### 1

#### Counterplan text – states ought to eliminate their nuclear arsenals – this card explains implementation and takes out circumvention.

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* This card also explains the scope of durable fiat

An important consideration is that nuclear disarmament policies will not guarantee any success as long as the states possessing these weapons are not engaged. To get them on board, it may be important to recognize that nuclear weapons have both a humanitarian dimension and a security dimension. It will be a difficult balancing act to combine these two in the same policy. Nevertheless, in order to effectively achieve **the** global elimination of nuclear weapons, it is crucial that the states possessing the weapons should participate in measures to that end, otherwise these measures would be mainly symbolic. Even if one argues that such symbolic measures will increase the pressure on nuclear weapon states to disarm, one may question if such pressure is really contributing to the elimination of nuclear weapons or is only creating a fragmentation of international support for existing nuclear taboos as established in the NPT. Nevertheless, it should be noted as well that only five of the current nine nuclear weapon states are a member state of the NPT (the United States, Russia, the United Kingdom, France and China). The other four (Israel, India, Pakistan and North Korea) are not. One could argue that many of the policy steps being discussed within the Humanitarian Initiative could be applicable to all states, regardless of membership of the NPT or any other treaty. Yet, confidence in and an ongoing commitment to the current multilatera system of non-proliferation and disarmament efforts, especially but not exclusively embodied by the NPT and CD, can be reinforced by the demonstrated implementation of concrete nuclear disarmament measures by the current nuclear weapon states. Constructive diplomacy has always proven to be the best method to increase international security and stability. The menu of choice below consists of 16 steps. The policy options described are of course all interconnected. Moreover, the order in which they are described is not static; although the aim is to start with the least drastic step and to end with the most radical option, combinations of measures could certainly be thought of. It is not necessary that every step should follow the previous one; parallel and simultaneous steps are also certainly possible. 1. Relying on existing disarmament fora The simplest policy option for any state involved is, of course, doing nothing new. This means sticking to the traditional disarmament efforts within the NPT and CD, trying to solve the deadlock on disarmament currently perceived by many member states within these fora themselves. Without doubting the importance of the NPT and CD, it is debatable whether this option is in itself the most effective one. Considering the many states and NGOs asking for increased disarmament efforts, one could question whether the option to stick to traditional fora and methods is enough. The discomfort concerning the pace of nuclear disarmament must be dealt with in a positive way to channel this energy into the right direction – doing nothing new may harm the massive support for existing non-proliferation and disarmament arrangements even more than looking for extra steps towards disarmament measures. Nevertheless, the five nuclear weapon states within the NPT appear to prefer this path, convinced that the NPT and CD are the best fora to negotiate on further disarmament. These negotiations could be combined with their own self-designated ‘P5 Process’ in which the five nuclear weapon states within the NPT discuss the issue among themselves. There have also been meetings of the so-called ‘P5 Plus Group’, but even this group, with the non-NPT nuclear weapon states India and Pakistan on board, still misses the participation of Israel and North Korea, who are considered to have nuclear weapons as well. Without any hesitation, it is positive that these states discuss disarmament efforts with each other, although this does not mean that more inclusive discussions, with the non-nuclear weapon states and the nuclear weapon states which are not party to the NPT being included as well, should be sidelined as counter-productive. Nevertheless, the P5 Process, or preferably an extended P5 Plus Process, could certainly be helpful in discussing more far-reaching policy options as will discussed in the options below. 2. Increased transparency measures While non-nuclear weapon states are obliged under the NPT to provide full transparency on their nuclear activities (if any), the nuclear weapon states are not. Their nuclear weapons programmes are generally dealt with as top secret. This entails that any discussion about nuclear weapons, including the issue of nuclear disarmament, is to some extent always speculative. From this perspective, further transparency in the form of (public) reporting by the nuclear weapon states on their nuclear weapons inventories and policies, as well as their fissile material stockpiles, would be helpful in enhancing informed debate and increased confidence between states. Such transparency measures could be implemented unilaterally, bilaterally or multilaterally by (any of) the nuclear weapon states. 3. Confidence-building measures An important problem of the current discontent regarding nuclear disarmament efforts is a lack of confidence by many state and non-state actors in the sincerity of nuclear weapon states to effectively work towards a further reduction of the threat of nuclear weapons – threats of use as well as accidents. A first step to increase confidence could be measures to minimize the inadvertent use of nuclear weapons. The initiative for this kind of measure should come from the nuclear weapon states – unilaterally or in cooperation with each other. The main focus should be increasing the predictability of states’ behaviour regarding the use of nuclear weapons, thus preventing misperceptions leading to inadvertent nuclear escalation.2 Various examples of confidence-building measures could be thought of. Developing and the sharing of guidelines and principles, as well as verification and accountability instruments regarding decreasing the risks of accidents with and/or inadvertent use of nuclear weapons could be effective measures to increase confidence. The same holds true for sharing best practices and lessons learned on risk reduction regarding the inadvertent use of nuclear weapons. Information sharing on nuclear postures and procedures could also increase confidence. Guarantees or standardization regarding decision making and judgement processes on the use of nuclear weapons could add to confidence in the prevention of misuse and accidents as well; decision makers on the use of nuclear weapons must, for example, have enough time and information tools for prudent judgement so as to resolve potential misperceptions and to receive vital pieces of information. Only if nuclear weapon states are able to show other states that they are serious in this kind of risk-reducing 2 Wolfgang Ischinger, Steven Pifer and Andrei Zagorski, Confidence Building Measures Are Now Needed More Than Ever, European Leadership Network, 30 June 2014. measures could confidence be increased as a first step towards a further reduction and elimination efforts. 4. Preparing measures for disarmament verification An important step preceding actual nuclear disarmament is discussing how, at any moment, it will be accomplished. A disarmament process can only be successful if it is irreversible, verifiable and transparent. Currently, a coalition of both nuclear weapon and non-nuclear weapon states is discussing this issue within the International Partnership for Nuclear Disarmament Verification (IPNDV). This partnership, led by the United States, is aimed at developing (technical) solutions for monitoring and verifying potential future nuclear disarmament efforts. It would be helpful if this initiative would be able to come up with practical recommendations in the short term. Increasing the inclusiveness of the partnership would be helpful as well; in the end, verification mechanisms could be developed that will be supported by all states. From this perspective, cooperation with the International Atomic Energy Agency (IAEA) may be helpful as well. 5. Reduced role of nuclear weapons in security policies As long as nuclear weapon states retain an important role for nuclear weapons in their security policies, including doctrines and postures, they do not demonstrate much priority for the elimination of these weapons. As a first step to increase the credibility of their NPT obligations of nuclear disarmament, nuclear weapon states could reduce the role of nuclear weapons in their security doctrines. By doing so, they will demonstrate that they are sincere in both decreasing their importance as well the risks of (inadvertent) use. This policy measure could be implemented unilaterally or in coordination with other nuclear weapon states. 6. De-alerting nuclear weapons Especially the United States and Russia have nuclear warheads on ballistic missiles that are on high alert and ready to be launched within only a few minutes. France and the United Kingdom also keep some of their nuclear weapons on alert, although at lower readiness levels than the United States and Russia. As far as is known, the other nuclear weapon states have no nuclear weapons on alert status.3 The very little time that decision makers in these states have to judge whether or not to use the nuclear weapons significantly increases the risk of inadvertent use. In the past, several cases have become public in which such inadvertent use – because of miscommunications, misperceptions, or technical errors – brought the world close to nuclear warfare with catastrophic results.4 To reduce the risks of the inadvertent use of high alert nuclear weapons, unilateral, bilateral or multilateral measures could be taken to decrease the operational readiness of nuclear forces. Reducing the alert status of nuclear weapons could be achieved through a phased approach, and should preferably be verified (at least by other nuclear weapon states de-alerting their weapons as well). This measure would decrease the risk of inadvertent use to some extent as well as demonstrate a commitment to reduce the role of nuclear weapons in security policies. 3 Hans M. Kristensen and Matthew McKinzie, Reducing Alert Rates of Nuclear Weapons, United Nations Institute for Disarmament Research (UNIDIR), 2012. 