s framework.**

**Whoever can save the most amount of lives should win the debate.**

# Contention 1: Asteroid Mining

#### Mining Industry destroying itself.

David Oni, Space analyst at Space in Africa, writes in 2019:

David Oni 19 (David Oni, Space industry and technology analyst at Space in Africa, Graduate of Mining Engineering from the Federal University of Technology Akure.) The Effect of Asteroid Mining On Mining Activities in Africa 9-24-2019 Space in Africa https://africanews.space/the-effect-of-asteroid-mining-on-mining-activities-in-africa/ //DebateDrills TJ

The earth, as we have come to know, is enriched with a vast array of mineral resources. But these resources are nonrenewable and hence, constant growing consumption in developing and developed countries, with the rising need for more resources to keep driving the fourth industrial revolution, will ultimately lead to a depletion in a couple of years to come. Experts say that elements needed for modern industry and food production could be exhausted on Earth within 50–60 years.

In terms of mineral resources, Africa has the most abundant of reserves. Currently, Africa hosts 30% of the world’s mineral reserve, 55% of the world’s diamond comes from Botswana and Congo, 60% of the mining in Africa is gold mining but to mention a few.

Given that the mining industry is consistently rising across sub-Saharan Africa, it is good news for the African mining sector as mining companies are beginning to expand operations, countries are already looking into improving regulatory frameworks that will enhance activities and also attract more investors.

But recent breakthroughs in space technology have led to many space scientists and engineers looking to explore alternatives to sustaining the earth while generating massive revenue and improving life generally. Currently, there are various comprehensive research documents on the Space Mining market, with detailed insights on growth factors and strategies. With the current advances and cutting edge technologies developed in preparation for the first stages of asteroid mining, one might want to ask if it is indeed good news for the African continent.

Apart from the environmental impacts, major mining activities are largely hindered in Africa by a handful of other factors such as access to energy, health and safety volatility of commodity prices, etc. Other issues such as political uncertainty, economic instability, religious and tribal wars, industrial unrest, and the fickle nature of regulatory bodies have also rendered foreign direct investment increasingly unattractive to global investors. Furthermore, most African countries have a relatively undeveloped infrastructure for exploiting resources effectively.

At the moment, Asteroid mining poses no threat to terrestrial mining; however, this will not hold for long. The space industry is progressing at such a rapid pace, and the prospects are unequivocally mouth-watering. The big question is, will asteroid mining lure away investors in Africa? The planetary resources company estimates that a single 30-m asteroid may contain 30 billion dollars in platinum alone and a 500m rock could contain half the entire world resources of PGM. Considering the abundance of minerals in asteroids, once asteroid mining materialises, it will severely affect the precious metals market, usurp the prices of rare earth minerals, and a whole lot more because minerals that are usually somewhat scarce on earth will be easily accessible on asteroids.

While foreign investors run the majority of the large-scale mining activities in the region, reports say that many African countries are dangerously dependent on mining activities. For some African countries, despite massive mineral wealth, their mining sectors are underdeveloped, and this is as a result of much focus on oil resources and a couple of other challenges. The million-dollar question is, what will become of the mining activities in Africa?

#### Dwindling precious metals are key to innovation.

Jeremy Hsu, Author in Popular Science and Scientific American mind, writes in 2012:

Jeremy Hsu 12 (Jeremy Hsu, Masters in Science Journalism from NYU, written in publications such as Popular Science, Scientific American Mind and Reader's Digest Asia.) Shortage of Rare Metals Could Threaten High-Tech Innovation 1-30-2012 livescience https://www.livescience.com/18167-shortage-rare-metals-threaten-high-tech-innovation-hitchhiker-metals-clean-technologies.html //DebateDrills TJ

A world in need of faster computers, smarter phones and more energy-efficient light bulbs threatens to strain the small supply of rare metals used by the global electronics industry. But limits on the production of such rare metals mean the supply can't easily expand to meet the demand for innovation in both consumer electronics and clean technologies.

