## 1 70

#### Interpretation – Private entities is generic – the aff can’t spec a subset of them

Nebel 20 [Jake Nebel is an assistant professor of philosophy at the University of Southern California and executive director of Victory Briefs. He writes a lot of this stuff lol – duh.] “Indefinite Singular Generics in Debate” Victory Briefs, 19 August 2020. no url AG

I agree that if “a democracy” in the resolution just meant “one or more democracy,” then a country-specific affirmative could be topical. But, as I will explain in this topic analysis, that isn’t what “a democracy” means in the resolution. To see why, we first need to back up a bit and review (or learn) the idea of generic generalizations.

The most common way of expressing a generic in English is through a *bare plural*. A bare plural is a plural noun phrase, like “dogs” and “cats,” that lacks an overt determiner. (A determiner is a word that tells us which or how many: determiners include quantifier words like “all,” “some,” and “most,” demonstratives like “this” and “those,” posses- sives like “mine” and “its,” and so on.) LD resolutions often contain bare plurals, and that is the most common clue to their genericity.

We have already seen some examples of generics that are not bare plurals: “A whale is a mammal,” “A beaver builds dams,” and “The woolly mammoth is extinct.” The first two examples use indefinite singulars—singular nouns preceded by the indefinite article “a”—and the third is a definite singular since it is preceded by the definite article “the.” Generics can also be expressed with bare singulars (“Syrup is viscous”) and even verbs (as we’ll see later on). The resolution’s “a democracy” is an indefinite singular, and so it very well might be—and, as we’ll soon see, is—generic.

But it is also important to keep in mind that, just as not all generics are bare plurals, not all bare plurals are generic. “Dogs are barking” is true as long as some dogs are barking. Bare plurals can be used in particular ways to express existential statements. The key question for any given debate resolution that contains a bare plural is whether that occurrence of the bare plural is generic or existential.

The same is true of indefinite singulars. As debaters will be quick to point out, some uses of the indefinite singular really do mean “some” or “one or more”: “A cat is on the mat” is clearly not a generic generalization about cats; it’s true as long as some cat is on the mat. The question is whether the indefinite singular “a democracy” is existential or generic in the resolution.

Now, my own view is that, if we understand the difference between existential and generic statements, and if we approach the question impartially, without any invest- ment in one side of the debate, we can almost always just tell which reading is correct just by thinking about it. It is clear that “In a democracy, voting ought to be compul- sory” doesn’t mean “There is one or more democracy in which voting ought to be com- pulsory.” I don’t think a fancy argument should be required to show this any more than a fancy argument should be required to show that “A duck doesn’t lay eggs” is a generic—a false one because ducks do lay eggs, even though some ducks (namely males) don’t. And if a debater contests this by insisting that “a democracy” is existen- tial, the judge should be willing to resolve competing claims by, well, judging—that is, by using her judgment. Contesting a claim by insisting on its negation or demanding justification doesn’t put any obligation on the judge to be neutral about it. (Otherwise the negative could make every debate irresolvable by just insisting on the negation of every statement in the affirmative speeches.) Even if the insistence is backed by some sort of argument, we can reasonably reject an argument if we know its conclusion to be false, even if we are not in a position to know exactly where the argument goes wrong. Particularly in matters of logic and language, speakers have more direct knowledge of particular cases (e.g., that some specific inference is invalid or some specific sentence is infelicitious) than of the underlying explanations.

But that is just my view, and not every judge agrees with me, so it will be helpful to consider some arguments for the conclusion that we already know to be true: that, even if the United States is a democracy and ought to have compulsory voting, that doesn’t suffice to show that, in a democracy, voting ought to be compulsory—in other words, that “a democracy” in the resolution is generic, not existential.

Second, existential uses of the indefinite, such as “A cat is on the mat,” are upward- entailing.3 This means that if you replace the noun with a more general one, such as “An animal is on the mat,” the sentence will still be true. So let’s do that with “a democracy.” Does the resolution entail “In a society, voting ought to be compulsory”? Intuitively not, because you could think that voting ought to be compulsory in democracies but not in other sorts of societies. This suggests that “a democracy” in the resolution is not existential.

#### It applies to this topic – a] entities is an existential bare plural bc it has no determiner b] The sentence “The appropriation of outer space by private entities is unjust” does not imply “the appropriation of outer space by private and public entities is unjust”

#### Violation – they spec []

#### Standards

#### 1] Limits – they can spec infinite different entities like spaceX, etc.. - that’s supercharged by the ability to spec combinations of types of entities. This takes out functional limits – it’s impossible for me to research every possible combination of entities, governments, and appropriation.