4 For examples of cases, see: Patricia Lewis, Heather Williams, Benoît Pelopidas and Sasan Aghlani, Too Close for Comfort: Cases of Near Nuclear Use and Options for Policy, Chatham House Report, April 2014, pp. 7-23. An extra option within a process of de-alerting could be programming all nuclear missiles on alert to a default target in the middle of any ocean. This would give decision makers some more response time in (perceived) crisis situations, because the weapons should be retargeted before being used. Moreover, this would limit the risk of nuclear weapons accidently being used against real targets. According to some sources, the United States has already implemented such a default ocean targeting.5 7. Improved ‘No First Use’ guarantees and security guarantees Some nuclear weapon states have declared that they will use nuclear weapons only in response to a nuclear attack, while others do not exclude ‘first use’. Unilateral, bilateral or multilateral measures could be taken to increase the confidence that nuclear weapons will not be used by a state before it is attacked by such weapons itself. Nuclear weapon states could develop nuclear doctrines clearly stating the No First Use principle, and establish protocols to guarantee this principle in their command and control procedures. A No-First-Use Treaty or No-First-Use Convention is a possibility as well, but currently this does not seem to be realistic.6 Closely linked to No First Use guarantees are security assurances to non-nuclear weapon states. It would be a positive sign if such assurances would be extended by all nuclear weapon states, publicly giving an absolute guarantee that they will not use nuclear weapons to threaten or attack any nonnuclear weapon state.7 8. Banning nuclear weapons tests Already in 1996 the Comprehensive NuclearTest-Ban Treaty (CTBT) was opened for signature. Since then many states have signed and ratified the treaty. However, the Treaty has not so far entered into force, because the required signatures and/or ratifications by various states are lacking, especially (but not exclusively) the nuclear weapon states of China, India, Israel, North Korea, Pakistan and the United States.8 It would be an important positive signal if those states would sign and/or ratify the CTBT as well. Even though the entry into force of the treaty will not depend on only one or a few of these states, their membership would demonstrate to the international community that they acknowledge the need for a ban on nuclear test explosions. Supporting a ban on nuclear weapons testing to some extent shows the willingness to end the development and modernisation of nuclear weapons as well, even though digitally simulated tests are always still possible. As long as the CTBT cannot enter into force, states could unilaterally decide to stop testing and/or to declare a moratorium on nuclear test explosions; currently all nuclear weapon states have already done so, except for North Korea. 7 On the importance of clear language in this regard, see: Michael S. Gerson, ‘No First Use. The Next Step for U.S. Nuclear Policy’, International Security, Vol. 35, No. 2 (Fall 2010), pp. 7-47. 8 Situation of 23 January 2016, according to CTBTO figures. 9. Reduction or removal of forward deployed nuclear weapons As far as is known, one nuclear weapon state, the United States, has some of its tactical nuclear weapons deployed in other NATO states in Western Europe – so-called ‘forward deployment’. Although, technically speaking, this forward deployment possibly cannot be labelled as illegal under NPT obligations (the weapons are not transferred but remain in possession and under the control of the US), it certainly is against the spirit of the treaty. Moreover, the greater the number of locations where nuclear weapons are stored, the more risks there are of accidents and inadvertent use. Measures to reduce or eliminate the number of forward deployed nuclear weapons – which ideally would consist of cooperative action by the US, NATO and the actual host countries – would be a symbolically important step towards further nuclear disarmament. Considering the increasing tensions between NATO and Russia in the past few years, one could question whether NATO is currently ready for this step. However, even starting serious deliberations within NATO on such measures would already be an important signal of a serious willingness to work on further nuclear reduction and disarmament. 10. Reduction of or ending deployment in border regions Nuclear weapons deployed in border regions between (potential) adversaries may contribute to increased tensions. Especially in the case of relatively low-yield tactical nuclear weapons, one may speculate that the threshold of use could be considered somewhat lower compared to strategic nuclear weapons or tactical nuclear weapons deployed further away from borders. The risk of use, inadvertent use (for example, in case local military commanders may decide on use in crisis situations), or accidents may be higher.9 Specific border areas where (as far as is known) tactical nuclear weapons are currently deployed are at the borders between India and Pakistan and between Russian and NATO territory (including forward deployed US nuclear weapons as described in the previous step). Unilateral or bilateral steps to end the deployment of (tactical) nuclear weapons in border regions may decrease the risks of accidents or (inadvertent) use as well as demonstrate a willingness to reduce the role of nuclear weapons in security policies. 11. Banning the production of fissile materials Discussions on achieving a Fissile Material Cut-Off Treaty (FMCT) have stalled within the CD for many years already. Such a treaty would ban the production of fissile materials which can be used to build nuclear weapons (plutonium and highly enriched uranium). Some states even favour a Fissile Material Treaty (FMT) which would also limit existing stockpiles of fissile materials.10 As one of the steps towards nuclear disarmament it would be helpful if negotiations on such a treaty would be given new impetus in a constructive way. Although an FMCT, or even an FMT, will not directly bring about nuclear disarmament, it will at least be helpful in building confidence that states with fissile material production facilities will not further increase their nuclear weapons resources. As long as negotiations towards such a treaty will not be successful, unilateral, bilateral or multilateral initiatives could be launched to make a start in limiting and/or 9 Shashank Joshi, ‘Pakistan’s Tactical Nuclear Nightmare: De’ja’ Vu?’, The Washington Quarterly, Summer 2013, pp. 159-172. 10 A Fissile Material Cut-off Treaty. Understanding the Critical Issues, United Nations Institute for Disarmament Research (UNIDIR), 2010. halting the production of fissile materials. Facilities used for the production of fissile materials for nuclear weapons could be dismantled or converted, and existing stockpiles of fissile materials could also be converted to materials which are useful for peaceful purposes only (for example, by ‘down blending’ highly enriched uranium). Such measures, especially if transparency and verification mechanisms are included, could be an important step in building confidence that nuclear weapon states are serious about limiting their nuclear weapon programmes.11 12. Moratorium on nuclear weapons modernisation Various nuclear weapon states are currently modernizing their nuclear weapons arsenal or are suspected of doing so.12 Although one may contend that in some cases it is merely maintenance rather than modernisation, or a modernisation that is aimed at increasing the security of the weapons (which few would oppose), in various cases it seems like modernisation to make nuclear weapons more effective within the context of national security policies. It is difficult not to consider such modernisation efforts as contradictory to any disarmament pledge. To demonstrate their sincerity regarding nuclear disarmament, nuclear weapon states could – via unilateral, bilateral or multilateral measures – end or forego efforts to modernize their nuclear weapons (preferably including ending and foregoing the development of new missions for their nuclear weapons). This could result in a moratorium on nuclear weapons modernisation. Ideally, any kind of verification arrangements should be included in such measures to ensure confidence in such a moratorium. 13. Reduction of (deployed) nuclear weapons numbers Considering nuclear disarmament as a phased process, starting with a reduction and ending with the elimination of nuclear weapons, accelerating the reduction phase is an important step towards the ultimate aim of ‘global zero’. Unilateral, bilateral or multilateral measures in which nuclear weapon states reduce the number of their nuclear weapons are thus essential steps. Any reduction of nuclear weapons would contribute to decreasing the risks of them being used (on purpose or by accident) and would increase the confidence in commitments towards the reduction and elimination of nuclear weapons in the long term. Some nuclear weapon states may contend that the United States and Russia should make a start with their nuclear weapons stockpile reduction, since they currently possess some 93% of the global number of nuclear weapons.13 However, this does not necessarily exclude reduction measures by other states as well – states have even eliminated their nuclear weapons without taking such figures into account (in the case of South Africa). Some nuclear weapon states use the principle of ‘strict sufficiency’, meaning something like maintaining their arsenal of nuclear weapons at the lowest possible level with regard to their perceived strategic context.14 This may sound interesting in theory, but how this lowest possible level 13 According to the most accurate estimates: ‘World nuclear forces, January 2015’, Stockholm International Peace Research Institute (SIPRI). 14 Jenny Nielsen and Marianne Hanson, The European Union and the humanitarian initiative in the 2015 Non-Proliferation Treaty review cycle, NonProliferation Papers No. 41, EU Non-Proliferation Consortium, December 2014, p. 13. should be measured in practice is hard to define. Although an actual reduction through the dismantlement of nuclear weapons would be the most optimal decision in this context, a preliminary step of only reducing the number of deployed nuclear weapons may also be considered as a first step. Although this would not be disarmament in itself, only removing some of the nuclear weapons from deployment into storage, it reduces the risk of these weapons being used in the short term and could at least be considered as a confidence-building measure. Settings to accomplish any steps on this topic could be, for example, the P5 Process or the P5 Plus Process, as well as bilateral dialogue like past arms reduction negotiations between the United States and Russia. During the last few years, however, little to no progress has been made in such processes.