Scarce metals such as gallium, indium and selenium — known as "hitchhiker" metals — come only as byproducts of mining major industrial metals such as aluminum, copper and zinc. That makes it hard to simply boost production of hitchhiker metals whenever industries face a shortage, even if the metals have become critical components of everything from high-performance computers to solar panels.

"With respect to metals that are hitchhikers, a higher price isn't going to lead to much more production," said Robert Ayres, a physicist and economist based at the international business school INSEAD in France. "And therefore it's much more important to think in terms of conservation, recycling and substitution."

That sobering message was delivered by Ayres at a Royal Society discussion meeting held in London Jan. 30. He wants both governments and industries to come up with a standard recycling process that could reuse rare metals.

"You produce something, you use it, but you don't just toss it in a landfill; it goes to another stage and another, and eventually the rare materials are recovered," Ayres told InnovationNewsDaily. "At present, hardly any are recovered."

Take gallium as an example. Gallium is a small byproduct of mining bauxite and zinc, but it has become a critical component for technologies such as lasers, energy-efficient LED lighting and solar panels. The metal has also become a replacement for silicon in faster microchips powering the latest generation of smartphones.

U.S. demand for gallium relied upon $66 million of overseas imports in 2011, according to the U.S. Geological Survey. And just one company, in Utah, recovered and refined gallium from scrap metal and impure gallium metal.

Indium has become a crucial ingredient in the liquid crystal displays for smartphones and in some types of solar panels. A third hitchhiker metal, selenium, also forms part of the solar panels containing both gallium and indium.

Ayres worries in particular about rare metal shortages crippling innovation in clean energy technologies such as solar power.

"Tellurium, part of the lowest-cost photovoltaic material, is only available from copper refineries," Ayres pointed out. "And so the quantity available in the world isn't anywhere near enough to satisfy the potential demand for thin-film photovoltaic surfaces (solar panels)."

#### Asteroid mining provides the necessary precious metals for innovation.

Matthew Williams, Journalist with articles in Universe Today and Business Insider, writes in 2020:

Matthew S. Williams 20 (Matthew S. Williams, writer for Universe Today, and the curator of their Guide to Space section, Articles have been featured in Phys.org, HeroX, Popular Mechanics, Business Insider, Gizmodo, and IO9, ScienceAlert, Knowridge Science Report, and Real Clear Science,) Asteroid Mining to Shape the Future of Our Wealth 11-6-2020 No Publication https://interestingengineering.com/asteroid-mining-to-shape-the-future-of-our-wealth //DebateDrills TJ

The argument in favor of asteroid mining is simple: within the Solar System, there are countless bodies that could contain a wealth of minerals, ores, and volatile elements that are essential to Earth's economy.

Asteroids, as we saw above, are believed to be the material left over from the formation of the Solar System. As such, many asteroids are thought to have compositions that are similar to that of Earth and the other rocky planets (Mercury, Venus, and Mars).

All told, there are thought to be more than 150 million asteroids in the inner Solar System alone, and that's only the ones that measure 100 meters (330 ft) or more in diameter.

These can be divided into three main groups: C-type, S-type, and M-type, which correspond to asteroids composed, respectively, largely of clay and silicates, silicates and nickel-iron, and metals. About 75% fall into the category of C-type; S-types account for 17%; while M-type and other types make up the remainder.

These latter two groups are thought to contain abundant minerals, including gold, platinum, cobalt, zinc, tin, lead, indium, silver, copper, iron, and various rare-Earth metals. For millennia, these metals have been mined from the Earth's crust and have been essential to economic and technological progress.

In addition, there are thought to be many asteroids and comets that contain water ice and other volatiles (ammonia, methane, etc.). Water ice could be harvested to satisfy a growing demand for freshwater on Earth, for everything from drinking to irrigation and sanitation.