#### 2] TVA solves – just read your aff as an advantage to a whole rez aff – we don’t stop them from reading new FWs, mechanisms or advantages. PICs aren’t aff offense – a] it’s ridiculous to say that neg potential abuse justifies the aff being non-T b] There’s only a small number of pics on this topic c] PICs incentivize them to write better affs that can generate solvency deficits to PICs

DTD

No RVIS

1. Baiting thoery
2. No win off being fair
3. Takes time to read

CI – reasonability arbitrary CI

### 1NC—CP Advantage

#### The United States and the People’s Republic of China should:

#### cooperate on space policy.

#### Plank 1 solves mining-based competition

Jamasmie 21 — (Cecilia Jamasmie, Cecilia has covered mining for more than a decade. She is particularly interested in Corporate Social Responsibility (CSR), Diamonds and Latin America. Cecilia has been interviewed by BBC News and CBC among others and has been a guest speaker at mining conventions, including MINExpo 2016 and the World’s Copper Conference 2018. She is also member of the expert panel on Social License to Operate (SLO) at the European project MIREU (Mining and Metallurgic Regions EU). She holds a Master of Journalism from the University of British Columbia, and is based in Nova Scotia., “Experts warn of brewing space mining war among US, China and Russia“, MINING, 4-29-21, Available Online at https://www.mining.com/experts-warn-of-brewing-space-mining-war-among-us-china-and-russia/, accessed 1-11-2022, DebateDrills EE)

The next Wild West?

China has historically been excluded from the US-led international order in space. It is not a partner in the International Space Station (ISS) program, and a US legislative provision has limited NASA’s ability to cooperate with it in space since 2011.

“America and China should cooperate in space,” say policy experts Anne-Marie Slaughter and Emily Lawrence. “If the US managed to coordinate with the Soviet Union on space policy during the Cold War, it can find a way to cooperate with China now,” they note.

Slaughter, a former director of policy planning in the US State Department from 2009 to 2011, believes that President Joe Biden’s team should distance from Trump’s accords and instead pursue a new course within the UN Committee on the Peaceful Uses of Outer Space.

“Biden can restore some of America’s global legitimacy by working to establish a multilateral framework, negotiated with all relevant parties that protects areas of common interest while granting internationally accepted commercial opportunities,” Slaughter and Lawrence wrote.

#### Also solves point 7

1AC Gautel 21 — (Gidon Gautel is currently an Analyst in the space industry. He was previously the Project Coordinator of China Foresight and Project Manager of the Economic Diplomacy Commission at LSE IDEAS. Gidon holds a BSc in Government and Economics with first class honours from the London School of Economics & Political Science, and an MSc in Innovation, Entrepreneurship & Management with distinction from Imperial College Business School., [insert quals], “Coordination Failure: Risks of US-China competition in space“, Medium, 4-29-2021, Available Online at https://lseideas.medium.com/coordination-failure-risks-of-us-china-competition-in-space-7112ca4f4da1, accessed 1-12-2022, HKR-AR)

Again, the described issues are most likely to occur should terrestrial geopolitical tensions between the US and China preclude proactive coordination and information sharing. While the establishment of separate lunar operations can, at this point, be taken as a given, it is far from too late to establish functionally sufficient coordination mechanisms to prevent a major international incident. While US-China coordination is limited by the Wolf Amendment, it is not wholly precluded, as indicated by NASA’s monitoring of the Chang’e 4 mission, utilising the Lunar Reconnaissance Orbiter[[17]](https://lseideas.medium.com/coordination-failure-risks-of-us-china-competition-in-space-7112ca4f4da1#_ftn17), and, more recently, an exchange of data to mitigate the risks of an orbital collision of Mars orbiters[[18]](https://lseideas.medium.com/coordination-failure-risks-of-us-china-competition-in-space-7112ca4f4da1#_ftn18). Ideally, therefore, the United States would proactively take the necessary bilateral steps to work with China to coordinate its respective beyond-Earth surface activities and prevent harmful interference.