### 2

#### Private mega-constellations make space solar power a reality – low costs, operational benefits and mass production – that solves warming and creates effective energy transition

Leonard **David, 21** (Leonard David, Space solar power's time may finally be coming, Space, https://www.space.com/space-solar-power-research-advances, 11-3-2021)//iLake-💣🍔

Over the past decade, researchers have made impressive advances that increase the likelihood that space solar power (SSP) will be realized during the next decade, said John Mankins, president of Artemis Innovation Management Solutions of Santa Maria, California. His view: the longstanding vision for SSP as a sustainable energy alternative should be revisited in light of such recent advances. Bolstering that outlook is a set of key perspectives, Mankins told Space.com. "Climate change is really going to be a disaster. Nations are committed to go [carbon net-zero](https://www.livescience.com/climate-report-net-zero.html) … and they have no idea how to do it." The rapidly unfolding value of "New Space" is also reshaping the landscape of 21st century space activities, he added. "Two of the biggest hurdles to the realization of SSP have always been the cost of launch and the cost of hardware," said Mankins. "Add flight rate, and all of a sudden you're looking at numbers always talked about for solar power satellites." Another recent change is the dawn of the megaconstellations, Mankins added.  That's exemplified by SpaceX's [Starlink](https://www.space.com/spacex-starlink-satellites.html) broadband network, a mass-production effort that now cranks out 30 tons of satellites a month. SpaceX is on course to potentially manufacture 40,000 satellites within five years, and launch all of them.  "The path to low-cost hardware has been shown," Mankins said. "It's modular and mass-produced. The hurdles of less-expensive launch and lowering hardware costs have been overcome." Mankins said that the economics of SSP concepts in the near term, within the next decade, have never been more viable. He flagged advances in space launch capabilities; progress in robotics for space assembly, maintenance and servicing systems; and the growth in various component technologies, such as high-efficiency solid state power amplifiers. As a result, SSP is ready to see the light of day, Mankins said. An early entrant in focusing on understanding the energy policy needed and establishment of SSP is James Michael Snead, president of the Spacefaring Institute. He's adopted the use of the term "astroelectricity" to describe the transmitted electrical power produced by SSP systems. In looking at what he terms the "[coming age of astroelectricity](https://www.youtube.com/watch?v=5E-0NYnAaUA)," he sees a world needing a replacement for oil and natural gas, the two primary sources of energy currently maintaining an industrial standard of living.  Snead envisions a world in the year 2100 where about 20% of electrical power comes from terrestrial nuclear and renewables, with 80% supplied by astroelectricity. "Just as the military, economic and diplomatic control of Middle East oil has substantially influenced world events for the past 80 years, the control of space solar power platforms will come to dominate outer space activities this century," Snead told Space.com. If SSP becomes a reality later this century, Snead said, the U.S. military will be required to protect and defend these new sources of national energy security just as it guards oil infrastructure in the Persian Gulf today. "While some people are developing SSP concepts that would be launched from the Earth and autonomously assembled in geostationary Earth orbit, I do not see this as a successful proposition," said Snead. He believes that building the thousands of SSP platforms needed requires a substantial [space industrialization effort](https://www.space.com/nasa-low-earth-orbit-iss-commercialization.html) involving more than a million people in space by the end of the century.  The starting point, Snead said, will be establishing the enabling "astrologistics" infrastructure operating throughout the Earth-moon system. He stressed that those astrologistics require high-priority U.S. Air Force — not [Space Force](https://www.space.com/42089-space-force.html) — leadership to draw upon nearly a century of human flight/operational logistics experience and expertise. That is necessary to manage industry's efforts to design and build the required new human spaceflight systems, with a clearly needed emphasis on safety and effectiveness, Snead said. As these new military astrologistics capabilities begin, Snead contends, commercialization of these capabilities will extend these safety and operational benefits to support the coming space industrial revolution needed to undertake SSP. "This is exactly what happened to enable U.S. airline manufacturers to dominate the airline and air cargo industry for decades. It is a successful model to now replicate in space — a model that neither NASA nor the U.S. Space Force can effectively execute," Snead said. While new artwork, economic plots and conceptual SPS thinking and visions flow, there's an in-space technology experiment already underway.  On its latest mission, which launched in May 2020, the Space Force's robotic [X-37B space plane](https://www.space.com/25275-x37b-space-plane.html) is toting the Photovoltaic Radio-frequency Antenna Module Flight Experiment (PRAM-FX), a Naval Research Laboratory (NRL) investigation into transforming solar power into radio-frequency microwave energy.  The focus of that X-37B investigation is not establishing an actual power-beaming link, but more on appraising the performance of sunlight-to-microwave conversion. "It is performing like a champ," said Paul Jaffe, an NRL electronics engineer working on power beaming and solar power satellites. "We are getting data regularly, and that data is exceeding our expectations," he told Space.com. [PRAM-FX](https://www.space.com/x-37b-space-plane-solar-power-beaming) is principally made out of commercial parts, not "space-grade" hardware. "The fact that it is continuing to operate and give us positive results is quite encouraging," Jaffe said. Commercial parts are mass-produced, while many space-grade parts are one-offs. Solar power satellites, like those envisioned in high Earth orbit, would have thousands of elements made out of similar components being tested onboard the X-37B, Jaffe said. There's much more work ahead, of course.  "The big strike against space solar power has always been making the economics work. People who have looked at the idea seriously do understand that, from a physics standpoint, there is no reason you couldn't do it," Jaffe said.  "With mass production of space hardware, and with the cost reduction of space access, it is more plausible that it could work," he added. "I would caution against excessive optimism … but also point out that things are changing. There are a lot of encouraging developments." SPS will assuredly be compared to a "levelized cost of energy" metric, Jaffe concluded. "There's just not enough data to come up with a levelized cost of energy basis for space solar power. It's premature. What you are seeing now is laying the foundation for that sort of evaluation." To that end, Mankins of Artemis Innovation Management Solutions has rolled out SPS-ALPHA ("Solar Power Satellite by means of Arbitrarily Large Phased Array"), a design he showcased at the 72nd International Astronautical Congress, which was held from Oct. 25 to Oct. 29 in Dubai, United Arab Emirates. Detailing a business model and step-by-step SSP roadmap, he feels the concept promises a clear, affordable path to deploying a critically needed new energy option. "I believe you could have operational solar power satellites to scale within a decade," Mankins said.  That possibility, combined with the fact that multiple nations are eying SSP as a promising power generation system of the future, begs a question: Is there a solar power satellite race afoot? It is close to that, Mankins said. "I think it has to be cooperation among friends and allies. But I think it's very likely to end up being competition with China. The longer we wait with regard to the urgency of policies on [climate change](https://www.space.com/climate-change-dimming-earth), the more likely it is we're going to miss the boat." Mankins is a 26-year veteran of assessing SSP and the technologies required. "The moment has come," he said. "I think the right answer is really clear: We need to just go do it."

#### SSP has net 0 emissions with no pollution

Esther **Katete, 21** (Esther Katete, Is Space-Based Solar Power Our Future? (2022), No Publication, https://www.greenmatch.co.uk/blog/2020/02/space-based-solar-power, 12-17-2021)//iLake-💣🍔

According to the [National Space Society](https://space.nss.org/space-solar-power/), space-based solar power has the potential to dwarf all the other sources of energy combined. They argue that space-based solar power can provide large quantities of energy with very little negative environmental impact. It can also solve our current energy and greenhouse gas emissions problems. The infographic below highlights information about space-based solar power, current related trends, and what different countries are doing in terms of research and funding. Current Global Energy Consumption and Trends The world’s energy consumption is only growing. According to a report by the University of Oxford’s Our World in Data, on the global primary energy consumption, the current world consumption is over 160,000 TWh annually. Solar energy contributes only 585 TWh. Although there is an increase in renewable energy solutions, investments, and usage, oil, coal, and gas still generate more than 80% of the global energy that is consumed - with solar energy generating less than 1%. Between 2004 and 2015, investments in renewable energy increased by 600% from £36.2 billion (US$46.7 billion) to £220.6 billion (US$284.8 billion). Current predictions indicate that the world population will reach [9.7 billion by 2050](https://www.un.org/development/desa/en/news/population/world-population-prospects-2019.html). With the increase in population, the world energy consumption is also predicted to grow by 50% by 2050. In addition, climate change impacts are accelerating. Although we generate a big percentage of the world energy from fossil fuels, fossil fuels contribute significantly to the increase of climate change. Comparatively, solar energy is the [safest source of energy](https://ourworldindata.org/uploads/2020/02/Safest-source-of-energy.png) today - though it still only contributes a small percentage of the global energy production. The death rates from solar production are 1,230 times lower than coal, and it has one of the lowest CO2 emissions, at 5g CO2 eq per kWh. Why Space-Based Solar Power? Space-based solar power has several benefits; unlike solar panels on our roofs that can only generate electricity during the day, space-based solar power can generate continuous electricity, 24 hours a day, 99% of the year. This is because, unlike Earth, the space environment does not have night and day, and the satellites are in the Earth's shadow for only a maximum of 72 minutes per night. Space-based solar panels can generate 2,000 gigawatts of power constantly. This is 40 times more energy than a solar panel would generate on Earth annually. This is also several folds higher than the [efficiency of solar panels](https://www.greenmatch.co.uk/blog/2014/11/how-efficient-are-solar-panels) today. What’s more, is that space-based solar power would generate [0% greenhouse gas emissions](https://space.nss.org/space-solar-power/) unlike other alternatives energy like nuclear, coal, oil, gas, and ethanol. The current source of energy that generates the lowest CO2 is nuclear power, which generates CO2 of 5g CO2 eq per kWh. Space-based solar power generates almost 0% hazardous waste to our environment compared to nuclear power.

#### Warming causes extinction – ca their ev

### 3

#### Internet is open to massive vulnerabilities now

Griffiths 19 James Griffiths 7-26-2019 "The global internet is powered by vast undersea cables. But they’re vulnerable." <https://www.cnn.com/2019/07/25/asia/internet-undersea-cables-intl-hnk/index.html> (CNN Analyst)//ELmer

