### 1

#### Interpretation: Appropriation is permanently taking property for exclusive use. Gorove 69:

Stephen Gorove, Interpreting Article II of the Outer Space Treaty, 37 Fordham L. Rev. 349 (1969). Available at: https://ir.lawnet.fordham.edu/flr/vol37/iss3/2

With respect to the concept of appropriation the basic question is what constitutes "appropriation," as used in the Treaty, especially in contradistinction to casual or temporary use. The term "appropriation" is used most frequently to denote the taking of property for one's own or exclusive use with a sense of permanence. Under such interpretation the establishment of a permanent settlement or the carrying out of commercial activities by nationals of a country on a celestial body may constitute national appropriation if the activities take place under the supreme authority (sovereignty) of the state. Short of this, if the state wields no exclusive authority or jurisdiction in relation to the area in question, the answer would seem to be in the negative, unless, the nationals also use their individual appropriations as cover-ups for their state's activities.5 In this connection, it should be emphasized that the word "appropriation" indicates a taking which involves something more than just a casual use. Thus a temporary occupation of a landing site or other area, just like the temporary or nonexclusive use of property, would not constitute appropriation. By the same token, any use involving consumption or taking with intention of keeping for one's own exclusive use would amount to appropriation.

#### Violation: Megaconstellations are not appropriation.

Johnson 20 [Christopher D. Johnson, “The Legal Status of MegaLEO Constellations and Concerns About Appropriation of Large Swaths of Earth Orbit,” Handbook of Small Satellites, 2020-09-13, p.1337-1358] CT

5.2 No, This Is Not Impermissible Appropriation

An opposite conclusion can also be reasonably arrived at when approached along the following lines. The counter argument would assert that the deployment and operation of these global constellations, such as SpaceX’s Starlink, OneWeb, Kepler, etc., are aligned with and in full conformity with the laws applicable to outer space. These constellations are merely the exercise and enjoyment of the freedom of exploration and use of outer space and do not constitute any impermissible appropriation of the orbits that they transit.

5.2.1 Freedom of Access and Use Permits Constellations

Rather than being a violation of other’s rights to access and explore outer space, the deployment of these constellations is more correctly viewed as the exercise and restrict or impinge on other users of the space domain. Because due regard is therefore displayed for the space domain, and to the interests of others, these constellations do not prejudice or infringe upon the freedoms of use and exploration of the space domain and are therefore not occupation, or possession, much less appropriation.

5.2.4 This Does Not Constitute Possession, or Ownership, or Occupation

The use of LEO by satellite constellations is substantially similar to the use of GSO, and therefore permissible. In each region, individual actors are given permission - either from a national administrator or from an international governing body (the ITU) via a national administer–to use precoordinated subsections of space. In a way that is overwhelmingly similar to the use of orbital slots in GSO, the placement of spacecraft into orbits in LEO or higher orbits does not constitute possession, ownership, or occupation of those orbits. This is because States (and their companies) have been occupying orbital slots in GSO for decades, and these uses of GSO have never been accused of “appropriating” GSO. The users have never claimed to be appropriating GSO, and their exercising of rights to use GSO is respected by other actors in the space domain. This is the same situation for other orbits, including LEO and other non-Geostationary orbits. And while GSO locations are relatively stable (subject to space weather and other perturbations, and require stationkeeping), spacecraft in LEO are actually moving through space and are not stationary, so it is even more difficult to see this use by constellations as occupation, much less appropriation. Moreover, Space Situational Awareness (SSA) and Space Traffic Management (STM) will allow other uses to use these orbits, and nothing about the use of any one user necessarily precludes others. Lastly, there is no intention by operators of constellations to exclusively occupy, must less possess or appropriate, these orbits. Would not the appropriation of outer space be an intentional, volutional act? No such intention can be found in the operators of global constellations.

#### Vote neg – two impacts:

#### Limits. Expanding the topic to anything that involves merely launching something into the atmosphere expands the topic into numerous new tech areas which undermines core neg prep.

#### Topic literature. Our definition has intent to define and exclude in the context of the OST, which is the core of all topic research and the only predictable source.

#### Drop the debater to preserve fairness and education – use competing interps – reasonability invites arbitrary judge intervention and a race to the bottom of questionable argumentation. No RVIs – they don’t get to win for following the rules.

### 2

#### Counterplan: The appropriation of outer space by private entities via Large Satellite Constellations in Lower Earth Orbit is unjust unless states charge private entities orbital use fees for each satellite put into low-Earth Orbit.

#### Solves the case while also boosting the economy. Vergoth 20:

Karin Vergoth {CIRES-NOAA Science Writer}, 20 - ("Solving the space junk problem," CU Boulder Today, 5-26-2020, https://www.colorado.edu/today/2020/05/26/solving-space-junk-problem)//marlborough-wr/