## 3

#### Public sector space innovation falls continues to fall short – . The private sector is key to space research/innovation. (Redistribution)

Follett 21 [Andrew Follett- previously space and science reporter for Daily Caller News Foundation, researcher for the Congressional Committee on Science, Space and Technology, the National Aeronautics and Space Administration, the Cato Institute, and the Competitive Enterprise Institute. currently conducts research analysis for nonprofit in Washington, D.C., area.. “Private Firms Are the Key to Space Exploration.” 8/21/21. National Review. https://www.nationalreview.com/2021/08/private-firms-are-the-key-to-space-exploration/]

America’s public-sector space program recently had a rough couple of weeks that perfectly exemplify why it desperately needs a free-market overhaul. On July 29, the International Space Station (ISS) suffered a serious loss of control after a Russian spacecraft docked with it, accidentally causing the station to make a full 540-degree rotation and a half before coming to a stop upside down, when the astronauts got it under control. Like most NASA programs, the ISS is massively over budget. Costs were initially projected at $12.2 billion, but the bill ultimately reached a stunning $150 billion. American taxpayers paid around 84 percent of that. What happened to the American dream of human space exploration? Put simply, the government happened. NASA devolved into a jobs program to bring home the space bacon. Then, on August 10, NASA’s inspector general released a report deeming plans to send astronauts back to the moon in 2024 unfeasible because of significant delays in developing the mission’s spacesuits. Right now the suits are being built by 27 different companies that successfully lobbied the government for a piece of the action. SpaceX’s Elon Musk has rightly noted that NASA has “too many cooks in the kitchen.” The difference between NASA’s cumbersome designed-by-committee suits and SpaceX’s suits — created by a single contractor — is remarkable, even to the naked eye. The report unconvincingly blames NASA’s failure to develop a new spacesuit over the last 14 years solely on shifting technical requirements. It recommends “ensuring technical requirements for the next-generation suits are solidified before selecting the acquisition strategy to procure suits for the ISS and Artemis programs.” Instead of dealing with the problem, the Biden administration is trying to distract attention from the space agency’s mismanagement by announcing plans to land the first person of color on the moon . . . even though NASA has been incapable of sending astronauts of any color into space under its own power since July 2011. NASA has been reduced to begging the Russians for a ride. The agency’s troubled Constellation program, meant to replace the Space Shuttle fleet, was canceled after tens of billions of dollars had already been spent. But NASA’s troubles are, depressingly, likely to get even worse. In November the James Webb Space Telescope (JWST) will finally launch, after taxpayers have forked over $9.7 billion. It was originally supposed to launch in 2007 on a budget of $500 million. That means the project is over a decade behind schedule and costing almost 20 times its initial budget. Perhaps the telescope, meant to locate potentially habitable planets around other stars and perhaps even extraterrestrial life, could instead search for a calendar . . . or fiscal sanity . . . in the stars? JWST isn’t the first NASA space telescope to suffer cost overruns and setbacks. The Hubble Space Telescope (HST) was originally intended to launch in 1983, but technical issues delayed the launch until 1990 because the main mirror was incorrectly manufactured. JWST is very likely to fail because it is supposed to unfold itself “origami style” in space in an extremely technically complicated process. If difficulties arise, JWST lacks HST’s generous margin for error because of its location far beyond earth’s orbit at the Sun-Earth L2 LaGrange point. NASA currently lacks the capability to send a team of astronauts out that far to fix any problems. Even if NASA could get out to JWST, the telescope doesn’t have a grappling ring for an astronaut to grab onto and thus could potentially kill astronauts attempting to fix it. It is hard to imagine a better example of the private sector’s amazing ability to outcompete government bureaucracy and mismanagement than NASA’s planned Shuttle replacement, the Space Launch System. It is estimated to cost more than $2 billion per flight. That’s on top of the $20 billion and nine years the agency has already spent developing the vehicle. Contrast that with the comparatively inexpensive $300 million spent by SpaceX to develop the Falcon 9 in a little over four years, and the fact that each Falcon 9 costs around $62 million. One SLS launch could pay for over 32 SpaceX launches. Private ventures such as SpaceX are more efficient because they have a lot more incentive to avoid excessive costs and focus on solutions: Their own money is at stake, and people spend their own money more carefully than they spend taxpayer dollars collected from others. Multiple private American space firms are currently pursuing accomplishments beyond those of NASA, and they are more advanced and ambitious than the entire government space programs of China and the European Union combined. So one possible solution to NASA’s woes would be to greatly increase its reliance on commercial launch providers. And one way to do that would be to return to the system that made civil aviation great: prizes to reward private-sector innovation