Hong Kong (CNN) - On July 29, 1858, two steam-powered battleships met in the middle of the Atlantic Ocean. There, they connected two ends of a 4,000 kilometer (2,500 mile) long, 1.5 centimeter (0.6 inch) wide cable, linking for the first time the European and North American continents by telegraph. Just over two weeks later, the UK’s Queen Victoria sent a congratulatory message to then US President James Buchanan, which was followed by a parade through the streets of New York, featuring a replica of a ship which helped lay the cable and fireworks over City Hall. In their inaugural cables, Queen Victoria hailed the “great international work” by the two countries, the culmination of almost two decades of effort, while Buchanan lauded a “triumph more glorious, because far more useful to mankind, than was ever won by conqueror on the field of battle. The message took over 17 hours to deliver, at 2 minutes and 5 seconds per letter by Morse code, and the cable operated for less than a month due to a variety of technical failures, but a global communications revolution had begun. By 1866, new cables were transmitting 6 to 8 words a minute, which would rise to more than 40 words before the end of the century. In 1956, Transatlantic No. 1 (TAT-1), the first underwater telephone cable, was laid, and by 1988, TAT-8 was transmitting 280 megabytes per second – about 15 times the speed of an average US household internet connection – over fiber optics, which use light to transmit data at breakneck speeds. In 2018, the Marea cable began operating between Bilbao, Spain, and the US state of Virginia, with transmission speeds of up to 160 terabits per second – 16 million times faster than the average home internet connection. Today, there are around 380 underwater cables in operation around the world, spanning a length of over 1.2 million kilometers (745,645 miles). Underwater cables are the invisible force driving the modern internet, with many in recent years being funded by internet giants such as Facebook, Google, Microsoft and Amazon. They carry almost all our communications and yet – in a world of wireless networking and smartphones – we are barely aware that they exist. Yet as the internet has become more mobile and wireless, the amount of data traveling across undersea cables has increased exponentially. “Most people are absolutely amazed” by the degree to which the internet is still cable-based, said Byron Clatterbuck, chief executive of Seacom, a multinational telecommunications firm responsible for laying many of the undersea cables connecting Africa to the rest of the world. “People are so mobile and always looking for Wi-Fi,” he said. “They don’t think about it, they don’t understand the workings of this massive mesh of cables working together. “They only notice when it’s cut.” Network down In 2012, Hurricane Sandy slammed into the US East Coast, causing an estimated $71 billion in damage and knocking out several key exchanges where undersea cables linked North America and Europe. “It was a major disruption,” Frank Rey, director of global network strategy for Microsoft’s Cloud Infrastructure and Operations division, said in a statement. “The entire network between North America and Europe was isolated for a number of hours. For us, the storm brought to light a potential challenge in the consolidation of transatlantic cables that all landed in New York and New Jersey.” For its newest cable, Marea, Microsoft chose to base its US operation further down the coast in Virginia, away from the cluster of cables to minimize disruption should another massive storm hit New York. But most often when a cable goes down nature is not to blame. There are about 200 such failures each year and the vast majority are caused by humans. “Two-thirds of cable failures are caused by accidental human activities, fishing nets and trawling and also ships’ anchors,” said Tim Stronge, vice-president of research at TeleGeography, a telecoms market research firm. “The next largest category is natural disaster, mother nature – sometimes earthquakes but also underwater landslides.” A magnitude-7.0 earthquake off the southwest coast off Taiwan in 2006, along with aftershocks, cut eight submarine cables which caused internet outages and disruption in Taiwan, Hong Kong, China, Japan, Korea and the Philippines. Stronge said the reason most people are not aware of these failures is because the whole industry is designed with it in mind. Companies that rely heavily on undersea cables spread their data across multiple routes, so that if one goes down, customers are not cut off. How a cable gets laid Laying a cable is a years-long process which costs millions of dollars, said Seacom’s Clatterbuck. The process begins by looking at naval charts to plot the best route. Cables are safest in deep water where they can rest on a relatively flat seabed, and won’t rub against rocks or be at risk of other disturbances. “The deeper the better,” Clatterbuck said. “When you can lay the cable down in deep water you rarely have any problems. It goes down on the bottom of the seabed and just stays there.” Things become more difficult the closer you get to shore. A cable that is only a few centimeters thick on the bottom of the ocean must be armored from its environment as reaches the landing station that links it with the country’s internet backbone. “Imagine a long garden hose, inside of which are very small tubes that house a very, very thin fiber pair,” Clatterbuck said. That hose is wrapped in copper, which conducts the direct current that powers the cable and its repeaters, sometimes up to 10,000 volts. “The fibers are wrapped in urethane and wrapped in copper and wrapped again in urethane,” he said. “If we’re going to have to put that cable on a shoreline that is very shallow and has a lot of rocks, you’re now going to have to armor coat that cable so no one can hack through it.” Cables in less hospitable areas can be far thicker than garden hoses, wrapped in extra plastic, kevlar armor plating, and stainless steel to ensure they can’t be broken. Depending on the coast, cable companies might also have to build concrete trenches far out to sea, to tuck the cable in to protect it from being bashed against rocks. “Before the cable-laying vessels go out they send out another specialized ship that maps the sea floor in the area when they want to go,” said TeleGeography’s Stronge. “They want to avoid areas where there’s a lot of undersea currents, certainly want to avoid volcanic areas, and avoid a lot of elevation change on the sea floor.” Once the route is plotted and checked, and the shore connections are secure, huge cable laying ships begin passing out the equipment. “Imagine spools of spools of garden hose along with a lot of these repeaters the size of an old travel trunk,” Clatterbuck said. “Sometimes it can take a month to load the cable onto a ship.” The 6,600 kilometer (4,000 mile) Marea cable weighs over 4.6 million kilograms (10.2 million pounds), or the equivalent of 34 blue whales, according to Microsoft, which co-funded the project with Facebook. It took more than two years to lay the entire thing. Malicious cuts The blackout came without warning. In February 2008, a whole swath of North Africa and the Persian Gulf suddenly went offline, or saw internet speeds slow to a painful crawl. This disruption was eventually traced to damage to three undersea cables off the Egyptian coast. At least one – linking Dubai and Oman – was severed by an abandoned, 5,400 kilogram (6-ton) anchor, the cable’s owner said. But the cause of the other damage was never explained, with suggestions it could have been the work of saboteurs. That raises the issue of another threat to undersea cables: deliberate human attacks. In a 2017 paper for the right-wing think tank Policy Exchange, British lawmaker Rishi Sunak wrote that “security remains a challenge” for undersea cables. “Funneled through exposed choke points (often with minimal protection) and their isolated deep-sea locations entirely public, the arteries upon which the Internet and our modern world depends have been left highly vulnerable,” he said. “The threat of these vulnerabilities being exploited is growing. A successful attack would deal a crippling blow to Britain’s security and prosperity.” However, with more than 50 cables connected to the UK alone, Clatterbuck was skeptical about how useful a deliberate outage could be in a time of war, pointing to the level of coordination and resources required to cut multiple cables at once. “If you wanted to sabotage the global internet or cut off a particular place you’d have to do it simultaneously on multiple cables,” he said. “You’d be focusing on the hardest aspect of disrupting a network.”

#### SpaceX satellites are key to internet access

James Pethokoukis 21 [James Pethokoukis, a columnist and an economic policy analyst, is the Dewitt Wallace Fellow at the American Enterprise Institute, where he writes and edits the AEIdeas blog and hosts a weekly podcast, “Political Economy with James Pethokoukis.” He is also a columnist for The Week and an official contributor to CNBC. “Why a SpaceX bankruptcy would hurt the global poor” Faster, Please! November 30, 2021 <https://fasterplease.substack.com/p/-why-a-spacex-bankruptcy-would-hurt>

I don’t have enough deep knowledge about SpaceX’s business or financials to reliably gauge the actual bankruptcy risk here, and the piece’s reporter is skeptical. I will note, however, that although the company is currently valued at around $100 billion, the bank Morgan Stanley assigns it a valuation “of somewhere between $5bn and $200bn, with uncertainty about its success accounting for the wide range,” according to The Economist. Starship and Starlink are key to that upper bound. (Also: A Morgan Stanley survey of “institutional investors and industry experts” expect SpaceX to become more valuable than Tesla, currently a trillion-dollar company. We’ll see.) So it’s not surprising that Musk emphasizes the importance of the Starlink internet satellite venture here, especially its next incarnation. Now go and Twitter search on the terms “Musk,” “ruining,” and “sky,” and you’ll find plenty of complaints about the Starlink constellation — with currently more than 1,700 satellites in low-Earth orbit. For many of these keyboard critics, Starlink is nothing more than an uberbillionaire's reckless effort to become an even wealthier uberbillionaire. Or maybe it’s just another Muskian vanity project, like building rockets to Mars. Either way, these diehard anti-Muskers see a cluttered sky for visual astronomers, both amateur and professional, as a horrific tradeoff just so the entrepreneur can sell global internet access. Now, the extreme version of this critique is unserious, little more than anti-billionaire emoting. The profit potential of Starlink is unclear, though it seems to be Musk’s goal that the telecom business will one day help fund his Mars ambitions. But the venture isn’t there yet. Last summer, Musk estimated that Starlink would likely need between $20 billion and $30 billion in investment. "If we succeed in not going bankrupt, then that'll be great, and we can move on from there," Musk said. For now, Starlink aims to add another 1,000 satellites a year, even more when Starship is operational. That is, assuming Starship become operational. But the astronomy issue is a real one, as SpaceX has acknowledged. And after astronomer complaints about the brightness of the first group of 60 satellites launched in 2019, SpaceX developed a work-around to minimize the glare from solar reflection on subsequent launches. Of course, some scientists don’t want to rely on the goodwill of SpaceX and other satellite companies. They see an international regulatory agreement, perhaps a new protocol under the Outer Space Treaty, as a necessity. But as such an add-on is unlikely to happen anytime soon, notes The Economist, “not least because other issues raised by the mega constellations, such as risks from debris, will doubtless seem more pressing.” Here’s one of the many pictures floating around the Internet showing the impact of Starlink satellites — “the 333-second exposure shows at least 19 satellites passing overhead” — on astronomical observations, via the IFLScience website: Of course, framing the trade-off as the above picture vs. “better global internet” doesn’t quite capture the benefits of the latter. And they are considerable. There remains a stark digital divide in global internet access. As the World Economic Forum notes: “Globally, only just over half of households (55 percent) have an internet connection, according to UNESCO. In the developed world, 87 percent are connected compared with 47 percent in developing nations, and just 19 percent in the least developed countries.” It seems pretty clear that broadband internet access brings considerable economic gains, particularly to poorer countries. (Musk has specifically said this is a goal of Starlink.) Here are a few examples from the August 2021 analysis “The Economic Impact of Internet Connectivity in Developing Countries” by Jonas Hjort (Columbia University) and Lin Tian (INSEAD): Quite a few studies convincingly estimate the effect on consumption of specific internet-enabled technologies (rather than internet connectivity itself) through model-based approaches, and a few do so more directly. Jack & Suri (2014) show that access to mobile money decreased consumption poverty by two percentage points in Kenya. In contrast, Couture et al. (2021) finds that expansion of e-commerce in China has little effect on income to rural producers and workers. Different areas of Sub-Saharan Africa got access to basic internet at different times starting in the early 2000s. Exploiting variation arising from the gradual arrival of submarine cable connections and using nighttime satellite image luminosity as a proxy for economic activity, Goldbeck & Lindlacher (2021) estimate that basic internet availability leads to about a two percentage point increase in economic growth. As we briefly discussed in Sub-section 3.1.1, Bahia et al. (2020) show evidence that the gradual roll-out of mobile broadband in Nigeria between 2010 and 2016 increased labor force participation and employment. The paper also shows that household consumption simultaneously increased and poverty decreased. Households that had at least one year of mobile broadband coverage experienced an increase in total consumption of about 6 percent. Masaki et al. (2020) document a similarly striking result. Combining household expenditure surveys with data on the location of fiber-optic transmission nodes and coverage maps of 3G mobile technology, they show that 3G coverage is associated with a 14 percent increase in total consumption and a 10 percent decline in extreme poverty in Senegal. Finally, Bahia et al. (2021) use a similar empirical approach to study the effect of mobile broadband roll-out in Tanzania and find a comparable increase in household consumption and decline poverty in this setting. The eventual endgame here is that there are going to be many tens of thousands more satellites in orbit, enabling total global internet coverage. And they will be joined by all manner of human-occupied installations for tourist, commercial, and scientific endeavors. (You may have missed the late October announcement that Blue Origin, the space company owned by Jeff Bezos, is teaming up with other firms to build a space station in Earth orbit.) Stargazing from Earth will never be the way it used to be. Then again, people still complain about shadows from skyscrapers even as humanity continues to build them. But recall one of the running themes of this newsletter: Technology solves one problem, creates another, then solves that one — rinse and repeat — even as the overall direction is forward. More astronomy in the future will be space based. And if all those space objects and structures make even low-Earth orbit astronomy difficult, more of it will need to be performed further out, as with the James Webb Space Telescope. Or maybe via telescopes on the Moon, such as the proposed Lunar Crater Radio Telescope, which would deploy robots to transform a half-mile wide crater into an observatory by attaching a wire mesh along the crater walls. And once there are lots of satellites around a fully colonized Moon, off to Mars — which might be accessible thanks to Starlink funding Musk’s deep-space ambitions. Meanwhile, there will be a lot less global poverty here on Earth than otherwise.