Space is getting crowded. Aging satellites and space debris crowd low-Earth orbit, and launching new satellites adds to the collision risk. The most effective way to solve the space junk problem, according to a new study, is not to capture debris or deorbit old satellites: it’s an international agreement to charge operators “orbital-use fees” for every satellite put into orbit. Orbital use fees would also increase the long-run value of the space industry, said economist Matthew Burgess, a [CIRES Fellow and co-author of the new paper](https://cires.colorado.edu/news/solving-space-junk-problem). By reducing future satellite and debris collision risk, an annual fee rising to about $235,000 per satellite would quadruple the value of the satellite industry by 2040, he and his colleagues concluded in a paper published today in the [Proceedings of the National Academy of Sciences](https://www.pnas.org/content/early/2020/05/20/1921260117). “Space is a common resource, but companies aren’t accounting for the cost their satellites impose on other operators when they decide whether or not to launch,” said Burgess, who is also an assistant professor in environmental studies and an affiliated faculty member in economics at CU Boulder. “We need a policy that lets satellite operators directly factor in the costs their launches impose on other operators.” Currently, an estimated 20,000 objects—including satellites and space debris—are crowding low-Earth orbit. It’s the latest tragedy of the commons, the researchers said: Each operator launches more and more satellites until their private collision risk equals the value of the orbiting satellite. So far, proposed solutions have been primarily technological or managerial, said Akhil Rao, assistant professor of economics at Middlebury College and the paper’s lead author. Technological fixes include removing space debris from orbit with nets, harpoons, or lasers. Deorbiting a satellite at the end of its life is a managerial fix. Ultimately, engineering or managerial solutions like these won’t solve the debris problem because they don’t change the incentives for operators. For example, removing space debris might motivate operators to launch more satellites—further crowding low-Earth orbit, increasing collision risk, and raising costs. “This is an incentive problem more than an engineering problem. What’s key is getting the incentives right,” Rao said. A better approach to the space debris problem, Rao and his colleagues found, is to implement an orbital-use fee—a tax on orbiting satellites. “That’s not the same as a launch fee,” Rao said, “Launch fees by themselves can’t induce operators to deorbit their satellites when necessary, and it's not the launch but the orbiting satellite that causes the damage.” Orbital-use fees could be straight-up fees or tradeable permits, and they could also be orbit-specific, since satellites in different orbits produce varying collision risks. Most important, the fee for each satellite would be calculated to reflect the cost to the industry of putting another satellite into orbit, including projected current and future costs of additional collision risk and space debris production—costs operators don’t currently factor into their launches. “In our model, what matters is that satellite operators are paying the cost of the collision risk imposed on other operators,” said Daniel Kaffine, professor of economics and RASEI Fellow at CU Boulder and co-author on the paper. And those fees would increase over time, to account for the rising value of cleaner orbits. In the researchers’ model, the optimal fee would rise at a rate of 14 percent per year, reaching roughly $235,000 per satellite-year by 2040. For an orbital-use fee approach to work, the researchers found, all countries launching satellites would need to participate—that's about a dozen that launch satellites on their own launch vehicles and more than 30 that own satellites. In addition, each country would need to charge the same fee per unit of collision risk for each satellite that goes into orbit, although each country could collect revenue separately. Countries use similar approaches already in carbon taxes and fisheries management. In this study, Rao and his colleagues compared orbital-use fees to business as usual (that is, open access to space) and to technological fixes such as removing space debris. They found that orbital use fees forced operators to directly weigh the expected lifetime value of their satellites against the cost to industry of putting another satellite into orbit and creating additional risk. In other scenarios, operators still had incentive to race into space, hoping to extract some value before it got too crowded. With orbital-use fees, the long-run value of the satellite industry would increase from around $600 billion under the business-as-usual scenario to around $3 trillion, researchers found. The increase in value comes from reducing collisions and collision-related costs, such as launching replacement satellites. Orbital-use fees could also help satellite operators get ahead of the space junk problem. “In other sectors, addressing the tragedy of the commons has often been a game of catch-up with substantial social costs. But the relatively young space industry can avoid these costs before they escalate,” Burgess said.

### 3

#### Cyber attacks on critical infrastructure are coming now

Underwood 20 [Kimberly Underwood is a reporter on emerging communication technologies, cyberwarfare, the intelligence community, military command operations and weaponry research. “China is Retooling, and Russia Seeks Harm to Critical Infrastructure.” June 24, 2020. https://www.afcea.org/content/china-retooling-and-russia-seeks-harm-critical-infrastructure]

Intelligence leader warns of the mounting threats of cyber espionage, digital attacks and influence operations from adversaries. U.S. adversaries are trying to take control of cyberspace as a medium, resulting in implications to our freedom of maneuver and access in cyberspace, says Brig. Gen. Gregory Gagnon, USAF, director of Intelligence (A2), Headquarters Air Combat Command (ACC), Joint Base Langley-Eustis. Increasing cyberspace activity is coming from China, Russia, Iran and North Korea. “We are seeing it not just in volume, but we are seeing an expansion in the ways that they use cyberspace, whether it is to steal information, whether it is to directly influence our citizens or whether it is to disrupt critical infrastructure,” Gen. Gagnon reports. The general spoke at the AFCEA Tidewater chapter’s recent monthly virtual luncheon. China and Russia continue to pose the greatest espionage and cyber attack threats to the United States, but the intelligence leader anticipates that other adversaries and strategic competitors will also build and integrate cyber espionage, cyber attacks and influence operations into how they conduct business. “Our strategic competitors will increasingly use cyber space capabilities including cyber espionage, cyber attack and continued influence operations to seek political, economic and military advantage over the United States, our allies and our partners,” he said. “This is not an ‘if,’ it is a yes. They are doing it and they will continue.” Gen. Gagnon warned that China in particular is using cyber espionage to collect intelligence, target critical infrastructure and steal intellectual property. It is all part of China’s plan to move from being a regional actor to being seen as a global power. The shift also means a greater role for the adversary’s military. The Chinese military is in the process of transitioning from a defensive, inflexible ground-based force charged with domestic and peripheral security to a joint, highly agile, expeditionary and power projecting arm of Chinese foreign policy, he noted. “What is going on in China is a dynamic revectoring of the objectives and goals of the People's Liberation Army,” Gen. Gagnon said. “This is not a small change. This is a major change in course and direction. They're doing it to be a power projection arm of a Chinese foreign policy that engages both in military diplomacy and operations around the globe, but also in predatory economic activity.” Moreover, China’s military spending in 2018 exceeded $200 billion, an increase of about 300% since 2002, the general stated. And while it is not the $750 billion that the United States government spends every year on military defense, the Chinese funding does not reflect the same level of investment in manpower or healthcare. A good portion of their $200 billion directly funds technology and capabilities. “A big chunk of our budget is not buying kit,” Gen. Gagnon explained. “If you're the CCP [Chinese Communist Party], you don't have the same extensive retirement programs that you have to pay for,” he said. “You don't have this extensive healthcare which you have to provide. So, when you think about $200 billion, think about that buying kit and buying operations. That is significant.” To the industry, Gen. Gagnon warned companies that Beijing will authorize Chinese espionage against key U.S technologies. “Many of your corporations hold this technology,” he stressed. “They are trying to undercut your ability to be profitable by developing those same technologies in China. They are competing against us in the international market. I will tell you that China's persistent cyber espionage threat and their growing tech threat to our core military and critical infrastructure will continue to be persistent. China remains the most active strategic competitor responsible for cyber espionage against corporations and allies.” China, like Russia, is also increasing its information warfare against the United States. “They are becoming more adept at using social media to deliver messages directly to the U.S. population that alter the way we think, the way we behave and the way we decide,” the general observed. The improvement of their cyber attack capabilities and ways to alter information online is intended to shape views inside China, shift the mindset of Chinese people around the world, as well as to try to shape the world’s view, not just of China, but also of the United States. “You are seeing that play out in the pandemic, how people view us around the world,” he offered. “We're also concerned about Chinese intelligence and security services,” the A2 continued. “They use Chinese information technology firms as routine and systemic espionage platforms against the United States and against our allies. Many of you are tracking what is in the news about 5G and Huawei, and that's what we're talking about.” As for Russia, their highly capable operations of cyber espionage, influence and cyber attacks continue to target the United States and its allies. In particular, Russia’s form of integrating cyber espionage attacks and influence operations, or information confrontation, is very effective, Gen. Gagnon emphasized. “If you think about it, they’re generally playing with the weaker hand, so they have been rather brilliant on the international stage in achieving their foreign policy objectives,” he said. In addition, Moscow is staging cyberattack assets to disrupt or damage U.S. military or civilian information systems during the COVID-19 pandemic. “There is activity that they undertake on a day-to-day basis to try to gain a decisive military intelligence,” he stated. “Their security services continue to target our systems, both for U.S. information systems and critical infrastructure, as well as the networks of our NATO and Five-Eye partners. They do it for positional advantage in cyberspace to be able to do the five Ds: deceive, deny, disrupt, degrade and destroy our assets, but also to gain intelligence on how systems are established and set up so that they can maintain attack vectors.” Russia also is targeting U.S. critical infrastructure, the general cautioned. “Russia has the ability to execute cyber attacks in the United States that can generate localized temporary disruptive effects on critical infrastructure, such as disrupting electric distribution networks for at least a few hours.” In fact, he warned, Moscow is mapping out critical infrastructure with the long-term goal of being able to cause “substantial damage.”