#### Chinese private Asteroid Mining key to sustaining Rare Earth Minerals.

Cohen 21 Ariel Cohen 10-26-2021 "China’s Space Mining Industry Is Prepping For Launch – But What About The US?" <https://www.forbes.com/sites/arielcohen/2021/10/26/chinas-space-mining-industry-is-prepping-for-launch--but-what-about-the-us/?sh=6b8bea862ae0> (I am a Senior Fellow at the Atlantic Council and the Founding Principal of International Market Analysis, a Washington, D.C.-based global risk advisory boutique.)//Elmer

Exploration of space-based natural resources are on the Chinese policy makers’ mind. The question is, what Joe Biden thinks? In April of this year, China’s Shenzen Origin Space Technology Co. Ltd. launched the NEO-1, the first commercial spacecraft dedicated to the mining of space resources – from asteroids to the lunar surface. Falling costs of space launches and spacecraft technology alongside existing infrastructure provides a unique opportunity to explore extraterrestrial resource extraction. Current technologies are equipped to analyze and categorize asteroids within our solar system with a limited degree of certainty. One of the accompanying payloads to the NEO-1 was the Yuanwang-1, or “little hubble” satellite, which searches the stars for possible asteroid mining targets. The NEO-1 launch marks another milestone in private satellite development, adding a new player to space based companies which include Japan’s Astroscale. Private asteroid identification via the Sentinel Space Telescope was supported by NASA until 2015. As private investment in space grows, the end goal is to be capable of harvesting resources to bring to Earth. “Through the development and launch of the spacecraft, Origin Space is able to carry out low-Earth orbit space junk cleanup and prototype technology verification for space resource acquisition, and at the same time demonstrate future asteroid defense related technologies.” In the end, it will come down to progressively lowering the cost of launched unit of weight and booster rocket reliability – before fundamentally new engines may drive the launch costs even further down. The April launch demonstrates that China is already succeeding while the West is spinning its wheels. The much touted Planetary Resources and Deep Space Industries (DSI) DSI -1% were supposed to be the vanguard of extra-terrestrial resource acquisition with major backers including Google’s GOOG -1.4% Larry Page. But both have since been acquired, the former by block chain company ConsenSys and the latter by Bradford Space, neither of which are prioritizing asteroid mining. This is too bad, given that that supply chain crunches here on Earth – coupled with the global green energy transition – are spiking demand for strategic minerals that are increasingly hard to come by on our environmentally stressed planet. And here China currently holds a monopoly on rare earth element (REE) extraction and processing to the tune of 90%. REE’s 17 minerals essential for modern computing and manufacturing technologies for everything from solar panels to semi-conductors. Resource-hungry China also has major involvement in global critical mineral supply chains, which include cobalt, tungsten, and lithium. As I’ve written before, the Chinese hold of upstream and downstream markets is staggering. Possessing 30% of the global mined ore, 80% of the global processing facilities, and an ever increasing list of high dollar investments around the world, China boasts over $36 billion invested in mining projects in Africa alone. Beijing’s space program clearly indicates that the Chinese would also like to tighten their grip on space-based resources as well. According to research, it is estimated that a small asteroid roughly 200 meters in length that is rich in platinum could be worth up to $300 million. Merrill Lynch predicts the space industry — including extraterrestrial mining industry – to value $2.7 trillion in the next three decades. REEs are fairly common in the solar system, but to what degree remains unknown. The most sought after are M-type asteroids which are mostly metal and hundreds of cubic meters. While these are not the most common, the 27,115 Near Earth asteroids are bound to contain a few. This – and military applications – are no doubt a driving factor of China’s ever increasing space ambitions.

#### Asteroid mining is an unqualified good – it’s essential to advanced asteroid deflection, deep space travel, and fighting climate change

Heise 18 -- Jack Heise (Judicial Law Clerk at U.S. Courts of Appeals), Space, the Final Frontier of Enterprise: Incentivizing Asteroid Mining Under a Revised International Framework, 40 Mich. J. Int'l L. 189 (2018). https://repository.law.umich.edu/mjil/vol40/iss1/5 WJ

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

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

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

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

#### Asteroids have no significance beyond their finite resources – property rights for asteroids are necessary for deep space travel and rare metals

Myers 16 -- Ross Myers (J.D. candidate at the University of Oregon Law School.), The Doctrine of Appropriation and Asteroid Mining: Incentivizing the Private Exploration and Development of Outer Space, 2016, Oregon Review of International Law, https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/19850/Meyers.pdf?sequence=1 WJ

Asteroids are “metallic, rocky bodies without atmospheres that orbit the sun and are too small to be classified as planets.”33 Like water, asteroids are limited resources that are unconnected to any form of real property. Asteroids vary greatly in size, and are believed to consist primarily of metals and water, sometimes in staggering quantities.34 As such, asteroids may contain significant resources that would help serve to incentivize and facilitate the exploration of space.