#### Internet access checks multiple existential threats

Eagleman ’10 [Dr. David; 11/9/2010; PhD in Neuroscience @ Baylor University, Adjunct Professor of Neoroscience @ Stanford University, Former Guggenheim Fellow, Director of the Center for Science and Law, BA @ Rice University; “Six Ways The Internet Will Save Civilization”; https://www.wired.co.uk/article/apocalypse-no]

Many great civilisations have fallen, leaving nothing but cracked ruins and scattered genetics. Usually this results from: natural disasters, resource depletion, economic meltdown, disease, poor information flow and corruption. But we’re luckier than our predecessors because we command a technology that no one else possessed: a rapid communication network that finds its highest expression in the internet. I propose that there are six ways in which the net has vastly reduced the threat of societal collapse.

Epidemics can be deflected by telepresence

One of our more dire prospects for collapse is an infectious-disease epidemic. Viral and bacterial epidemics precipitated the fall of the Golden Age of Athens, the Roman Empire and most of the empires of the Native Americans. The internet can be our key to survival because the ability to work telepresently can inhibit microbial transmission by reducing human-to-human contact. In the face of an otherwise devastating epidemic, businesses can keep supply chains running with the maximum number of employees working from home. This can reduce host density below the tipping point required for an epidemic. If we are well prepared when an epidemic arrives, we can fluidly shift into a self-quarantined society in which microbes fail due to host scarcity. Whatever the social ills of isolation, they are worse for the microbes than for us.

The internet will predict natural disasters

We are witnessing the downfall of slow central control in the media: news stories are increasingly becoming user-generated nets of up-to-the-minute information. During the recent California wildfires, locals went to the TV stations to learn whether their neighbourhoods were in danger. But the news stations appeared most concerned with the fate of celebrity mansions, so Californians changed their tack: they uploaded geotagged mobile-phone pictures, updated Facebook statuses and tweeted. The balance tipped: the internet carried news about the fire more quickly and accurately than any news station could. In this grass-roots, decentralised scheme, there were embedded reporters on every block, and the news shockwave kept ahead of the fire. This head start could provide the extra hours that save us. If the Pompeiians had had the internet in 79AD, they could have easily marched 10km to safety, well ahead of the pyroclastic flow from Mount Vesuvius. If the Indian Ocean had the Pacific’s networked tsunami-warning system, South-East Asia would look quite different today.

Discoveries are retained and shared

Historically, critical information has required constant rediscovery. Collections of learning -- from the library at Alexandria to the entire Minoan civilisation -- have fallen to the bonfires of invaders or the wrecking ball of natural disaster. Knowledge is hard won but easily lost. And information that survives often does not spread. Consider smallpox inoculation: this was under way in India, China and Africa centuries before it made its way to Europe. By the time the idea reached North America, native civilisations who needed it had already collapsed. The net solved the problem. New discoveries catch on immediately; information spreads widely. In this way, societies can optimally ratchet up, using the latest bricks of knowledge in their fortification against risk.

Tyranny is mitigated

Censorship of ideas was a familiar spectre in the last century, with state-approved news outlets ruling the press, airwaves and copying machines in the USSR, Romania, Cuba, China, Iraq and elsewhere. In many cases, such as Lysenko’s agricultural despotism in the USSR, it directly contributed to the collapse of the nation. Historically, a more successful strategy has been to confront free speech with free speech -- and the internet allows this in a natural way. It democratises the flow of information by offering access to the newspapers of the world, the photographers of every nation, the bloggers of every political stripe. Some posts are full of doctoring and dishonesty whereas others strive for independence and impartiality -- but all are available to us to sift through. Given the attempts by some governments to build firewalls, it’s clear that this benefit of the net requires constant vigilance.

Human capital is vastly increased

Crowdsourcing brings people together to solve problems. Yet far fewer than one per cent of the world’s population is involved. We need expand human capital. Most of the world not have access to the education afforded a small minority. For every Albert Einstein, Yo-Yo Ma or Barack Obama who has educational opportunities, uncountable others do not. This squandering of talent translates into reduced economic output and a smaller pool of problem solvers. The net opens the gates education to anyone with a computer. A motivated teen anywhere on the planet can walk through the world’s knowledge -- from the webs of Wikipedia to the curriculum of MIT’s OpenCourseWare. The new human capital will serve us well when we confront existential threats we’ve never imagined before.

Energy expenditure is reduced

Societal collapse can often be understood in terms of an energy budget: when energy spend outweighs energy return, collapse ensues. This has taken the form of deforestation or soil erosion; currently, the worry involves fossil-fuel depletion. The internet addresses the energy problem with a natural ease. Consider the massive energy savings inherent in the shift from paper to electrons -- as seen in the transition from the post to email. Ecommerce reduces the need to drive long distances to purchase products. Delivery trucks are more eco-friendly than individuals driving around, not least because of tight packaging and optimisation algorithms for driving routes. Of course, there are energy costs to the banks of computers that underpin the internet -- but these costs are less than the wood, coal and oil that would be expended for the same quantity of information flow.

The tangle of events that triggers societal collapse can be complex, and there are several threats the net does not address. But vast, networked communication can be an antidote to several of the most deadly diseases threatening civilisation. The next time your coworker laments internet addiction, the banality of tweeting or the decline of face-to-face conversation, you may want to suggest that the net may just be the technology that saves us.

### Mining

#### Mining fails and can’t efficiently establish an earth-bound market – empirics ow

**Abrahamian 19** Abrahamian, A. A. (2019, June 26). *How the asteroid-mining bubble burst*. MIT Technology Review. <https://www.technologyreview.com/2019/06/26/134510/asteroid-mining-bubble-burst-history/> (MIT Technology review attempts to bring about better-informed and more conscious decisions about technology through authoritative, influential, and trustworthy journalism.) //Aadit

It was sci-fi come to life—and everybody loved it.

“Space mining could become a real thing!” headlines squealed. A[mazon CEO Jeff Bezos](https://www.technologyreview.com/silicon-valley/amazon/) began speaking of a future in which all heavy industry took place not on Earth, but above it. NASA funded asteroid-mining research; the Colorado School of Mines offered an asteroid-mining degree program; Senator Ted Cruz predicted that Earth’s first trillionaire would be made in space.

“There was a lot of excitement and tangible feeling around all of these things that we’ve been dreaming about,” says Chad Anderson (no relation to Eric), the CEO of [Space Angels](https://www.spaceangels.com/), a venture capital fund that invests in space-related companies.

Also crucial to the money-making opportunities was the burgeoning commercial space sector’s lobbying, which shepherded the SPACE Act through Congress in 2015. This not--uncontroversial bill included a “finders, keepers” rule whereby private American companies would have all rights to the bounty they extracted from celestial bodies, no questions asked. (Before that, property rights and mining concessions in space, which belongs to no country, were not a given.)

That, in turn, would make it possible to work toward a goal that Eric Anderson predicted could be reached by the mid-2020s: extracting ice from asteroids near Earth and selling it in space as a propellant for other missions. Water can be broken into hydrogen and oxygen to make combustible fuel, or—as in DSI’s technology—just heated up and expelled as a jet of steam.

“Both companies believed one of the early products would be propellant itself—that is, water,” says Grant Bonin, the former chief technology officer of Deep Space Industries. “What DSI had been doing is developing propulsion systems to run on water. And everyone who buys one is creating an ecosystem of users now that can be fueled by resources of the future.”

