## **1**

#### **The United States federal government should construct isolated, continuously manned, self-sufficient underground and underwater refuges that can support at least 100 people.**

#### **Solves extinction from nuclear war**

Karim **Jebari 15**. Royal Institute of Technology, KTH, Teknikringen. 06/2015. “Existential Risks: Exploring a Robust Risk Reduction Strategy.” Science and Engineering Ethics, vol. 21, no. 3, pp. 541–554.

Costs While this measure would be quite expensive, it would probably be much cheaper than **even the most optimistic assessments of colonizing the moon**. There are already shelters that could be refitted for this purpose. A nuclear reactor with highly enriched uranium, similar to that which powers large submarines, would probably be the most costly item. Thus, a **comparison with an Ohio-class submarine**, with a crew of 155, seems **reasonable**. This submarine costs 2 billion USD. Even if this shelter would be an **order of magnitude more expensive**, it would still cost **only a fraction of what a Moon colony would cost on the most optimistic cost assessment**. Furthermore, this facility would **reduce the risk of black swan extinction events** with **existing and proven technology**. It could also be implemented at a **very short notice**, compared with even the most optimistic plans to colonize the Moon. Conclusion The notion of black swan extinction events present us with a daunting task. How to even start thinking about risks that are unknown? The stakes are further raised when considering that, on a large number of normative theories, an existential catastrophe implies a staggering loss of value. Thus, it is unwise to ignore the risk such an event represents. In engineering safety, a number of heuristics and strategies are device to prevent a catastrophic failure in a large number of possible scenarios. These strategies could be employed in thinking about how to reduce the risk of a black swan extinction event. Safety barriers are an instance of such a strategy. These could be actual physical barriers in some systems, or subsystems that prevent catastrophic failure by compartmentalization and physical separation. This article has discussed an example implementation of this strategy: isolated, continuously manned and self-sufficient underground refuges that could protect a large enough number of people to ensure the continued existence of mankind. While building such a ‘‘doomsday shelter’’ is **less glamorous** than colonizing the Moon, it may give us **much more risk reduction for the money invested**. The conceptual sketch of the project in this paper should be further developed in an interdisciplinary research project, which could benefit from the extensive literature on isolated, self-containing habitats. Architecture, engineering, social psychology and decision theory would probably be needed to fully assess the costs, and social and technological challenges.

#### **Only takes 100 – studies.**

**Powell 18**, 8-13-2018, "How many humans would it take to keep our species alive? One scientist's surprising answer," NBC News, https://www.nbcnews.com/mach/science/how-many-humans-would-it-take-keep-our-species-alive-ncna900151//HM

In recent years, astronomers have found thousands of planets orbiting nearby stars, making the old science-fiction trope of off-world colonies seem a bit less absurd. But it was the 2016 discovery of a potentially habitable Earth-size planet around Proxima Centauri, the nearest star after the sun, that really got people thinking: Are we too vulnerable to asteroid strikes and other cataclysms to stick with our single planet? Could we safeguard our species by sending a space ark to a new home, a la "Battlestar Galactica" or the movie "Passengers?" Frédéric Marin is among those who are doing the hard thinking. The University of Strasbourg astrophysicist has been focusing not on the engineering issues of interstellar travel (which lie beyond current technology) but on the biology side of the question: How many crew members would be needed for an interstellar voyage that might last dozens of generations? In other words, what is the minimum number of people required to deliver and successfully plant a self-sustaining population of Homo sapiens on another Earth? “I was reading a lot on the human psychological aspect of spaceflight, and I realized that all books I’ve read and all the movies I’ve seen that were dealing with multiple-generation ships were very naïve,” Marin says. “Since I have access to huge computing power and state-of-the-art simulation tools, I decided to solve this on my spare time.” So when he wasn’t busy simulating galaxies and black holes, Marin created a computer program that mimics the progress of a breeding population. Then he used the program, dubbed Heritage, to simulate the risks a spacefaring population would face, including the effects of inbreeding as well as of catastrophic events like a deadly pandemic or being hit by some celestial object. A paper about his research was published in February in the Journal of the British Interplanetary Society. The magic number The number Marin came up with is 98. Just 98 healthy people would be needed to operate the ship over many generations and to set up a healthy (non-inbred) population on another world, he estimates. That number holds even for his test case of a space ark mission lasting more than 6,000 years, although he allows for the population aboard the ark to grow over time — up to about 500, perhaps. The implications of this finding go far beyond the sorts of spaceships we might be able to build in another century or two. “Our results apply to any enclosed environment where emigration and immigration are not possible,” Marin says. “The same elements are essential for any self-sustaining colony, so our code can easily compute the survival rate of a group of humans after a local or global catastrophe as well.” So even if billions of humans were wiped out by some catastrophe, as long as a suitable group of 98 survived and were able to mate, Marin says, they could carry enough genetic diversity to propagate the species and rebuild the population. Rival calculation Marin acknowledges that 98 sounds like an awfully small number. But he insists it makes sense, even knowing that Cameron Smith, an anthropologist at Portland State University in Oregon, looked at the same basic problem in 2014 and came up with a minimum crew size of 14,000. “Genetic minimum viable population doesn’t deal with real-world concerns,” Smith says, adding that he based his calculation on the demographics of actual populations on Earth. Many hunter-gatherer societies survive in groups of about 100, but even isolated tribes always interact with and have offspring with neighboring groups. Even a population of 14,000 strikes Smith as a modest number if you’re counting on it to sustain our species. “Suppose a catastrophe comes along and it knocks out 70 percent of the population,” he says. “Now the demographic structure of the population has been so disrupted that you can no longer find appropriate mating partners. One little catastrophe and the whole thing could fall apart.” The settling of the South Pacific is an interesting case study, according to Smith. That’s because Polynesians populated the islands one by one, much as we might eventually populate other planets. Of course, the Polynesians had abundant open land for population growth and were followed by a stream of other migrants who could keep things going if they got wiped out.