Volatile materials could also be used as a source of chemical propellant like hydrazine, thus facilitating further exploration and mining ventures. In fact, Planetary Resources indicates that there are roughly 2.2 trillion US tons (2 trillion metric tons) of water ice in the Solar System.

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

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

#### Space Research is key to solving climate change.

Greg Autry, Professor of Space Leadership at Thunderbird School of Global Management, writes in 2019:

Greg Autry 19 (Greg Autry, Clinical Professor of Space Leadership, Policy and Business at Thunderbird School of Global Management, Tech startup founder, Researcher on entrepreneurship, commercial space and economics. Former NASA Presidential Appointee. Writer & regular Forbes contributor, 2021 Space Advocate of the Year.) Space Research Can Save the Planet—Again 7-20-2019 Foreign Policy https://foreignpolicy.com/2019/07/20/space-research-can-save-the-planet-again-climate-change-environment/ //DebateDrills TJ

Indeed, understanding the evolution of other planets’ climates is essential for modeling possible outcomes on Earth. NASA probes revealed how, roughly 4 billion years ago, a runaway greenhouse gas syndrome turned Venus into a hot, hellish, and uninhabitable planet of acid rain. Orbiters, landers, and rovers continue to unravel the processes that transformed a once warm and wet Mars into a frigid, dry dust ball—and scientists even to conceive of future scenarios that might terraform it back into a livable planet. Discovering other worlds’ history and imagining their future offers important visions for climate change mitigation strategies on Earth, such as mining helium from the moon itself for future clean energy.

Spinoff technologies from space research, from GPS to semiconductor solar cells, are already helping to reduce emissions; the efficiency gains of GPS-guided navigation shrink fuel expenditures on sea, land, and air by between 15 and 21 percent—a greater reduction than better engines or fuel changes have so far provided. Modern solar photovoltaic power also owes its existence to space. The first real customer for solar energy was the U.S. space program; applications such as the giant solar wings that power the International Space Station have continually driven improvements in solar cell performance, and NASA first demonstrated the value of the sun for powering communities on Earth by using solar in its own facilities.

Promisingly, space-based solar power stations could overcome the inconvenient truth that wind and solar will never get us anywhere near zero emissions because their output is inherently intermittent and there is, so far, no environmentally acceptable way to store their power at a global scale, even for one night. Orbital solar power stations, on the other hand, would continually face the sun, beaming clean power back through targeted radiation to Earth day or night, regardless of weather. They would also be free from clouds and atmospheric interference and therefore operate with many times the efficiency of current solar technology. Moving solar power generation away from Earth—already possible but held back by the current steep costs of lifting the materials into space—would preserve land and cultural resources from the blight of huge panel farms and save landfills from the growing problem of discarded old solar panels.

Sustainable energy advocates in the U.S. military and the Chinese government are actively pursuing space-based solar power, but just making solar cells damages the environment due to the caustic chemicals employed. Space technology offers the possibility of freeing the Earth’s fragile biosphere and culturally important sites from the otherwise unavoidable damage caused by manufacturing and mining.

The U.S. start-up Made in Space is currently taking the first steps toward manufacturing in orbit. The company’s fiber-optic cable, produced by machinery on the International Space Station, is orders of magnitude more efficient than anything made on Earth, where the heavy gravity creates tiny flaws in the material. Made in Space and others are eventually planning to build large structures, such as solar power stations, in space. As these technologies develop, they will augment each other, bringing costs down dramatically; space manufacturing, for instance, slashes the cost of solar installations in space.