By the spring of 2017, Planetary Resources was operating a lab in a warehouse in Redmond, Washington, decorated with NASA paraphernalia and vintage pinball machines. Engineers tinkered with small cube satellites behind thick glass walls, crafting plans to launch prospecting machines. Luxembourg had given the company a multimillion-dollar grant to open a European office. Japan, Scotland, and the United Arab Emirates announced their own asteroid-mining laws or investments.

The stars had burned through their red tape. The heavens were ready for Silicon Valley.

Then things started going south. Last summer, Planetary failed to raise the money it was counting on. Key staffers, including Peter Marquez, the firm’s policy guy in Washington, had already jumped ship. “We were all frustrated about the revenue prospects, and the business model wasn’t working out the way we’d hoped,” recalls Marquez, who now works for a Washington, DC, advisory shop called Andart Global.

“There was more of a focus on the religion of space than the business of space,” Marquez adds. “There’s the religious [segment] of space people who believe that almost like manifest destiny, we’re supposed to be exploring the solar system—and if we believe hard enough, it’ll happen. But the pragmatists were saying there’s no customer base for asteroid mining in the next 12 to 15 years.”

Amid rumors that it was auctioning off its gear, Planetary Resources was acquired last year by ConsenSys, a blockchain software company based in Brooklyn that develops decentralized platforms for signing documents, selling electricity, and managing real estate transactions, among other things. Anderson Tan, an early investor in Planetary Resources, was baffled by the acquisition—and he’s the kind of blockchain guy who promotes other blockchain guys’ blockchain ventures on LinkedIn. “I honestly have no idea … I was shocked. I think they wanted to acquire the equipment and assets,” he says. “For what? I’m not so sure.”

DSI, in turn, was acquired by an aeronautics company named Bradford Space. These acquisitions aren’t taking the companies anywhere. “They’re gone; they’re done. They don’t exist,” says Chad Anderson.

What went wrong? Predictably, ex--employees and investors tell slightly different stories.

Bonin blames DSI’s demise on investors’ unwillingness to take long-term risks. “We had a plan that would take off after a certain point, and we didn’t get to that point,” he explains. “And we were only $10 million away from hitting that point, but our planning was decades long, and a VC fund’s life cycle is one decade long. They’re incompatible.” Meagan Crawford, who worked with Bonin and is now starting her own venture capital fund for commercial space startups, concurs: “A traditional VC time line is 10 years, when they have to give money back to investors, so in seven years they want to exit. A 15-year business plan isn’t going to fit in.”

On the money side, the story is a little less forgiving. “They did not deliver on their promises to investors,” says Chad Anderson, whose Space Angels invested in PR. “Both companies were really good at storytelling and marketing and facilitating this momentum around a vision that their technology never really substantiated.” He adds, “I think that these weren’t the right teams to do it.”

There were also bigger structural obstacles—such as, in former employees’ telling, the lack of any infrastructure for an asteroid--mining industry. That put investors off, too: “If you mine an asteroid, mostly likely you’ll [have to] send it to the moon to process it. It wouldn’t be processed on Earth, because the cost would be tremendous,” says Anderson Tan. “So then it’s like a chicken-and-egg problem: do we mine first and then develop a moon base, or invest in building up the moon and then go to asteroid mining?”

On the money side, the story is a little less forgiving.

Finally, asteroid miners had to compete for funding with a proliferating number of other space-related ventures. Between 2009—“the dawn of the entrepreneurial space age”—and today, “we’ve gone from a world with maybe a dozen privately funded space companies serving one client, the government, to one with more than 400 companies worth millions of bucks,” Chad Anderson says. So if commercial space startups seemed like an out-there proposition in 2012, by 2018 VCs who wanted space in their portfolios could have their pick of companies with better short-term prospects: telecom startups selling internet access, for instance, or firms analyzing the much-more-accessible moon.

“The bottom line is that space is hard,” says Henry Hertzfeld, the director of the Space Policy Institute at George Washington University. (Hertzfeld advised Planetary Resources on legal matters; the space world, on Earth, is still very small.) “It’s risky, it’s expensive; lots of high up-front costs. And you need money. You can get just so much money for so long.”

#### 6-10 years just for flight time alone – delays their impact at least decades

Reiderer 14 – New Republic tech writer (Rachel Riederer, 5-19-2014, "Silicon Valley Says Space Mining Is Awesome and Will Change Life on Earth. That’s Only Half Right.," New Republic, https://newrepublic.com/article/117815/space-mining-will-not-solve-earths-conflict-over-natural-resources)//AP

The “getting there first” will not be simple, or cheap. Most of the asteroids in the solar system are in the asteroid belt between Mars and Jupiter. But the orbit paths of some near-Earth asteroids, or NEAs, bring them relatively close to our planet—that is, within around 30 million miles. Planetary Resources has developed what is essentially an outer-space drone: a small telescope-equipped spacecraft, around the size of a desktop computer, that will survey near-Earth asteroids. Once an asteroid is identified and determined to be valuable, the extraction could begin, though that introduces a new set of technical obstacles. Because of the difficulty and expense of getting heavy machinery from Earth into space, some have suggested using 3D printing technology to use materials found in space to create the necessary equipment. Then, some modified version of a terrestrial mining method, like drilling or magnetic separation, could be used for the mining itself. But these extraction processes have been developed for the pressure and gravity of Earth, and they would need to be overhauled to function in the low-gravity, vacuum environment of space. If this part of the process sounds unclear, it’s because it is. To give an idea of the scale—in time and difficulty—of these kinds of operations, consider the government’s version of asteroid prospecting. In April, NASA greenlighted a mission in which a spacecraft called OSIRIS-REx will rendezvous with an asteroid called Bennu. OSIRIS-Rex is scheduled to launch in 2016, reach the asteroid in 2018, reconnoiter it for over a year, and then bring back samples for scientific study. The amount of asteroid that NASA plans to collect after all this time and trouble? Two ounces. A major premise of private space mining companies is that they will be able to work far faster and more economically than NASA, and will be willing to take on levels of risk beyond that of a government operation, but the scale and timeline of OSIRIS-REx shows how complex these operations will be, even for the swiftest companies. The most far-out proposal in space mining is to "redirect" an NEA toward Earth and into lunar orbit. There, the asteroid could spin safely around the moon, accessible to our planet. A 2012 Cal Tech study determined that this method would be not only feasible, but “essential” for long-term human space exploration. According to the study, it will soon be possible for an unmanned spacecraft to identify a target asteroid—one around seven meters in diameter and 500,000 kilograms in mass—approach it, “loiter” nearby to determine its spin, and ultimately enclose the asteroid in what is described as a “draw-string bag.” (Take a moment to imagine a man-made drawstring bag capturing a giant mass of precious metal hurtling through space. “This is awesome!” does feel like the only reasonable response.) Once the asteroid and spacecraft are connected, a solar-powered propulsion system could fly the asteroid back to our moon and deposit it in lunar orbit. Depending on the mass of the asteroid, this retrieval flight would last between six and ten years. This idea, like the other space-mining projects, will require tremendous patience, money, vision, and bluster. So it's no surprise that the futurists of Silicon Valley are behind them: The group of companies founded with the intention of mining space are backed largely by investors who made their names and fortunes in tech. Peter Diamandis is the founder of the X Prize Foundation and of Silicon Valley’s Singularity University, which he co-founded with futurist Ray Kurzweil; Eric Schmidt is one of Planetary Resources’ major investors; before starting Moon Express, Naveen Jain was a senior executive at Microsoft and then CEO of his own startup, InfoSpace; Elon Musk founded PayPal and now has a private space company, SpaceX, currently under contract with NASA to begin carrying astronauts to the International Space Station.

#### Scoles –

High threshold explanation

Asteroids lunar orbit

#### Physics and math proofs prove no debris impact.

Cairncross 17 [Duncan Cairncross, Retired Planetary Science Engineer, BSc in Mechanical Engineering from the University of Glasgow, Diploma in Management DMS, Business Administration and Management, General from Teeside University, Former Asset Management Officer for the Gore District Council, “Is the Kessler Syndrome Disputed By Some Scientists?”, Quora, 10/25/2017, https://www.quora.com/Is-the-Kessler-Syndrome-disputed-by-some-scientists

Lets look at some numbers - we are talking LEO - so anything very small will de-orbit itself quite fast from atmospheric drag

These lumps are going the same direction - at similar speeds - as our satellites - so we are not talking about km/sec impacts - just rifle bullet speeds - 300 m/sec at maximum and the vast majority would have much much lower speeds

Everything is in a torus

Altitude 100 km to 300 km, - 1000 km North to 1000 km South - and about 40,000 km long

200 x 2000 x 40,000 = volume 16 billion cubic km -

18,000 Big bits - 100 mm - including 1,200 satellites

750,000 “bullets” - 10 mm

150 million bits 1 mm

Small bits we will ignore as they will not be going fast enough relative to our satellite to cause damage - and they will de-orbit quite fast

So one “bullet” for every 21,000 cubic km

That does not sound like too dangerous a neighborhood!

What happens if start some sort of cascade?