Asteroids can be divided into classes, the three most commercially relevant being C-type, M-type, and S-type.35 C-type asteroids (carbonaceous) are the most common variety, and approximately half of the near Earth asteroids that are at least 1km large are C-type asteroids.36 These asteroids have a high content of water, hydrogen, and methane, all of which could potentially be mined to create rocket fuel on-site.37 Rocket fuel storage provides a limit on how far space vessels can be sent into deep space, so the creation of rocket fuel on asteroids would allow missions to probe deeper into space without having to bring enough fuel for a return trip. This could reduce the cost and difficulty of such endeavors significantly, allowing for more efficient exploration and development of deep space.

M-type asteroids (metallic) have the high radar reflectivity characteristic of metals,38 and are probably the most economically attractive targets for mining missions because of the commercial value of the metals in an Earth market. S-type asteroids (stony) are rocky mixtures of silicates, sulphides, and metals,39 but the metals they contain may not be as valuable as those found in M-type asteroids, so they will probably not be the target of initial space mining missions.

Recent scientific reports have suggested a single asteroid may contain staggering quantities of rare metals.40 One report estimated that a moderately sized (1 km) M-type asteroid with a fair enrichment in platinum group metals may contain twice the tonnage of platinum group metals already harvested on Earth combined with economically viable platinum group metal resources still in the ground.41 Put simply, it is believed a single asteroid could contain more platinum than has ever been mined or ever will be mined on Earth. While the economic gain from a mining mission on such an asteroid would be offset by the huge initial cost of reaching the asteroid and capturing the metals, this figure suggests mining missions to asteroids could be extremely profitable. Planetary Resources, a fledgling asteroid mining company, has already targeted a metallic asteroid for a possible future mining mission.42 According to Planetary Resources, this single asteroid may contain more platinum than has ever been mined on Earth.43

Scientific reports have also suggested asteroids may contain large quantities of volatiles, such as hydrogen and methane, which could potentially be broken down and used to synthesize rocket fuel and transport spacecraft between space environments.44 Several companies are already researching how to successfully mine the metals contained in asteroids by using frozen water contained in the asteroid to produce rocket fuel for a return journey.45

Asteroids are similar to water in many respects: both have economic and practical importance and limited availability; both exist as floating objects unconnected to land; and both are practically and commercially important to society and many different industries both in the context of space travel, and in the context of natural resource acquisition. However, unlike water, under the current international treaties regarding space, claims by either private or government entities on celestial objects are prohibited.46

#### NEOs can and will kill us all – ignore defense that confuses uncertainty with improbability – uncertainty in assessments means you should assign it a higher risk

Boslough 19 -- Mark Boslough (University of New Mexico), “Chapter 13 Uncertainty and Risk at the Catastrophe Threshold”, 2019, Planetary Defense, Space and Society, https://dl1.cuni.cz/pluginfile.php/634091/mod\_resource/content/1/Planetary%20Defence.pdf