# Contention 2: Safety Zones

#### Keep-out zones are crucial to preventing space wars

James Acton, Co-director of the Nuclear Policy Program at the Carnegie Endowment for International Peace, writes in 2021:

James M. Acton et al. 21 (James M. Acton, Thomas Macdonald, Pranay Vaddi, Acton holds the Jessica T. Mathews Chair and is co-director of the Nuclear Policy Program at the Carnegie Endowment for International Peace.) Reimagining Nuclear Arms Control: A Comprehensive Approach 12-16-2021 Carnegie Endowment for International Peace https://carnegieendowment.org/2021/12/16/reimagining-nuclear-arms-control-comprehensive-approach-pub-85938 //DebateDrills TJ

Establishing keep-out zones around high-altitude satellites could help reduce the vulnerability of key nuclear C3I capabilities. Specifically, China, Russia, and the United States should commit not to maneuver their satellites within an agreed minimum distance—700 kilometers (430 miles) in any direction—of another participant’s high-altitude satellites (with the exception of repositioning maneuvers conducted one at a time and declared in advance). This agreement would apply only to satellites nationally owned by China, Russia, and the United States and not to privately owned satellites or to satellites owned by other states (so would not contravene the 1967 Outer Space Treaty’s prohibition on “national appropriation”).

Currently, the regulation of high-altitude satellite orbits is minimal. The International Telecommunication Union (ITU), a United Nations agency, allocates slots to geostationary broadcast and communication satellites in order to prevent interference—though these slots can overlap if satellites operate on different frequencies or broadcast to non-contiguous regions on the ground. Participation in the ITU is voluntary and is designed only to minimize broadcast interference.

Establishing keep-out zones would go further than the ITU rules by applying to all Chinese, Russian, and U.S. satellites in both geostationary and Molniya orbits—not just geostationary satellites broadcasting at a particular frequency band—without permitting any overlap. It would begin to establish rules of the road for good behavior in space and help break the deadlock in improving space governance. Even recognizing that keep-out zones could not physically prevent one participant state from attacking another’s satellites in conflict—although the proposed agreement would still apply then—they would still help to reduce escalation risks in three ways.

First, keep-out zones would mitigate the danger that repositioning operations could lead one state to wrongly conclude that one or more of its satellites were under attack—that is, the zones would help to define the difference between innocuous and aggressive actions in space. Even (or perhaps especially) in a conflict, a state that did not intend to attack a nuclear C3I satellite belonging to its adversary would have a clear incentive to abide by rules designed to prevent such threats from arising inadvertently.

Second, even if one participant decided to attack another’s satellites—for whatever reason—keep-out zones could buy time. An attacking satellite would typically have to close in on a target before launching an attack (how close it would need to come would depend on its capabilities).14 This process would not be instantaneous. If the target state detected a violation of its keep-out zones before the attacking satellites were able to execute the attack, it could take preventative action (by, for example, maneuvering its satellites away from the attacking ones). Increasing the warning time of an intentional attack would also reduce the likelihood of escalation resulting from time pressure.

The margin of warning afforded by keep-out zones would depend, in part, on their size. Fuel-efficient maneuvers in geostationary orbit to cross from the edge to the center of a 700-kilometer keep-out zone would require about one day (see appendix B for more details). Faster crossing would be possible by using larger amounts of fuel. For example, the same keep-out zone could be crossed in six hours by expending the same amount of fuel that a communication satellite typically uses each year for station keeping (that is, making minor adjustments so the satellite remains in its correct orbit during day-to-day operations). Larger keep-out zones would buy more warning time and further complicate attacks—but they would be more disruptive to satellite operations. The keep-out distance of 700 kilometers proposed here aims to strike a balance between increasing warning and reducing disruption.

Third, each state could use negotiations to underscore to the others the dangers of attacking its high-altitude satellites. Such messaging could reduce the likelihood of one participant’s deliberately attacking another’s dual-use satellites in an effort to win (or at least not lose) a conventional war because it had underestimated the consequent risk of nuclear escalation.