There is not much to cascade - 18,000 - “big bits” - if each of them became 1000 “bullets” then we would have 18 million “bullets” + the existing 750,000 bullets

And that is erring on the generous side - these bits are mostly metallic and metals don’t shatter into lots of 10 mm bits when hit by rifle bullets

That would be one “bullet” for every 853 cubic km AND most of the “bullets” will not actually be going very fast

Some time in the future when we have a lot mor,e as in a 100,000 times as much stuff in orbit then the Kessler Syndrome may be possible

If you are worried about communication satellites way up there in geostationary orbit then the situation is even better - there is a LOT more space up there and we have boosted a lot less junk up to those orbits

It is worth tracking the big bits and making sure that most satellites are safely de-orbited? - YES

But worrying about a Kessler Syndrome? - no not really

#### intagliata

missing internal link – no Kessler claim

#### Alonso

Not a question of data – policymakers refuse to take action anyways

#### Satellite loss shuts down global fracking

Les Johnson 13, Deputy Manager for NASA's Advanced Concepts Office at the Marshall Space Flight Center, Co-Investigator for the JAXA T-Rex Space Tether Experiment and PI of NASA's ProSEDS Experiment, Master's Degree in Physics from Vanderbilt University, Popular Science Writer, and NASA Technologist, Frequent Contributor to the Journal of the British Interplanetary Sodety and Member of the American Institute of Aeronautics and Astronautics, National Space Society, the World Future Society, and MENSA, Sky Alert!: When Satellites Fail, p. 99-105

Energy, environment, farming, mining, land use. All of these areas and more are now inextricably linked to satellite data and would be devastated should that flow of data stop.

Environmental Monitoring

Oh how complacent we've become. We take for granted that we will have instant images from space showing a volcanic eruption somewhere in the South Pacific within hours of learning that it happened. When the BP oll spill happened in the Gulf of Mexico in 2010, satellite images were used in conjunction with aircraft and ships to monitor the extent and evolving nature of the spill (Figures 10.1 and 10.2).

The data were also used to direct the ships that were attempting to clean up the spill, to warn fishermen of areas in which it would be dangerous to fish, and to generally monitor the extent of the disaster. This is the type of data we get from space in a field known as remote sensing.

Remote sensing is, well, exactly what its name implies. With it, you gather data, or sense, usually in the form of electromagnetic radiation (light), remotely - that is, you are not physically touching what you are looking at. Satellite remote sensing began shortly after we began launching satellites and many industries are now totally dependent upon having the capability.

We use satellites, like the venerable Landsat series, to study the Earth m unprecedented detail. Since 1972, Landsat satellites have taken millions of high resolution images of the Earth's surface, allowing comprehensive studies of how the land has changed due to human intervention (deforestation, agriculture, settlement, etc.) and natural processes (desertification, floods, etc.).

The best way to understand how useful Landsat and similar data can be to governments at all levels is best illustrated by looking at 14then and now" photographs. For example, Africa's Lake Chad has been shrinking for 40 years, as the desert has encroached on this once plentiful inland freshwater lake. Forty years ago, there were about 15,000 square miles of water within the lake. Now, it is less than 500 square miles (Figure 10.3) [1].

And what is the practical side of this particular bit of information?

Governments use this type of satellite imagery to avoid human tragedy. Hundreds of thousands of people, if not millions, depend upon the waters of Lake Chad for agriculture, industry, and personal hygiene. With the lake going dry, how has this impacted on their livelihoods, their families, and their very lives?

The European Space Agency (ESA) is freely providing satellite data to developing countries as they search for new sources of drinking water. For example, ESA assessed data obtained from space over Nigeria to find over 90 new freshwater sources within that country. After ground teams visited the new sites, all were confirmed to contain fresh water. This was no accident. These were satellites with sensors developed for just such purposes in mind [2].

Desertification is but one example of changing climates affecting people's everyday lives. What about more direct observations of our impact on the planet? Figures 10.4 and 10.5 show the scarring of the Earth's surface as a result of surface mining in West Virginia. This is not a polemic against mining; rather, it is an observation that we can use satellite imagery to monitor such mining and be mindful of its impact on the environment.

Other than taking pictures of surface features, like lakes and open pit mines, how are satellites monitoring the Earth's changing climate? In just about every way, by: monitoring global land, sea, and atmospheric temperatures; measuring yearly average rainfall amounts just about everywhere on the globe; measuring glaciation rates; measuring sea surface heights; and more. Remote sensing is more than taking pictures of the Earth in the visible part of the spectrum. We can learn a great deal from looking at part of the spectrum that our eyes cannot see - but our instruments can.

Shown in Figure 10.6 is a composite image of the Earth's surface showing the average land-surface temperature at night. The data came from two NASA satellites, Terra and Aqua, as they orbit the Earth in a polar orbit. (This means that they circle the Earth from top to bottom, passing over both the North and South Poles with each complete orbit.) Terra's orbit is such that it passes from the north to the south across the equator in the morning; Aqua passes south to north over the equator in the afternoon. Taken together, they observe the Earth's surface in its entirety every two days. Data sets such as this exist for just about any day of the year and can show either night-time lows or daytime highs.

By looking in different parts of the spectrum, like the infrared light discussed above, we can make observations as described in Table 10.1.

Pollution Monitoring

As emerging countries industrialize, they also become polluters. Many of these countries are not exactly forthright about releasing air-pollution details to the media, so much of our awareness of the rising pollution there is anecdotal - typically m the form of stories told by people who have visited these countries and seen the extreme pollution at first hand. This, by the way, is not exactly scientific.

Using satellites, and not relying on either the governments in question or second-hand stories, we can accurately assess the pollution levels there and elsewhere. Using satellite images to measure the amount of light absorbed or blocked by fine particulates in the atmosphere, otherwise known as air pollution, you can determine not only what the airborne pollutant might be, but also its size. And, by looking at the overall light blockage, an accurate estimate of the amount of pollution in the air can also be made. Recent studies show that many of these countries are covered in a pollution cloud that countries in the developed world would deem extremely harmful. And how do we know this with scientific certainty? From satellite measurements.

Energy Production

The recent boom in the production of shale oil in the United States and elsewhere is due in large part to the identification and geolocation of promising geologic formations for test drilling and fracking. "Fracking" is a somewhat new term that comes from the phrase "hydraulic fracturing". In fracking, massive amounts of previously unusable reservoirs of oil and natural gas are released for capture, sale, and transport from deposits deep within the Earth - many located at least a mile below the surface. In the United States alone, there may be as much as 750 trillion cubic feet of natural gas within shale deposits releasable by fracking [3]. How do energy companies know where to look for these deposits? In large part, by analyzing satellite imagery.

According to Science Daily (26 February 2009), a new map of the Earth's gravitational field based on satellite measurements makes it much less resource intensive to find new oil deposits. The map will be particularly useful as the ice melts in the oil-rich Arctic regions. The easy-to-find oilfields have already been found. To fuel the growing world economy, those harder-to-find deposits must be located and tapped - which is why satellite imagery is so important. Take away this and other satellite-dependent techniques of oil and gas exploration and the world economy will feel the impact through higher oil and natural gas prices.

#### Fracking makes extinction inevitable---try-or die to shut it off

Rev. Mac Legerton 18, Co-Founder and Executive Director of the Center for Community Action, Member of the Board of Directors of the NC Climate Solutions Coalition, Member of the Board of Directors of the Windcall Institute, “Will The U.S. Blaze A Trail To Mass Extinction?”, APPPL News, 1/15/2018, https://www.apppl.org/news/will-the-u-s-blaze-a-trail-to-mass-extinction/

As an elder, I now realize that there is even a greater threat to humanity and life on Earth than nuclear war—though, unlike a nuclear exchange, this threat is a slow-motion catastrophe. Can you guess what it is? Here’s a clue: it is something with which most people don’t have a personal relationship. Tragically, some persons remain in total denial of its validity, much less its present danger. And that’s the problem – that’s why this threat needs to be more seriously addressed on the local, state, national, and international level.

What is it? It’s the slow-motion but rapidly growing catastrophe of climate change. There’s now good news amidst this seemingly overwhelming challenge. But the answer may surprise you. Today we know what is the #1 preventable cause of climate change. It’s not coal, it’s not nuclear, and it’s not oil and gasoline. It’s actually the use of the very fuel that is touted as being cleaner, greener, and cheaper than all the rest. This fuel is called “Natural Gas”.

Let’s start with its name – “Natural Gas”. What is “natural gas”? There’s actually nothing “natural” about it when it is forcibly extracted from the ground through hydraulic fracturing, commonly known as “fracking”. When something is forcibly ruptured from deep within the earth with the use of toxic chemicals, the last name you would use for it is “natural”.

Fracking disrupts the geologic fault lines causing earthquakes, uses millions of gallons of fresh water that becomes permanently poisoned by unknown, cancer-producing chemicals added to it, creates air pollution during the drilling process, increases the risk of injury and explosions, raises major health risks to both people and place in close proximity to it, and changes the nature of both neighborhoods and landscapes. Fracking also leaves a massive carbon footprint of drilling wells as deep as 8,000 feet and then drilling horizontally over 10,000 feet; On top of all this, it leaks major amounts of gas into the environment.

So, what is this gas? It is 90-95% methane gas which is a hydrocarbon compound made up of one carbon atom and four hydrogen atoms (CH4). It releases carbon into the atmosphere and produces carbon dioxide (C02) just like coal does when it is burned. Methane is not its trace element–it is its undisputed compound of this fossil fuel product. If a compound is 90-95% of a product, it makes sense to call it by that name. Doesn’t it? Well, actually not if you want people to believe and think that it is something that it is not. It is un-natural methane gas produced under massive and highly toxic pressure and hazardous conditions.

Now that we know what this gas is, what does it do to the atmosphere and climate that is so dangerous? This hydrocarbon has properties that block the radiation of heat from Earth’s surface 100 times more effectively than CO2 (released from burning coal) during its first 10 years of release and 86 times more effectively in its first 20 years. Because of the climate emergency underway, the first 10 or 20 years matter most.