#### Megaconstellations function as critical infrastructure that increase resiliency and protect against cyberattacks

Hallex and Cottom 20 [Matthew A. Hallex is a Research Staff Member at the Institute for Defense Analyses. Travis S. Cottom is a Research Associate at the Institute for Defense Analyses. “Proliferated Commercial Satellite Constellations: Implications for National Security.” 2020. https://ndupress.ndu.edu/Portals/68/Documents/jfq/jfq-97/jfq-97\_20-29\_Hallex-Cottom.pdf?ver=2020-03-31-130614-940]

While potentially threatening the sustainability of safe orbital operations, new proliferated constellations also offer opportunities for the United States to increase the resilience of its national security space architectures. Increasing the resilience of U.S. national security space architectures has strategic implications beyond the space domain. Adversaries such as China and Russia see U.S. dependence on space as a key vulnerability to exploit during a conflict. Resilient, proliferated satellite constellations support deterrence by denying adversaries the space superiority they believe is necessary to initiate and win a war against the United States.28 Should deterrence fail, these constellations could provide assured space support to U.S. forces in the face of adversary counterspace threats while imposing costs on competitors by rendering their investments in counterspace systems irrelevant. Proliferated constellations can support these goals in four main ways. First, the extreme degree of disaggregation inherent in government and commercial proliferated constellations could make them more resilient to attacks by many adversary counterspace systems. A constellation composed of hundreds or thousands of satellites could withstand losing a relatively large number of them before losing significant capability. Conducting such an attack with kinetic antisatellite weapons—like those China and Russia are developing—would require hundreds of costly weapons to destroy satellites that would be relatively inexpensive to replace. Second, proliferated constellations would be more resilient to adversary electronic warfare. Satellites in LEO can emit signals 1,280 times more powerful than signals from satellites in GEO.29 They JFQ 97, 2nd Quarter 2020 Hallex and Cottom 25 also are faster in the sky than satellites in more distant orbits, which, combined with the planned use of small spot beams for communications proliferated constellations, would shrink the geographic area in which an adversary ground-based jammer could effectively operate, making jammers less effective and easier to geolocate and eliminate.30 Third, even if the United States chooses not to deploy national security proliferated constellations during peacetime, industrial capacity for mass-producing proliferated constellation satellites could be repurposed during a conflict. Just as Ford production lines shifted from automobiles to tanks and aircraft during World War II, one can easily imagine commercial satellite factories building military reconnaissance or communications satellites during a conflict. Fourth, deploying and maintaining constellations of hundreds or thousands of satellites will drive the development of low-cost launches to a much higher rate than is available today. Inexpensive, high-cadence space launch could provide a commercial solution to operationally responsive launch needs of the U.S. Government. In a future where space launches occur weekly or less, the launch capacity needed to augment national security space systems during a crisis or to replace systems lost during a conflict in space would be readily available.31

#### Cyberattacks cause extinction---false warnings, stealing nukes, and introducing vulnerability

Ernest J. Moniz et al. 18, Ernest J. Moniz is the CEO of the Nuclear Threat Initiative, served as the thirteenth United States Secretary of Energy from 2013 to January 2017. Sam Nunn, and Des Browne, September 2018, “Nuclear Weapons in the New Cyber Age,” https://media.nti.org/documents/Cyber\_report\_finalsmall.pdf

The Cyber Threat to Nuclear Weapons and Related Systems

Cyber-based threats target all sectors of society—from the financial sector to the entertainment industry, from department stores to insurance companies. Governments face an even more critical challenge when it comes to cyberattacks on their most critical systems. Attacks on critical infrastructure could have extraordinary consequences, but a successful cyberattack3 on a nuclear weapon or related system—a nuclear weapon, a delivery system, or the related Nuclear Command, Control, and Communications (NC3) systems—could have existential consequences. Cyberattacks could lead to false warnings of attack, interrupt critical communications or access to information, compromise nuclear planning or delivery systems, or even allow an adversary to take control of a nuclear weapon.

Given the level of digitization of U.S. systems and the pace of the evolving cyber threat, one cannot assume that systems with digital components—including nuclear weapons systems—are not or will not be compromised. Among the reasons: nuclear weapons and delivery systems are periodically upgraded, which may include the incorporation of new digital systems or components. Malware could be introduced into digital systems during fabrication, much of which is not performed in secure foundries. In addition, there are a range of external dependencies, such as connections to the electric grid, that are outside the control of defense officials but directly affect nuclear systems. Finally, the possibility always exists that an insider, either purposefully or accidentally, could enable a cybersecurity lapse by introducing malware into a critical system.

Increased use of digital systems may also adversely affect the survivability of nuclear systems. New technologies can enhance reliability and performance, but they can also lead to new vulnerabilities in traditionally survivable systems, such as submarines or mobile missile launchers.4

### 4

#### Starlink is key to rural broadband expansion

Weinschenk 2/25 [(Carl, IT and telecom journalist for Telecompetitor, Teleco Transformation, and IT Business Edge) “Report: Starlink Looks Very Promising for Rural Broadband,” Telecompetitor, 2/25/2021] JL

SpaceX’s Starlink satellite broadband service has the potential to be a game changer for rural broadband, according to an analysis by PCMag of Starlink speeds. The analysis is based on beta tester data exclusively provided to it by Ookla Speedtest.

The site looked at data from rural, suburban and urban areas. Among its more than 10,000 users in its semi-public beta were “a perplexing” number in urban and suburban areas where a variety of high-speed options already are available. The story cites Chicago, Seattle and Minneapolis as places where there were testers, despite readily available alternatives.

The site compared download speeds against other fixed service providers in 30 counties with at least 30 samples in any month from December 30 to February 24. The counties in which the fixed providers had the biggest speed advantage over Spacelink were urban or suburban: Los Angeles and Santa Clara counties, CA; Cook County, IL; King County, WA and Washington County, MN.