#### Space wars destroys satellites which hinders innovation and deters private companies.

Thomas Roberts, space security researcher at the Center for Strategic and International Studies, writes in 2017:

Thomas GonzáLez Roberts 17 (Thomas GonzáLez Roberts, Space security researcher at the Center for Strategic and International Studies) Why We Should Be Worried about a War in Space 12-15-2017 Atlantic https://www.theatlantic.com/science/archive/2017/12/why-we-should-be-worried-about-a-war-in-space/548507/ //DebateDrills TJ

One hundred miles above the Earth’s surface, orbiting the planet at thousands of miles per hour, the six people aboard the International Space Station enjoy a perfect isolation from the chaos of earthly conflict. Outer space has never been a military battleground. But that may not last forever. The debate in Congress over whether to create a Space Corps comes at a time when governments around the world are engaged in a bigger international struggle over how militaries should operate in space. Fundamental changes are already underway. No longer confined to the fiction shelf, space warfare is likely on the horizon.

While agreements for how to operate in other international domains, like the open sea, airspace, and even cyberspace, have already been established, the major space powers—the United States, Russia, and China—have not agreed upon a rulebook outlining what constitutes bad behavior in space. It’s presumed that International Humanitarian Law would apply in outer space—protecting the civilian astronauts aboard the International Space Station—but it’s unclear whether damaging civilian satellites or the space environment itself is covered under the agreement. With only a limited history of dangerous behavior to study, and few, outdated guidelines in place, a war in space would be a war with potentially more consequences, but far fewer rules, than one on Earth.

Although there has never been a military conflict in space, the history of human activity above our atmosphere is not entirely benign. In 1962, the United States detonated a 1.4 megaton nuclear weapon 250 miles above the Earth’s surface. The blast destroyed approximately one third of satellites in orbit and poisoned the most used region of space with radiation that lasted for years. Although the United States, Russia, and others soon agreed to a treaty to prevent another nuclear test in space, China and North Korea never signed it. In 2007, China tested an anti-satellite weapon, a conventionally-armed missile designed to target and destroy a satellite in orbit. In the process, it annihilated an old Chinese weather satellite and created high-velocity shrapnel that still threatens other satellites. Even though demonstrations like this have consequences for everyone, countries are free to carry them out as they see fit. No treaties address this kind of test, the creation of space debris, or the endangerment of other satellites.

The U.S. has the most to lose in a space-based conflict

With by far the most satellites in orbit, the U.S. has the most to gain by establishing norms, but also the most to lose. Almost half of all operational satellites are owned and operated by the United States government or American commercial companies. That’s twice as many as Russia and China, combined. Space may seem distant, but what happens there affects our everyday lives on the ground. When we use our phones to plan a trip, we depend on American GPS satellites to guide us. When the U.S. military deploys troops overseas, satellite communications connect forces on the ground to control centers. When North Korea launches an intercontinental ballistic missile, the U.S. and its allies depend on early-warning satellites to detect it.

#### **Recall the Greg Autry Evidence. It explains that space research solves climate change because it allows for efficient solar panels in space and spinoff technologies that reduce fuel emissions.**

# Case

## A2 Space Debris

#### Debris crashes and Kessler syndrome is mere hype.

**Fange 17** [Daniel von Fange, 5-21-2017, "Kessler Syndrome is Over Hyped”, http://braino.org/essays/kessler\_syndrome\_is\_over\_hyped/]//DDPT

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.

#### Thousands of satellites and a half-million objects in space now and only 15 collisions have ever happened.

**Albrecht and Graziani 16** [Mark Albrecht and Paul Graziani, 5-9-2016, "Op-ed," SpaceNews, https://spacenews.com/op-ed-congested-space-is-a-serious-problem-solved-by-hard-work-not-hysteria/]//DDPT

There are over a half million pieces of human-made material in orbit around our planet. Some are the size of school buses, some the size of BB gun pellets. They all had a function at some point, but now most are simply space debris littered from 100 to 22,000 miles above the Earth. Yet, all behave perfectly according to the laws of physics. Many in the space community have called the collision hazard caused by space debris a crisis.