When utility companies and the larger fossil fuel companies state that they are committed to lowering carbon emissions, this just isn’t true. They are radically escalating the most dangerous and worst of all fossil fuels in relation to its impact on the climate. Now the industry wants to expand production of methane gas all over the world by calling it “the most environmentally friendly fossil fuel”and a “bridge fuel” that we can safely use until we transition to 100% renewable energy sources.

Why would a major business industry want to call its product by another name? Perhaps for the same reason that the tobacco industry did not like the term “coffin nails” or “cancer sticks” for cigarettes. Honestly, there’s a striking similarity between what are called cigarettes and natural gas. When both were produced and named, their harm was not fully known. Once the industries promoting them learned of their significant harm, they did everything they could to hide this knowledge from the public. They even hired scientists to deny their dangers. The tobacco industry was eventually sued, the truth was acknowledged, and billions of dollars were paid out in the tobacco settlement.

This same scenario that occurred with the tobacco industry needs to occur with methane gas and the fossil fuel industry. The major difference in these two scenarios is that that this fossil fuel product doesn’t just threaten the lives of individuals who voluntarily breathe it in – it threatens the lives of not only every human being, but also all life on the planet. The outcome of this scenario needs to be a moratorium and eventual end to all use of methane gas as an energy source. For the sake of all of us, our communities, and world, the sooner the better. This abomination is different. There is no time to waste.

### Exploration

#### CSIS

1 -- their only warrant is a quote from a nasa official

2 -- not reverse causal

3 -- turn. empirics. Space race heightened tensions. Private defuses

#### Weir

#### 1 – ZERO risk of extinction over Ukraine – NATO troops are not involved

Crowley 22

https://www.nytimes.com/2022/02/05/us/politics/biden-ukraine-russia-war.html

WASHINGTON — President Biden flexed America’s military power in hopes of deterring a Russian invasion of Ukraine with his announcement this week that 3,000 U.S. troops were heading to Eastern Europe. But Mr. Biden is not readying for war with Russia. The troops will be [shoring up NATO countries](https://www.nytimes.com/live/2022/02/02/world/ukraine-russia-news/us-troops-will-be-deployed-to-nato-allies-in-eastern-europe), not defending Ukraine itself — which is not a member of the alliance — as President Vladimir V. Putin of Russia builds up military forces near the borders of its neighbor. And lest there be any misunderstanding, Mr. Biden has repeatedly made clear that he has no intention of sending U.S. troops to Ukraine. During national security crises, presidents often issue the cryptic warning that “all options are on the table.” But Mr. Biden pointedly said in early December that the military option was “not on the table.” “There is not going to be any American forces moving into Ukraine,” Mr. Biden reiterated to reporters last month. Mr. Biden was reflecting a political reality in war-wary Washington, where even many reliably hawkish voices in both parties show no appetite for seeing U.S. troops fight and potentially die for [Ukraine](https://www.nytimes.com/2022/02/04/world/europe/russian-troops-ukraine-crimean-peninsula.html). His thinking is also surely informed by the frightening reality of Russia’s 4,500-warhead nuclear stockpile, which experts say Moscow would be quick to use, at least on a limited scale, in any losing fight with the West. That position has frustrated some Russia hawks who believe it wise to keep Mr. Putin guessing about America’s intentions — and even a few who say the United States should be prepared to go to war for Ukraine. “Putin is someone who responds to brute force. And he is willing to pay a very high economic price for Ukraine,” said Ian Brzezinski, a former deputy assistant secretary of defense for Europe and NATO policy under President George W. Bush. “So Biden diluted our most important source of leverage in this crisis.” Mr. Brzezinski said that, among other actions, Mr. Biden should consider sending troops to western Ukraine as a deterrent. But Mr. Brzezinski is part of a distinct minority. In a Thursday address on the Senate floor, Senator Ted Cruz, Republican of Texas and an outspoken critic of Mr. Putin, said some people feared that “Biden will send American troops into Ukraine and start a shooting war with Putin if Russia invades.” “I want to be clear and unequivocal,” Mr. Cruz added. “Under no circumstances should we send our sons and daughters to die to defend Ukraine from Russia.” [Continue reading the main story](https://www.nytimes.com/2022/02/05/us/politics/biden-ukraine-russia-war.html#after-pp_edpick) It is a rare point of agreement between Mr. Cruz and liberal Democrats, and even former President Barack Obama, who [told](https://www.theatlantic.com/magazine/archive/2016/04/the-obama-doctrine/471525/#3) The Atlantic magazine in 2016 that Ukraine was “an example of where we have to be very clear about what our core interests are and what we are willing to go to war for.”

#### Arbatov

space weapons nq --

not an extinction claim

#### No extinction – isolated island populations repopulate Earth after radiation and nuclear winter

Turchin and Green 18 (Alexey Turchin – Scientist for the Foundation Science for Life Extension in Moscow, Russia, Founder of Digital Immortality Now, author of several books and articles on the topics of existential risks and life extension. Brian Patrick Green – Director of technology ethics at the Markkula Center for Applied Ethics, teaches AI ethics in the Graduate School of Engineering at Santa Clara University. <MKIM> “Islands as refuges for surviving global catastrophes”. September 2018. DOA: 7/20/19. https://www.emerald.com/insight/content/doi/10.1108/FS-04-2018-0031/full/html?fullSc=1&mbSc=1&fullSc=1)

Different types of possible catastrophes suggest different scenarios for how survival could happen on an island. What is important is that the island should have properties which protect against the specific dangers of particular global catastrophic risks. Specifically, different islands will provide protection against different risks, and their natural diversity will contribute to a higher total level of protection: **Quarantined island survives pandemic** . An island could impose effective quarantine if it is sufficiently remote and simultaneously able to protect itself, possibly using military ships and air defense. **Far northern aboriginal people survive an ice age**. Many far northern people have adapted to survive in extremely cold and dangerous environments, and under the right circumstances could potentially survive the return of an ice age. However, their cultures are endangered by globalization. If these people become dependent on the products of modern civilization, such as rifles and motor boats, and lose their native survival skills, then their likelihood of surviving the collapse of the outside world would decrease. Therefore, preservation of their survival skills may be important as a defense against the risks connected with **extreme cooling**. Remote polar island with high mountains survives brief global warming of median surface temperatures, up to 50˚C. There is a theory that the climates of planets similar to the Earth could have several semi-stable temperature levels (Popp et al., 2016). If so, because of climate change, the Earth could transition to a second semi-stable state with a median global temperature of around 330 K, about 60˚C, or about 45˚C above current global mean temperatures. But even in this climate, **some regions of Earth could still be survivable for humans**, such as the Himalayan plateau at elevations above 4,000 m, but below 6,000 (where oxygen deficiency becomes a problem), or on polar islands with mountains (however, global warming affects polar regions more than equatorial regions, and northern island will experience more effects of climate change, including thawing permafrost and possible landslides because of wetter weather). In the tropics, the combination of increased humidity and temperature may increase the wet bulb temperature above 36˚C, especially on islands, where sea moisture is readily available. In such conditions, proper human perspiration becomes impossible (Sherwood and Huber, 2010), and there will likely be increased mortality and morbidity because of tropical diseases. If temperatures later returned to normal – either naturally or through climate engineering – **the rest of the Earth could be repopulated**. ‘‘Swiss Family Robinsons’’ survive on a tropical island, unnoticed by a military robot ‘‘mutiny’’. Most AI researchers ignore medium-term AI risks, which are neither near-term risks, like unemployment, nor remote risks, like AI superintelligence. But a large drone army – if one were produced – could receive a wrong command or be infected by a computer virus, leading it to attack people indiscriminately. Remote islands without robots could provide protection in this case, allowing survival until such a drone army ran out of batteries, fuel, ammunition or other supplies: Primitive tribe survives civilizational collapse. The inhabitants of **North Sentinel Island**, near the Andaman Islands in the Indian Ocean, are hostile and uncontacted. **The Sentinelese survived the 2004 Indian Ocean tsunami apparently unaffected** (Voanews, 2009), and if the rest of humanity disappear, **they might well continue their existence without change.** Tropical Island survives extreme global nuclear winter and glaciation event. Were a **nuclear**, bolide impactor or volcanic “**winter**” scenario to unfold, these islands would remain surrounded by Warm Ocean, and local volcanism or other energy sources might provide heat, energy and food. Such island refuges may have helped life on Earth survive during the **“Snowball Earth”** event in Earth’s distant past (Hoffman et al., 1998). Remote island base for project “Yellow submarine”. Some catastrophic risks such as a gamma ray burst, a global nuclear war with high radiological contamination or multiple pandemics might be best survived **underwater in nuclear submarines** (Turchin and Green, 2017). However, after a catastrophe, the submarine with survivors would eventually need a place to dock, and an island with some prepared amenities would be a reasonable starting point for rebuilding civilization. Bunker on remote island. For risks which include multiple or complex catastrophes, such as a bolide impact, extreme volcanism, tsunamis, multiple pandemics and nuclear war with radiological contamination, **island refuges could be strengthened with bunkers**. Richard Branson survived hurricane Irma on his own island in 2017 by seeking refuge in his concrete wine cellar (Clifford, 2017). Bunkers on islands would have higher survivability compared to those close to population centers, as they will be neither a military target nor as accessible to looters or unintentionally dangerous (e.g. infected) refugees. These bunkers could potentially be connected to water sources by underwater pipes, and passages could provide cooling, access and even oxygen and food sources