It is in rural areas that Starlink shines, according to the research. The five counties in which Starlink had the biggest download speed advantage over the fixed group were rural: Vilas County, WI; Ravali County, MT; Waldo County, ME; Okanogan County, WA and Lamoile County, VT.

The number of counties in which Starlink beat the fixed providers and those in which the fixed providers beat Starlink appeared to be about equal, as was the speed differential.

“Our own analysis shows that Starlink will make the biggest difference in rural, low-density, low-population counties with few options other than lower-quality satellite services,” wrote Sascha Segan, author of the PCMag article about Startlink rural speeds.

#### Broadband enables precision agriculture transition

ABI 19 [(American Broadband Initiative, a leading force in driving changes across Federal Agencies to identify and remove barriers to broadband access and leverage public assets and resources to expand our Nation’s broadband infrastructure capacity.) “A Case for Rural Broadband,” The United States Department of Agriculture, 4/2019] BC

HOW E-CONNECTIVITY WILL TRANSFORM THE BUSINESS OF AGRICULTURE

Across the agricultural production cycle, farmers and ranchers can implement digital technologies as other modern businesses are doing, enhancing agriculture by driving decision-making based on integrated data, automating processes to increase operational efficiency, improving productivity with tasks driven by real-time insights, augmenting the role of management in the business of farming, and creating new markets with extended geographic reach.

These patterns of digital transformation create fundamental shifts in agricultural production, developing new ways of working that make the industry more productive, attractive, and financially sustainable for farmers and ranchers. Tech companies which stand to benefit from industry transformation continue to capitalize on these shifts by developing new technologies, which according to one recent study, may help position themselves to capture a portion of an estimated $254 billion to $340 billion in global addressable digital agriculture market.13

BUSINESS MANAGEMENT shifts decisionmaking from instinct to integrated data

Precision Agriculture is transforming the way producers collect, organize, and rely on information to make key decisions. Traditionally, producers’ long-term experiences have created a competitive advantage: years of experiments have produced insights and instincts about the land they have farmed and the animals they have raised. But the volume of data that is possible

to collect today can accelerate that learning curve, helping producers learn faster and more rapidly adapt to market shifts—particularly on new fields and with new animals—and creating more nuanced insights, enabling them to act on leading indicators. This creates a disparity between producers who can utilize high-speed Internet service and those who cannot. Examples include the ability to do the following:

create decision tools to help farmers and ranchers estimate the potential profit and economic risks associated with growing one particular crop over another • decide which fertilizer is best for current soil conditions • apply pesticides in targeted areas of the field, to control pests rather than applying pesticides over the entire field • use limited water resources more effectively • respond to findings of sensors that monitor animal health and nutrition

Better choices about what, where, and when to plant, fertilize, and harvest—or breed, feed, and slaughter—can drive above-average returns by removing unrecognized inefficiencies and scaling insights.

DIGITIZATION shifts supply chain management and resource allocation from generic to precise

Precision Agriculture helps make the business of farming more efficient by minimizing inputs— such as raw materials and labor—and maximizing outputs.

For example, previous research has found that 40 percent of fields are over-fertilized, which not only inflates the cost of inputs but also results in 15 percent–20 percent yield loss suffered from improper fertilizer application.14 Precise application of inputs, such as fertilizer, herbicides, and pesticides, allows farmers to adjust inputs to location-based characteristics and use exact amounts needed, which saves money and increases sustainability due to more efficient resource stewardship. Improved fertilizer, soil, and water use can significantly improve water quality with less runoff and reduce climate gas emissions, which is important since agriculture accounts for 10-15 percent of worldwide emissions.15 Despite reductions in necessary inputs, Next Generation Precision Agriculture helps maintain or increase yields, leading to significant gains in efficiency14.

Real-time insights also improve logistics. When growing melons, for instance, real-time data can help farmers overcome challenges in storing and shipping their products. Melons should be stored in an optimal refrigeration environment to minimize spoilage, and real-time precision sensors can reduce spoilage by alerting staff to suboptimal variations in temperature and humidity, allowing the execution of remedies before major losses occur. When refrigerated storage is full or the market price is at a peak, the “Internet of Things” can provide real-time information about where trucks are located and locating customers to market products to help make the sale.

LABOR EFFICIENCY boosts productivity by automating routine processes and enabling real-time response

Connected devices equip farmers with a clear picture of their operations at any moment, making it possible to prioritize tasks more effectively and triage the most pressing issues. While routine inspection and scouting has typically been a regular part of farm management and has increased farm profitability14, connected technologies can track, sense, and flag where a producer should focus their time and attention that day. Similarly, e-connectivity has allowed rural farms to access new training resources and high-skilled labor that has not been previously available.

#### Food insecurity causes state collapse, nuclear war, and terror – extinction

DeFeo 17 [(Michael, Regional Organizing Director at Arizona Democratic Party who graduated in 2019 with a bachelor’s degree in political science from Gettysburg College) “Food Insecurity and the Threat to Global Stability and Security in the 21st Century” Inquires Journal, 2017] BC

Poor Institutional Capacity

Although the developed world experiences food insecurity, it is the lack of infrastructure and government institutions in developing countries that contribute to civil wars and state fragility. Foreign exchange shortages can provoke food and fuel scarcities that force governments to spend less on essential services and public goods. Accordingly, citizens see their medical and educational entitlements melt away. Such circumstances create breeding grounds for internal conflict.

All violent conflicts destroy land, water, and social resources for food production. Developing countries do not have massive industrial machines that can remedy such losses, therefore, the population will suffer. Food insecurity is a recruitment tool for violent extremist groups. Promising food and water to a starving population, especially in urban areas, makes recruiting young and disgruntled youth easier (Messer & Cohen, 2015). Syria had limited institutional capacity to deal with the mass displacement, and that lead to a civilian revolt and recruitment into the Islamic State.

Countries that fail to provide their people with basic services often experience gross economic inequality, and even human-rights violations, as was the case in both Syria and Sudan. Both countries are classified as Least Developed Countries (LDCs). LDCs are distinguished not just by their widespread poverty, but also by their structural weaknesses in economic, institutional, and human resources that make them unable to maintain stability during a drought. The combination of drought and political instability or violence led to famine in Somalia (another LDC) in 2011. Even with urgent humanitarian action, the country still plunged into chaos and violence (Messer & Cohen, 2015). Severe drought, like Somalia's, may result in crop failure in major food producing areas, which in turn is a significant threat to social stability and peace (Wischnath, 2014).