Popular culture has embraced the risks of collisions in space in films like Gravity. Some participants have dramatized the issue by producing graphics of Earth and its satellites, which make our planet look like a fuzzy marble, almost obscured by a dense cloud of white pellets meant to conceptualize space congestion.

Unfortunately, for the sake of a good visual, satellites are depicted as if they were hundreds of miles wide, like the state of Pennsylvania (for the record, there are no space objects the size of Pennsylvania in orbit). Unfortunately, this is the rule, not the exception, and almost all of these articles, movies, graphics, and simulations are exaggerated and misleading. Space debris and collision risk is real, but it certainly is not a crisis.

So what are the facts?

On the positive side, space is empty and it is vast. At the altitude of the International Space Station, one half a degree of Earth longitude is almost 40 miles long. That same one half a degree at geostationary orbit, some 22,000 miles up is over 230 miles long. Generally, we don’t intentionally put satellites closer together than one-half degree. That means at geostationary orbit, they are no closer than 11 times as far as the eye can see on flat ground or on the sea: That’s the horizon over the horizon 10 times over. In addition, other than minute forces like solar winds and sparse bits of atmosphere that still exist 500 miles up, nothing gets in the way of orbiting objects and they behave quite predictably. The location of the smallest spacecraft can be predicated within a 1,000 feet, 24 hours in advance.

Since we first started placing objects into space there have been 11 known low Earth orbit collisions, and three known collisions at geostationary orbit. Think of it: 135 space shuttle flights, all of the Apollo, Gemini and Mercury flights, hundreds of telecommunications satellites, 1,300 functioning satellites on orbit today, half a million total objects in space larger than a marble, and fewer than 15 known collisions. Why do people worry?

#### Space wars are impossible and can’t escalate --- debris, high monetary costs, and lack of lift capabilities

Handberg, 17 – Faculty and Research, School of Politics, Security, and International Affairs, UCF Roger Handberg, “Is space war imminent? Exploring the possibility,” Comparative Strategy. 2017. <https://www.tandfonline.com/doi/pdf/10.1080/01495933.2017.1379832?needAccess=true>

--Space wars were discounted in 1960s – things haven’t changed now – environment still hostile – moreso now bc debris is worse

--Costs a ton to send stuff up there

--Lift capabilities are weak which means war can’t be sustained

--Replacements are slow so war has to be ended

Why now?

Recently, there has been an ongoing resurgence of interest in the possibilities for actual combat in outer space, effectively war in a new domain. Why this would become plausible now is interesting, since the physical realities present in the early days of space activity have not changed. Spacecraft remain vulnerable to attack from the ground by anti-satellite (ASAT) weapons, while the debris issue grows exponentially worse now, given the proliferation of such objects in space as part of the normal operations in outer space: used boosters, dead satellites, pieces of broken spacecraft and satellites, and small particles with deadly impact on other spacecraft. The space shuttles routinely returned to Earth with dings and scars from space debris, while the International Space Station (ISS) several times has been lifted out of harm’s way due to oncoming debris. More critically for assessing space-war possibilities, the sheer cost of conducting such operations remains extremely high, while the possibilities for sustaining combat in space are suspect due to lack of lift capability. The difficulty in orbiting replacement satellites to restore functionality remains, assuming the environment is not too hostile due to expanding debris fields. Replacement satellites or other space hardware are still slow-production items, although that in principle could be placed on more of an assembly-line basis, as was done with the Iridium satellite flotilla of 66 comsats plus multiple spares.19 Or, smaller cube satellites with more limited functionality could be orbited as gap fillers while larger, more functional satellites are built and flown if time exists to do so.