The planetary defense community came to a similar conclusion. The NEO population is analogous the numbers of rounds in the revolvers of our pretend laboratory experiment. But the expected consequences of an impact depend on the size of the asteroid. The largest asteroids have the greatest effect—including the possibility of extinction—but the quantification of consequence is also very uncertain. We simply do not know how big an asteroid must be to cause an ecological collapse, to destroy agricultural production and end civilization, or to wipe out the human race. This calculation is not possible because we do not understand all the damage mechanisms associated with an Earth system that is complex and nonlinear. The asteroid that erased the dinosaurs altered the Earth forever, first by direct impact effects—the generation of an enormous crater and expulsion of ejecta. About 100 million megatons of energy was released in a massive explosion that changed the atmosphere, heating it up by an unknown amount. The air became opaque with dust and debris, leading to an impact winter that lasted years. The composition and radiative properties of the atmosphere were forever altered, and the climate changed. The precise mechanism for the resulting mass extinction is still debated and is unlikely to ever be completely understood. Fortunately, impacts by 10-km asteroids occur only once every 100 million years or so. The current risk is zero, because a 10-km asteroid on a collision course would be large enough to have been discovered already. The same cannot be said for long-period comets, however, the frequency of large comets entering the inner Solar System is low. A 5-km asteroid almost certainly exceeds the global catastrophe threshold, but at half the diameter of the dinosaur killer. An asteroid’s mass governs its impact energy and damage potential, so mass is a better measure of “size” for purposes of consequence estimates. A 5-km asteroid is therefore really only an eighth as big as the dinosaur killer, and its impact would deliver about one-eighth the destructive energy (for a given impact velocity). But there are more of the smaller ones, so the Earth is exposed to more frequent impacts from them (once about every 30 million years). The Earth doesn’t experience mass extinctions with that high of a frequency, so it is unlikely that 5-km asteroids exceed the extinction threshold, at least not every time they hit. But if one were to hit the Earth today, the energy released (roughly 10 million megatons) and the amount of debris produced would lead to certain global catastrophe, killing billions of people. The population of asteroids continues to increase as the size (and consequences) go down. Like the “bullets-in-guns” thought experiment, space is a shooting gallery where most of the shots are relatively harmless, but rare ones are catastrophic. There are sound arguments based on physics and backed by evidence in the geological record that more frequent and smaller impacts can have local, regional, or even continental-scale consequences without causing a major climate disruption or global catastrophe. That suggests the existence of an unknown size threshold for global catastrophe. There is no reason to think that such a threshold even corresponds to a definite size. An impact into one spot might release a large quantity of planet-warming greenhouse gases or cause soot-producing firestorms, resulting in an impact winter. On the other hand, if it landed in a deep ocean basin, there might be little if any global consequences. The threshold for catastrophe is therefore fuzzy in addition to being uncertain. 13.6 Avoiding Catastrophe by Situational Awareness Chapman and Morrison (1994) published the first comprehensive probabilistic risk assessment for asteroids and comets. They used observations of the effects of nuclear weapons along with physics-based scaling laws to estimate the direct damage caused by an impact of a given size. However, such scaling laws only work well for impacts that are too small to cause indirect global environmental effects such as climate change. They argued that above some threshold size (which they estimated to be around 1.5 km in diameter, with large uncertainty) a comet or asteroid impact would create a global catastrophe that would kill at least a quarter of the world’s population, increasing all the way up to extinction for the largest impacts. They spliced the nuclear weapons-based estimates together with the global catastrophe estimates to create a single, but crude “kill curve” that related the number of deaths to the size of an impacting body. In our Russian Roulette illustration, our three different guns were loaded with three different integer numbers of live rounds (since bullets exist as discrete units). This is a discrete math problem with three different possible consequences, each with its own probability. For the planetary defense risk assessment, the size of the comet or asteroid is a continuous parameter, so the sum becomes an integral. We can solve it by integrating the kill curve (as a function of size) times the probability of an impact of that size, over all possible sizes. In practice, this is done by dividing the curves up into discrete size bins. One can construct a table consisting of the number of expected impacts within some size range in a specified interval of time, and the number of resulting fatalities (averaged over all possible scenarios). According to Chapman and Morrison (1994), the expected long-term number of impact fatalities per year is 3000 if the threshold asteroid diameter for a globally catastrophic impact is 1.5 km (for further discussion of the threshold for global impact effects, see (Toon et al. 1997)). If our ability to simulate the consequences of an impact were perfect, we could improve on these estimates by running a statistically significant number of computer experiments and determining how many people would be killed, on average, from an impact of a given size. We could simulate random impacts in numbers proportional to the size distribution of the asteroid population, add up the numbers of fatalities, and divide by the number of impacts to generate a better kill curve. Unfortunately, our ability to simulate impact consequences is still far from perfect. The estimates for ocean impacts are particularly uncertain because the efficiency of impact tsunami generation is not well understood. The severity of climate-changing global catastrophes from asteroid impacts are even more uncertain because climate is a nonlinear dynamic system with unknown thresholds and feedbacks. With increased uncertainty comes greater assessed risk. Most of the uncertainty is associated with impact consequences and the “kill curve”. Complex geophysical simulations will never be perfect, therefore decisions will always need to be made in the face of this uncertainty. Nevertheless, such calculations are the best way to ensure that such decisions are objective. The estimated risk of a few thousand fatalities per year is counterintuitive, because there are no examples of unambiguous, confirmed asteroid fatalities. It depends on low-probability, high consequence events—something that only happens every million years or so but could kill hundred million people. The odds of such an event taking place in a given year are only about one in a million, but it would contribute 100 fatalities per year to the total. The expected number of fatalities per year is zero, but the long-term average is much greater. This is not the only possible way to quantify risk, and may not even be the best, yet it has become the de facto metric for the impact risk assessments, for intercomparison of contributing factors, and for performing sensitivity studies in support of cost/benefit analyses for various risk-reduction strategies. As an example, the Chapman and Morrison (1994) analysis led to an obvious policy recommendation: catastrophe avoidance. This is analogous to removing the single live round from the gun that is pointed at your head in the Russian Roulette example. The optimal risk reduction method is to prevent large impacts. The first step toward avoidance of catastrophic impact is to find all the asteroids in Earthcrossing orbits that are above the global catastrophe threshold. This recommendation led to the establishment of a survey program and the 1998 NASA directive to discover 90% of NEOs greater than 1 km in diameter. This was also the easiest solution, because there are only about 1,000 NEOs of that size. Since they are also the biggest and brightest in the sky, they were the easiest to find. The survey was a success and led to a large reduction in assessed risk. Using astronomical NEO surveys to eliminate catastrophic risk is based on the same philosophy as looking both ways before crossing the street. The survey is an act of situational awareness that doesn’t by itself change the probability of impact. An object in a deterministic orbit will either collide with the Earth on some specified time interval or it won’t. Its intrinsic impact probability is either zero or one. The situational awareness provided by looking creates the opportunity to take preventive action to mitigate the risk if something is discovered to be on a collision course. A pedestrian can change his or her own course by waiting until a potentially hazardous vehicle passes. For planetary defense, the preventive option of choice is asteroid deflection. But without a survey to discover the threat, that option is not available.