Sometimes droughts of exceptional severity (and the civil unrest that follows) are attributed to climate change, especially in particularly arid regions. Scholars are divided on whether climate change actually impacts civil conflict. That is why African countries like Somalia and Sudan are prime case studies. Africa has the lowest percentage of irrigated land in the world. Agriculture is the most important sector of most African countries. Very high percentages of civilians in African countries live in rural areas. Those characteristics combined with low economic and state capacity make African, particularly sub-Saharan African countries the most vulnerable to climate change and civil instability. Africa experiences more civil conflict than other parts of the world, therefore, it is possible to argue that a lack of climate variability effect on civil conflict in Africa would make it unlikely to cause civil conflict in other parts of the world (Koubi et al., 2012). Secretary-General of the United Nations, Ban Ki-moon attributed the conflict in Darfur to an ecological crisis arising “at least in part from climate change” (Ki-moon, 2007). The Fourth Report of the Intergovernmental Panel on Climate Change assessed that climate change will continue to worsen. As it does, it will increase food shortages, which may lead to conflict (AR4, 2007). The report also stated that forced displacement and rising social instability is the most likely result of food insecurity. This is almost exactly what happened in Syria. The first step towards conflict might be food riots, which often occur during a food shortage or when there is an unequal distribution of food. These are usually caused by food price increases, food speculation, transport problems, or extreme weather. In 1977, Egyptians became so desperate for food that they attacked shops, markets, and government buildings just to obtain bread and grain (Paveliuc-Olariu, 2013).

Moreover, civil war can create economic opportunities for certain groups, so they try to avoid resolving the conflict. Urban elites in Somalia profited tremendously off of internal conflict because of the absurd amount of foreign aid that was pumped into the country and then largely stolen (Shortland, Christopoulou, & Makatsoris, 2013). Once a country experiences a food shortage, it may lead to protests, riots, and violence. This all contributes to state instability, but it is not the state alone that suffers. If one country fails, it creates a crisis that could destabilize an entire region.

State Failure and the Threat to Regional Stability

Although fragile governments in developing countries are at a heightened risk for internal conflict that could topple them, that risk also threatens the country’s neighbors. After the Soviet Union collapsed in 1991, Afghanistan found itself alone in regional trade. Without a guaranteed source of cereal, the government had to turn to Iran and Pakistan for support in order to avoid its own collapse (Clarke, 2000). Unlike Afghanistan, many other developing countries have been unable to work together on food and water security. Thirteen of the twenty-two members of the Arab League rank among the most water-scarce nations on the planet. Food cannot be grown without water. The majority of the world is engaged in some sort of agreement with neighboring countries to share water supplies, but thirty-seven countries still do not share their water resources (El Hassan, 2014). Lack of cooperation can cause civil as well as interstate conflict. South Sudan legally has no share of the Nile River and the effects of that lack of water access have been mass starvation and violence.

The effects of climate change, water shortages, and mass migrations have resulted in acute food insecurity not just in Syria, but across the region (El Hassan, 2014). Food insecurity, plus an increase in the prices of staple foods have destabilized much of the area. The Arab Spring was the beginning of multiple conflicts that have affected countries like Syria, Egypt, and Libya. In Syria, food insecurity resulted in mass violence and has now created an international crisis involving multiple world powers.

Food insecurity is such a threat to entire regions because people cannot live without food and people want to live. When a region experiences food scarcity and that population feels threatened by hunger, it will relinquish dependency on any political authority and take up arms in order to ensure its well-being (Paveliuc-Olariu, 2013). This is human survivalism. It is important for developing countries in areas that are at risk for food insecurity to formulate policy that ensures aid goes to the food insecurity hotspots so as to maintain stability.

South Sudan experienced what happens when countries do not work together to feed their people. After gaining its independence from Sudan in 2011, 360,000 South Sudanese refugees returned to the country. This influx of human beings, coupled with drought conditions exacerbated economic strain and drove food prices up. The increases were the result of trade restrictions between Sudan and South Sudan. The overall reason for the food crisis, however, was the government's preoccupation with fighting a political and quasi-ethnic civil war rather than negotiating fair access to the Nile River (Tappis et al., 2013). Because of South Sudan’s weak institutions, it has done little to address the food shortage. That inability to solve the problem fuels insurgent recruitment that continues the bloodshed in South Sudan. The conflict is keeping regional rivalries alive with Uganda, Kenya, Ethiopia, and Sudan; all of whom have attempted to intervene in South Sudan militarily to bring about stability (Council on Foreign Affairs 2016). Aside from South Sudan, multiple conflicts across Africa are consuming massive amounts of diplomatic, political, and humanitarian resources in a region that faces a multitude of threats.

South Sudan, Somalia, and Syria are all failing states that are experiencing huge food shortages, humanitarian crises, and most importantly, extreme civil violence. South Sudan is mired in a civil war. Somalia is controlled by warlords and terror organizations. Syria has both of those problems. Conflict has turned these countries into “breeding grounds of instability, mass migration, and murder” rather than sovereign states with a monopoly on violence and control over their borders (Rotberg, 2002). To be sure, failing states are a concern because of their ability to destabilize entire regions, but states at risk for failure are also very important. Countries like Pakistan that are politically unstable and have food and water shortages could result in uncontrollable civil upheaval (The Fund for Peace, 2016).

Global Consequences of State Failure

Failing states and destabilized regions are not just a problem for the developing world. They are a very real concern for the United States and other developed countries as well. The Islamic State fed off of the Syrian Civil War and helped destabilize Iraq, Syria, Libya, and even Afghanistan and the Philippines. They have at also inspired terror attacks in Europe and the United States. They are a threat to both the developed and developing world. State instability allows them to recruit and train without government interference, which in turn allows them to plan attacks outside the region. An important source of income for the Islamic State has been agriculture from Iraq and Syria. While this revenue has received less media attention than oil extraction, it is still an important part of their economy (Jaafar & Woertz, 2016). It is also a key aspect of their political legitimacy because it allows them to feed their soldiers and those they control. Controlling some of the most fertile regions of the two countries has also helped the Islamic State starve off areas that have resisted them (Jaafar & Woertz, 2016). If Syria or Iraq are ever going to stabilize, those breadbaskets must be retaken and the food must reach the civilians in the cut off areas.

In the 20th century, state failure had few implications for international peace and security. Thanks to globalization, that is no longer the case. Failed states pose a threat to themselves, their neighbors, and the entire international community (

Rotberg, 2002). Islamic State - inspired terror attacks in Belgium and France are a direct result of state collapse in Syria and Iraq. Preventing states from failing, rather than having to intervene militarily when they do, ought to be a top priority in the foreign policy of rich nations. Although the situations in Syria, Somalia, and South Sudan seem beyond repair, nation-building projects have had success in the past. Tajikistan, Lebanon, Cambodia, Kosovo and East Timor are all examples of relatively successful attempts to put failing states back on the right track (Rotberg, 2002). Developed countries must have the political will to ensure that people in developing countries are fed so that they remain pacified. It is often severe food insecurity that precedes ethnic or religious violence, as has been the case in South Sudan, therefore, adequate food is paramount to avoiding humanitarian crises that accompany ethnic and sectarian conflict (The Economist, 2016).