## A2 Environment

#### Asteroid Mining solves for climate. Benefit outweighs the greenhouse gases released during launch.

**Emerging Technology 18** (Emerging Technology, Emerging Technology from the arXiv covers the latest ideas and technologies that appear on the Physics arXiv preprint server.) Asteroid mining might actually be better for the environment 10-19-2018 MIT Technology Review https://www.technologyreview.com/2018/10/19/139664/asteroid-mining-might-actually-be-better-for-the-environment/ //DebateDrills TJ

For a certain kind of investor, asteroid mining is a path to untold riches. Astronomers have long known that asteroids are rich in otherwise scarce resources such as platinum and water. So an obvious idea is to mine this stuff and return it to Earth—or, in the case of water, to a moon base or Earth-orbiting space station.

There is no shortage of interest in these ventures. In the last decade, investors have **funded half a dozen companies** that have set their sights on various nearby rocks. To many observers, it’s only a matter of time before such a mission gets the green light.

But profit margins are only part of the picture. A potentially more significant aspect of these missions is the impact they will have on Earth’s environment. But nobody has assessed this environmental impact in detail.

Today, that changes thanks to the work of Andreas Hein and colleagues at the University of Paris-Saclay in France. These guys have calculated the greenhouse-gas emissions from asteroid-mining operations and compared them with the emissions from similar Earth-based activities. Their results provide some eyebrow-raising insights into the benefits that asteroid mining might provide.

The calculations are relatively straightforward. Rocket launches release significant amounts of greenhouse gases into the atmosphere. The fuel on board the first stage of a rocket burns in Earth’s atmosphere to form carbon dioxide. For kerosene-burning rockets, one kilogram of fuel creates three kilograms of CO2. (The second and third stages operate outside the Earth’s atmosphere and so can be ignored.)

Reentries are just as damaging. That’s because a significant mass of a re-entering vehicle ablates in the upper atmosphere, producing NOx such as nitrous oxide (N2O), a greenhouse gas that is about 300 times more potent than CO2. By one estimate, the space shuttle released about 20% of its mass in the form of N2O every time it returned to Earth.

Hein and co use these numbers to calculate that a kilogram of platinum mined from an asteroid would release some 150 kilograms of CO2 into Earth’s atmosphere. However, **economies of scale from large asteroid-mining operations could lower this to about 60 kilograms of CO2 per kilogram of platinum.**

That needs to be compared with the emission from Earth-based mining. Here, platinum mining generates significant greenhouse gases, mostly from the energy it takes to remove this stuff from the ground.

Indeed, the numbers are huge. The mining industry estimates that producing one kilogram of platinum on Earth releases around 40,000 kilograms of carbon dioxide. “The global warming effect of Earth-based mining is several orders of magnitude larger,” say Hein and co.

The figures for water are also encouraging. In this case, the authors calculate the greenhouse-gas emissions from an asteroid-mining operation that returns water to anywhere within the moon’s orbit, a so-called cis-lunar orbit.  They compare this to the emissions from sending the same volume of water from Earth into orbit.

The big difference is that a water-carrying vehicle from Earth can haul only a small percentage of its mass as water. But an asteroid-mining spacecraft can transport a significant multiple of its mass as water to cis-lunar orbit. “Substantial savings in greenhouse gas emissions can be achieved,” say Hein and co.

This interesting work should help to focus minds on the environmental impacts of mining, which are rapidly increasing in profile. But it is only a first step. There is significant uncertainty in the numbers here, so these will need to be better understood.

Other factors will also eventually need to be taken into account. The Earth-bound mining industry **could become more environmentally friendly by using renewable energy rather than burning coal to generate power (as it does in South Africa). Rocket launching could also become greener** if more eco-friendly fuels are developed. Both these things would change the numbers.

There are also emissions that this analysis does not take into account. For example, it does not include the emissions from mission control on Earth or from launch-pad construction. Then there are the ongoing effects of rocket launches on the ozone layer, which also need to be considered.

So there is more work to be done. But Hein and co have taken a significant first step toward realistic environmental life-cycle assessments for asteroid mining, a task that will surely become more pressing as this industry matures.