#### Warming causes extinction

Yangyang Xu 17, Assistant Professor of Atmospheric Sciences at Texas A&M University; and Veerabhadran Ramanathan, Distinguished Professor of Atmospheric and Climate Sciences at the Scripps Institution of Oceanography, University of California, San Diego, 9/26/17, “Well below 2 °C: Mitigation strategies for avoiding dangerous to catastrophic climate changes,” Proceedings of the National Academy of Sciences of the United States of America, Vol. 114, No. 39, p. 10315-10323

We are proposing the following extension to the DAI risk categorization: warming greater than 1.5 °C as “dangerous”; warming greater than 3 °C as “catastrophic?”; and warming in excess of 5 °C as “unknown??,” with the understanding that changes of this magnitude, not experienced in the last 20+ million years, pose existential threats to a majority of the population. The question mark denotes the subjective nature of our deduction and the fact that catastrophe can strike at even lower warming levels. The justifications for the proposed extension to risk categorization are given below.

From the IPCC burning embers diagram and from the language of the Paris Agreement, we infer that the DAI begins at warming greater than 1.5 °C. Our criteria for extending the risk category beyond DAI include the potential risks of climate change to the physical climate system, the ecosystem, human health, and species extinction. Let us first consider the category of catastrophic (3 to 5 °C warming). The first major concern is the issue of tipping points. Several studies (48, 49) have concluded that 3 to 5 °C global warming is likely to be the threshold for tipping points such as the collapse of the western Antarctic ice sheet, shutdown of deep water circulation in the North Atlantic, dieback of Amazon rainforests as well as boreal forests, and collapse of the West African monsoon, among others. While natural scientists refer to these as abrupt and irreversible climate changes, economists refer to them as catastrophic events (49).

Warming of such magnitudes also has catastrophic human health effects. Many recent studies (50, 51) have focused on the direct influence of extreme events such as heat waves on public health by evaluating exposure to heat stress and hyperthermia. It has been estimated that the likelihood of extreme events (defined as 3-sigma events), including heat waves, has increased 10-fold in the recent decades (52). Human beings are extremely sensitive to heat stress. For example, the 2013 European heat wave led to about 70,000 premature mortalities (53). The major finding of a recent study (51) is that, currently, about 13.6% of land area with a population of 30.6% is exposed to deadly heat. The authors of that study defined deadly heat as exceeding a threshold of temperature as well as humidity. The thresholds were determined from numerous heat wave events and data for mortalities attributed to heat waves. According to this study, a 2 °C warming would double the land area subject to deadly heat and expose 48% of the population. A 4 °C warming by 2100 would subject 47% of the land area and almost 74% of the world population to deadly heat, which could pose existential risks to humans and mammals alike unless massive adaptation measures are implemented, such as providing air conditioning to the entire population or a massive relocation of most of the population to safer climates.