While it is true that many developed countries, especially the United States, are weary of providing so much financial aid and intervening militarily in war-torn, developing countries, it is imperative that the rich do not abandon the poor to a fate of internal destruction. Money must not be thrown blindly towards humanitarian crises and military intervention must be the last resort. Developed countries provided $1.4 billion for humanitarian aid in South Sudan in its first year of independence, but without specific conditions, that money went to kleptocrats rather than infrastructure projects or public services (The Economist, 2016).

Paying to help developing nations is expensive and will continue to be so. Afghanistan and Iraq are proof of that. But the war on terror, repeated military intervention, and humanitarian aid are expensive as well. In 2002, Robert Rotberg suggested that a new Marshall Plan was required for places like Afghanistan, the DRC, Sierra Leone, Somalia, and Sudan. If it is true that food and water security are the keys to keeping relative peace in new and developing countries and their collapse threatens the safety of the developed world, it seems logical that assisting those countries is wise.

In 1999, Susan L. Woodward argued that military leaders focus too much on force versus force combat rather than the issues of insurgency and terrorism in failed states. In 2017, military leaders have adjusted their strategies accordingly. Woodward believed that globalization made states less important, but their failure would still be felt around the world. Failed states cannot exercise their monopoly on violence and they cannot control their borders, thus threatening more than just the failed state (Woodward, 1999). Because state failure is so consequential, the United States military must continue to look into measures it can take to prevent it.

The Threat of the Future

Finally, the threats from food shortages in South Sudan, Somalia, Afghanistan, Iraq, and Syria are important to the United States and the international community at large, but there is one country that, while it is not a failing state right now, could easily become one if the wealthy nations of the world do not ensure its stability. That country is Pakistan. The Fund for Peace ranked Pakistan as the 14th most fragile state in the world in 2016, giving it a “High Alert” designation for state failure (The Fund for Peace, 2016). Its Demographic Pressure Indicator was an 8.9 - 10.2 Although it improved by one-tenth of a point last year, its decade trend is worse by seven-tenths of a point and its five-year trend is worse by four-tenths of a point, suggesting that the food situation is actually worsening overall (The Fund for Peace, 2016). If internal conflict and potential state failure at its most basic level begins with food and water insecurity, then Pakistan could become a real problem very soon.

Considering the risk of state failure, Pakistan poses the greatest threat to the rest of the world because of the existence of nuclear weapons within the country. Pakistan is not a member of the Nuclear Non-Proliferation Treaty, yet it has about 120 nuclear weapons. It also has a Shaheen 1A ballistic missile that can reach targets 550 miles away (Pakistan Defence, 2015). Should a food crisis arise in Pakistan that results in civil war and governmental collapse, those weapons could end up in the hands of a group that intends to use them maliciously as an act of terror. That prospect should be incentive enough for the developed countries to realize that they cannot and must not leave food insecure countries to devour themselves.

While it is difficult to argue that food insecurity immediately and directly causes civil conflict, there is no denying that people need food and water and will fight to survive. In South Sudan, ethnic and political armies fight one another. In Syria, rebels and government forces fight each other while also fighting the Islamic State. And in Somalia, warlords and their armies fight. The Syrian Civil War began six years ago after a water shortage forced thousands of migrants into urban centers. Developing countries tend to be most affected by climate change, poor governance, and food price increases. Therefore, they are the most prone to instability that may lead to outright violence. Without the wherewithal to handle civil conflict, these countries may become fragile or even failing states. Once that happens, they represent a threat not just in their region of influence, but the whole world. That is why the developed Western nations must pay attention and provide aid to the developing world in order to maintain stability. There will be more food crises in developing countries in the future, but if the North has the strength to continue aiding the South, perhaps it will be able to curb mass starvation and avoid the horrendous violence that consumes starving countries.

## CASE

### Collisions

**Time frame – Kessler effect 200 years away.**

Peter **Stubbe**, PhD in law @ Johann Wolfgang Goethe University Frankfurt, **’17**, State Accountability for Space Debris: A Legal Study of Responsibility for Polluting the Space Environment and Liability for Damage Caused by Space Debris, Koninklijke Brill Publishing, ISBN 978-90-04-31407-8, p. 27-31

The prediction of possible scenarios of the future evolution of the debris p o p ulation involves many uncertainties. Long-term forecasting means the prediction of the evolution of the future debris environment in time periods of decades or even centuries. Predictions are based on models84 that work with certain assumptions, and altering these parameters significantly influences the outcomes of the predictions. Assumptions on the future space traffic and on the initial object environment are particularly critical to the results of modeling efforts.85 A well-known pattern for the evolution of the debris population is the so-called Kessler effect’, which assumes that there is a certain collision probability among space objects because many satellites operate in similar orbital regions. These collisions create fragments, and thus additional objects in the respective orbits, which in turn enhances the risk of further collisions. Consequently, the number of objects and collisions increases exponentially and eventually results in the formation of a self-sustaining debris belt around the Earth. While it has long been assumed that such a process of collisional cascading is likely to occur only in a very long-term perspective (meaning a time 1 n of several hundred years),87 a consensus has evolved in recent years that an uncontrolled growth of the debris population in certain altitudes could become reality much sooner.88 In fact, a recent cooperative study undertaken by various space agencies in the scope of i a d c shows that the current l e o debris population is unstable, even if current mitigation measures are applied. The study concludes:

Even with a 90% implementation of the commonly-adopted mitigation measures [...] the l e o debris population is expected to increase by an average of **30% in the next 200 years.** The population growth is primarily driven by catastrophic collisions between 700 and 1000 km altitudes and such collisions are likely to occur every 5 to 9 years.89

**Space debris is hype---there are thousands of satellites and only 15 debris collisions ever**

Mark **Albrecht 16**, Chairman of the board of USSpace LLC & fmr. head of the National Space Council, “Congested space is a serious problem solved by hard work, not hysteria, 5/9/16, https://spacenews.com/op-ed-congested-space-is-a-serious-problem-solved-by-hard-work-not-hysteria/

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 commercialization is a strong constraint on conflict – solves space war

Wendy N. Whitman **Cobb 20**, is currently an associate professor of strategy and security studies at the US Air Force's School of Advanced Air and Space Studies, 7-21-2020, "Privatizing Peace: How Commerce Can Reduce Conflict in Space," Routledge & CRC Press, <https://www.routledge.com/Privatizing-Peace-How-Commerce-Can-Reduce-Conflict-in-Space/Cobb/p/book/9780367337834> // AAli

By the end of the twentieth century, scholars zeroed in on the democratic peace theory which attempts to explain why democracies do not go to war with other democracies and why, in some analyses, they seem to be more prone to peace in general than non-democracies. Similar to the golden arches, what is it about democracy that seems to induce such peacefulness? Academics have proposed everything from the nature of mediating institutions to the restraint of public opinion, to trade relations. While these variations will be explored further in Chapter 3, of interest here are the versions that focus explicitly on trade, commercial ties, and capitalism. Along these lines, Erik Gartzke argues, "peace ensues when states lack differences worthy of costly conflict."31 If the costs of conflict are too high, then states should be more unlikely to engage in it. To this end, economic globalization can provide the means through which costs are raised. “The integration of world markets not only facilitates commerce, but also creates new interests inimical to war. Financial interdependence ensures that damage inflicted on one economy travels through the global system, afflicting even aggressors."32 Focusing his analysis primarily on the influence of capitalism, Gartzke's findings suggest that states with markets more closely tied to the global economy are far less likely to experience a militarized dispute.

In thinking about the space environment today, there are obvious principles of capitalism at work. However, China, a major spacefaring state that has been making capitalist reforms, arguably remains far from a true capitalist country. This is especially true in their space industry which is heavily subsidized by the state and almost wholly integrated with China's military.34 Many other states continue to subsidize space activities heavily as well. A better approach through which to examine conflict in space is presented by an offshoot of the capitalist peace which is termed the commercial peace. The commercial peace thesis emphasizes the role of trade and the connections made through it to explain a lack of conflict. Han Dorussen and Hugh Ward write:

Trade is important not only because it creates an economic interest in peace but also because trade generates 'connections' between people that promote communication and understanding.... Based on these ideas, the flow of goods between countries creates a network of ties and communication links. If two countries are more embedded in this network, their relations should be more

peaceful 35

Given the interconnectedness of the global economy to space-based assets, a version of the commercial peace thesis can be used to argue that the chance of conflict in space is less than is commonly understood or recognized precisely because of the extent to which the global economy has become dependent on space-based assets.

To understand this argument, consider a scenario in which Russia, in preparation for a new assault on Eastern Europe, attacks a key US military satellite with the purpose of disrupting and disabling military communications in Europe. This action would conceivably enable the Russians to undertake their attack under more favorable conditions and prevent a quicker response from America and its allies. However, if the satellite was attacked via an ASAT that kinetically destroyed the US satellite, the debris cloud created from the attack could have disastrous consequences beyond military communications Much like the movie Gravity, the debris cloud could cause a chain reaction, hitting and ~~disabling~~ dismantling other satellites that would in turn disrupt civilian communications, business transactions, and perhaps even Russian military satellites. The economic effects of lost satellites would not be restricted to one country alone; the global economic consequences in terms of lost property (satellites), lost transactions, and financial havoc would echo throughout the world, including in Russia itself. Finally, the attack on one satellite could even ultimately endanger the ISS and its inhabitants, several of which are Russians. Destruction of the ISS would negate billions of dollars in investment from not just Russia, but other countries that have participated in it including Japan, Italy, and Canada. Therefore, an attack on a US military satellite would not just be an attack on one but an attack on all.

While the previous scenario highlights several reasons why it would not be in Russia's best interest to attack a US satellite, this book argues that the economic argument is both the strongest and the most restraining especially as space becomes more congested, competitive, contested, and commercialized

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. The emergence of private space companies enhances this argument. "In the commercial sector, companies need reliability and legal enforcement mechanisms if they are going to operate profitably in a shared environment."36 In order to foster the growing area of space commercialization, companies must be assured that the activities they undertake in space will be protected in some way or, at a minimum, allowed to proceed to the extent where they can reap the profit. This could be done through international organizations that would provide some sort of space traffic control, but the likelihood of a major international breakthrough on rules regarding space is unlikely in the near term. Therefore, actors must rely on the protections afforded them by an increasingly globalized economy that is ever more dependent on space-based assets.

### Asteroid Detection

#### Ground-based observatories already can’t see because of the sun, no impact to asteroid collision, and turn – satellites are key for asteroid detection. Blumberg 19:

Nick Blumberg { Public Insight Journalist Nick Blumberg (Phoenix) has served as an Associate Producer for KJZZ’s Here and Now, a news and public affairs talk show covering the Phoenix area. He grew up on the far North Side of Chicago, and has been a news junkie as long as he can remember. He moved to Arizona to attend the Walter Cronkite School of Journalism at Arizona State University, graduating magna cum laude. He was part of the Murrow and PRNDI-award winning team at KJZZ that covered Arizona’s controversial SB 1070 anti-immigration law throughout 2010.}, 19 - ("How Satellites Can Detect and Protect Earth From Asteroids," WTTW News, 9-10-2019, https://news.wttw.com/2019/09/10/how-satellites-can-detect-and-protect-earth-asteroids)//marlborough-wr/

This week, scientists from NASA, the European Space Agency and other institutions will gather at a conference in Italy, where they’ll be looking at a bold proposal to use two spacecraft to deflect an asteroid. That planetary defense plan is one of many worldwide efforts to ensure that Earth remains safe from collisions. While ground-based observatories have done great work in detecting asteroids, Adler Planetarium astronomer Mark Hammergren says they’re stymied by the bright light of the sun and that an infrared satellite orbiting Earth would be a more valuable sentry. “Out in space there’s no atmosphere, so you can look closer to the sun,” Hammergren said. “You can find what we think is an almost entirely unknown population of hazardous asteroids orbiting closer to the sun than us and every once in a while crossing our path.” Why infrared? Hammergren says it’s because darker asteroids are harder to detect visually. “If you have … a dark car sitting in the summer sun, it gets hotter than the white car next to you. The darker car – or darker asteroid – will emit more infrared light, so they appear brighter.” While Hammergren thinks a satellite to detect asteroids is valuable, he also advises people not to worry too much about Armageddon scenarios. “We have found virtually all of the large asteroids that could cause mass extinctions on Earth and not a single one of them is going to hit the Earth for at least a thousand years in the future,” Hammergren said. “It’s probably one of the greatest unsung victories that NASA and maybe even civilization has accomplished.”