Climate risks can vary markedly depending on the socioeconomic status and culture of the population, and so we must take up the question of “dangerous to whom?” (54). Our discussion in this study is focused more on people and not on the ecosystem, and even with this limited scope, there are multitudes of categories of people. We will focus on the poorest 3 billion people living mostly in tropical rural areas, who are still relying on 18th-century technologies for meeting basic needs such as cooking and heating. Their contribution to CO2 pollution is roughly 5% compared with the 50% contribution by the wealthiest 1 billion (55). This bottom 3 billion population comprises mostly subsistent farmers, whose livelihood will be severely impacted, if not destroyed, with a one- to five-year megadrought, heat waves, or heavy floods; for those among the bottom 3 billion of the world’s population who are living in coastal areas, a 1- to 2-m rise in sea level (likely with a warming in excess of 3 °C) poses existential threat if they do not relocate or migrate. It has been estimated that several hundred million people would be subject to famine with warming in excess of 4 °C (54). However, there has essentially been no discussion on warming beyond 5 °C.

Climate change-induced species extinction is one major concern with warming of such large magnitudes (>5 °C). The current rate of loss of species is ∼1,000-fold the historical rate, due largely to habitat destruction. At this rate, about 25% of species are in danger of extinction in the coming decades (56). Global warming of 6 °C or more (accompanied by increase in ocean acidity due to increased CO2) can act as a major force multiplier and expose as much as 90% of species to the dangers of extinction (57).

The bodily harms combined with climate change-forced species destruction, biodiversity loss, and threats to water and food security, as summarized recently (58), motivated us to categorize warming beyond 5 °C as unknown??, implying the possibility of existential threats. Fig. 2 displays these three risk categorizations (vertical dashed lines).

#### Delaying space colonization by even a second is worth 100 trillion lives -- most conservative estimate

Bostrom 3 -- Nick Bostrom (Needs no further introduction), Astronomical Waste: The Opportunity Cost of Delayed Technological Development, Utilitas Vol. 15, No. 3 (2003): pp. 308-314, https://www.nickbostrom.com/astronomical/waste.html WJ

As I write these words, suns are illuminating and heating empty rooms, unused energy is being flushed down black holes, and our great common endowment of negentropy is being irreversibly degraded into entropy on a cosmic scale. These are resources that an advanced civilization could have used to create value-structures, such as sentient beings living worthwhile lives.

The rate of this loss boggles the mind. One recent paper speculates, using loose theoretical considerations based on the rate of increase of entropy, that the loss of potential human lives in our own galactic supercluster is at least ~10^46 per century of delayed colonization.[1] This estimate assumes that all the lost entropy could have been used for productive purposes, although no currently known technological mechanisms are even remotely capable of doing that. Since the estimate is meant to be a lower bound, this radically unconservative assumption is undesirable.

We can, however, get a lower bound more straightforwardly by simply counting the number or stars in our galactic supercluster and multiplying this number with the amount of computing power that the resources of each star could be used to generate using technologies for whose feasibility a strong case has already been made. We can then divide this total with the estimated amount of computing power needed to simulate one human life.

As a rough approximation, let us say the Virgo Supercluster contains 10^13 stars. One estimate of the computing power extractable from a star and with an associated planet-sized computational structure, using advanced molecular nanotechnology[2], is 10^42 operations per second.[3] A typical estimate of the human brain’s processing power is roughly 10^17 operations per second or less.[4] Not much more seems to be needed to simulate the relevant parts of the environment in sufficient detail to enable the simulated minds to have experiences indistinguishable from typical current human experiences.[5] Given these estimates, it follows that the potential for approximately 10^38 human lives is lost every century that colonization of our local supercluster is delayed; or equivalently, about 10^29 potential human lives per second.

While this estimate is conservative in that it assumes only computational mechanisms whose implementation has been at least outlined in the literature, it is useful to have an even more conservative estimate that does not assume a non-biological instantiation of the potential persons. Suppose that about 10^10 biological humans could be sustained around an average star. Then the Virgo Supercluster could contain 10^23 biological humans. This corresponds to a loss of potential equal to about 10^14 potential human lives per second of delayed colonization.

What matters for present purposes is not the exact numbers but the fact that they are huge. Even with the most conservative estimate, assuming a biological implementation of all persons, the potential for one hundred trillion potential human beings is lost for every second of postponement of colonization of our supercluster.[6]

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