#### No risk of extinction from asteroids---the probability of one hitting earth is extremely slim and countries developing prevention methods now

Inigo Monzon, IBT Correspondent, 9-2-2019, "Scientist Reveals Truth About Earth’s Chances Of Surviving An Asteroid Impact", International Business Times, 9-2-2019, https://www.ibtimes.com/scientist-reveals-truth-about-earths-chances-surviving-asteroid-impact-2820951, hec)

Dr. Lewiss Dartnell, a professor of science communication, believes that humans have a very good chance of enduring an asteroid impact. Despite what happened to the dinosaurs 66 million years ago, Dartnell thinks that humans are not in danger of going extinct due to an asteroid strike. The professor noted that in order to wipe out all life on Earth, an asteroid has to be hundreds or even thousands of kilometers long. Although NASA has already detected and identified asteroids that are certainly big enough to kill planets, the agency noted that none of these are currently on a collision course with Earth. “The Earth is not going to be destroyed by an asteroid,” Dartnell told Mashable India. “Alright, so a different question might be, could all life on Earth be driven to extinction by asteroids?” “Again, the answer would be that no,” he continued. “There’s no asteroid big enough that on a collision with the Earth could do that.” Dartnell, however, believes that there asteroids out there that can easily take out cities. Despite this, he still believes that chances of city-killers hitting Earth are very slim. One of the currently known asteroids that are capable of destroying entire cities is Apophis. Scientists once thought that his asteroid, which measures about 1,214 feet long, was in danger of colliding with Earth in the next decade. However, after follow-up observations, space agencies ruled out a possible collision between Apophis and Earth in the near future. “If we were very, very unlucky, and they strike over a major city, then they could destroy the city,” Dartnell said. “But the chances of that happening are very unlikely.” “Asteroid Apophis is one of the asteroids that we are tracking and we know that it is not going to impact for the next few decades and will continue on trail,” the professor added. Aside from the asteroid’s slim chances, space agencies from various countries are hatching their own plans to save Earth from getting hit by a massive space boulder.

### Ozone

#### Non-unique – climate change causes ozone depletion, not satellites. Marlborough reads yellow

AC Browne 20 “Scientists warn erosion of ozone layer could lead to a modern mass extinction event” EDWARD BROWNE May 28, 2020 <https://www.express.co.uk/news/science/1287983/ozone-layer-global-warming-mass-extinction-dinosaurs-Southampton> SM

Scientists warn erosion of ozone layer could lead to a modern mass extinction event

AN unexplained mass extinction event that occurred 359 million years ago may have been caused by erosion of the ozone layer, a UK study has found.

It could have alarming implications for the way our current world is headed, regarding rising global temperatures. Researchers from the University of Southampton have been investigating an extinction event that occurred at the end of the Devonian geological period.

During their study, they found evidence that plant spores from around the time had been damaged by UV radiation, suggesting that the Earth’s ozone layer was not providing sufficient protection from the sun’s deadly rays.

While it is already known that ozone depletion could lead to an extinction event, the scientists were alarmed by the reason behind why the ozone depletion seemed to have occurred.

The researchers discovered that this particular ozone erasure could have been linked to global warming, which the scientists described as a “new mechanism for mass extinctions.”

Mass extinction events have occurred a number of times in Earth’s past, with known causes being asteroid impacts and large-scale volcanic eruptions, Phys.org reports.

Many will associate the asteroid impact event as the one that led to the extinction of the dinosaurs.

The extinction event that the Southampton scientists were studying came after a period of rapid global warming after an ice age, Phys.org continues.

As part of their study, the researchers collected rocks from sites in Greenland as well as Bolivia in order to study any clues about what Earth conditions may have been like way back 360 million years ago.

Indeed, these rocks held some clues as to what had been happening around the time of the Devonian period.

The researchers found that the rocks contained plant spores – which plants use to reproduce – that had been preserved within them for hundreds of millions of years.

They discovered that some of these spores appeared to have been damaged by something, noting that they had “malformed sculpture and pigmented walls”.

This sort of damage is similar to what would occur if the spores had been hit by high levels of ultraviolet light – also called UV rays – that are given off by the sun.

The researchers explained: “This indicates the temporary loss of the global protective ozone layer.”

This is because the ozone layer absorbs some of the UV light – a particular type called UBV – that travels from the sun to the Earth.

The US Environmental Protection Agency (EPA) notes that UVB light has been linked to skin cancer and can cause harm to crops and marine life.

The ozone layer is a part of Earth’s atmosphere located in the stratosphere between 9 and 18 miles up.

Professor Marshall, lead researcher for the team, said that “current estimates suggest we will reach similar global temperatures to those of 360 million years ago,” according to phys.org.

He added that this raises the possibility of another collapse in the ozone layer, which could have disastrous consequences for all life on Earth, including us.

In the study’s abstract, the team said: “ozone loss during rapid warming is an inherent Earth system process with the unavoidable conclusion that we should be alert for such an eventuality in the future warming world.”

As well as global warming, human activity is associated with the depletion of the Earth’s vital ozone layer.

Scientists have reported that a large ozone hole over the Antarctic is slowly beginning to recover amid international efforts to limit the amount of ozone-depleting substances belched out by mankind.

#### Continued private space development is the only way to make sustainable energy feasible and solve ozone depletion – empirics prove. Autry 19:

Greg Autry {the director of the Southern California Commercial Spaceflight Initiative at the University of Southern California, vice president at the National Space Society, and chair of the International Space Development Conference, }, 19 - ("Space Research Can Save the Planet—Again," Foreign Policy, 7-20-2019, <https://foreignpolicy.com/2019/07/20/space-research-can-save-the-planet-again-climate-change-environment/)//marlborough-wr/>

Today conservationists and other critics are more likely to see space programs as militaristic splurges that squander billions of dollars better applied to solving problems on Earth. These well-meaning complaints are misguided, however. Earth’s problems—most urgently, climate change—can be solved only from space. That’s where the tools and data already being used to tackle these issues were forged and where the solutions of the future will be too. Space research has already been critical in averting one major environmental disaster. It was NASA satellite data that revealed a frightening and growing hole in the ozone layer over the South Pole, galvanizing public concern that, in 1987, produced the Montreal Protocol: the first international agreement addressing a global environmental problem. Since then, thanks to worldwide restrictions on damaging chlorofluorocarbons, the ozone situation has stabilized, and a full planetary recovery is expected. As this case showed, space can provide the vital information needed to understand a problem—and a surprising range of ways to solve it. Climate change is a poster child for the critical role of space data. Trekking across the globe to measure ice sheets with drills and gauge sea temperatures from the sides of ships is an expensive, slow, and insufficient way to assay the state of the planet. Satellites operated by NASA, the U.S. National Oceanic and Atmospheric Administration, and an increasing number of commercial firms provide a plethora of multispectral imaging and radar measurements of developments such as coral reef degradation, harmful plankton blooms, and polar bears negotiating thinning ice. Much of the technology involved in observing the Earth today was initially developed for probes sent to explore other planets in our solar system. 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

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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. Eventually, firms will be able to supply endeavors in space with materials from the moon and asteroids, avoiding the cost and environmental impact of lifting them into orbit. Mining the solar system comes with its own potential impacts, but extracting resources from distant and lifeless worlds is clearly preferable to the continued degradation of the Earth.