## **Case**

#### **Existential threats outweigh**

**GPP 17** (Global Priorities Project, Future of Humanity Institute at the University of Oxford, Ministry for Foreign Affairs of Finland, “Existential Risk: Diplomacy and Governance,” Global Priorities Project, 2017, <https://www.fhi.ox.ac.uk/wp-content/uploads/Existential-Risks-2017-01-23.pdf>

1.2. THE ETHICS OF EXISTENTIAL RISK In his book Reasons and Persons, Oxford philosopher Derek Parfit advanced an influential argument about the importance of avoiding extinction: I believe that if we destroy mankind, as we now can, this outcome will be much worse than most people think. Compare three outcomes: (1) Peace. (2) A nuclear war that kills 99% of the world’s existing population. (3) A nuclear war that kills 100%. (2) would be worse than (1), and (3) would be worse than (2). Which is the greater of these two differences? Most people believe that the greater difference is between (1) and (2). I believe that the difference between (2) and (3) is very much greater. ... The Earth will remain habitable for **at least another billion years**. Civilization began only a few thousand years ago. If we do not destroy mankind, these few thousand years may be only **a tiny fraction** of the whole of civilized human history. The difference between (2) and (3) may thus be the difference between this tiny fraction and all of the rest of this history. If we compare this possible history to a day, what has occurred so far is only a **fraction of a second**.65 In this argument, it seems that Parfit is assuming that the survivors of a nuclear war that kills 99% of the population would eventually be able to recover civilisation without long-term effect. As we have seen, this may not be a safe assumption – but for the purposes of this thought experiment, the point stands. What makes existential catastrophes especially bad is that they would “**destroy the future**,” as another Oxford philosopher, Nick Bostrom, puts it.66 This future could potentially be extremely long and full of flourishing, and would therefore have extremely large value. In standard risk analysis, when working out how to respond to risk, we work out the expected value of risk reduction, by weighing the probability that an action will prevent an adverse event against the severity of the event. Because the value of preventing existential catastrophe is so vast, even a tiny probability of prevention has huge expected value.67 Of course, there is persisting reasonable disagreement about ethics and there are a number of ways one might resist this conclusion.68 Therefore, it would be unjustified to be overconfident in Parfit and Bostrom’s argument. In some areas, government policy does give significant weight to future generations. For example, in assessing the risks of nuclear waste storage, governments have considered timeframes of thousands, hundreds of thousands, and even a million years.69 Justifications for this policy usually appeal to principles of intergenerational equity according to which future generations ought to get as much protection as current generations.70 Similarly, widely accepted norms of sustainable development require development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs.71 However, when it comes to existential risk, it would seem that we fail to live up to principles of intergenerational equity. Existential catastrophe would not only give future generations less than the current generations; **it would give them nothing**. Indeed, reducing existential risk plausibly has a quite low cost for us in comparison with the huge expected value it has for future generations. In spite of this, relatively little is done to reduce existential risk. Unless we give up on norms of intergenerational equity, they give us a strong case for significantly increasing our efforts to reduce existential risks. 1.3. WHY EXISTENTIAL RISKS MAY BE SYSTEMATICALLY UNDERINVESTED IN, AND THE ROLE OF THE INTERNATIONAL COMMUNITY In spite of the importance of existential risk reduction, it probably receives less attention than is warranted. As a result, concerted international cooperation is required if we are to receive adequate protection from existential risks. 1.3.1. Why existential risks are likely to be underinvested in There are several reasons why existential risk reduction is likely to be underinvested in. Firstly, it is a global public good. Economic theory predicts that such goods tend to be underprovided. The benefits of existential risk reduction are widely and indivisibly dispersed around the globe from the countries responsible for taking action. Consequently, a country which reduces existential risk gains only a small portion of the benefits but bears the full brunt of the costs. Countries thus have strong incentives to free ride, receiving the benefits of risk reduction without contributing. As a result, too few do what is in the common interest. Secondly, as already suggested above, existential risk reduction is an intergenerational public good: most of the benefits are enjoyed by future generations who have no say in the political process. For these goods, the problem is temporal free riding: the current generation enjoys the benefits of inaction while future generations bear the costs. Thirdly, many existential risks, such as machine superintelligence, engineered pandemics, and solar geoengineering, pose an unprecedented and uncertain future threat. Consequently, it is hard to develop a satisfactory governance regime for them: there are few existing governance instruments which can be applied to these risks, and it is unclear what shape new instruments should take. In this way, our position with regard to these emerging risks is comparable to the one we faced when nuclear weapons first became available. Cognitive biases also lead people to underestimate existential risks. Since there have not been any catastrophes of this magnitude, these risks are not salient to politicians and the public.72 This is an example of the misapplication of the availability heuristic, a mental shortcut which assumes that something is important only if it can be readily recalled. Another cognitive bias affecting perceptions of existential risk is scope neglect. In a seminal 1992 study, three groups were asked how much they would be willing to pay to save 2,000, 20,000 or 200,000 birds from drowning in uncovered oil ponds. The groups answered $80, $78, and $88, respectively.73 In this case, the size of the benefits had little effect on the scale of the preferred response. People become numbed to the effect of saving lives when the numbers get too large. 74 Scope neglect is a particularly acute problem for existential risk because the numbers at stake are so large. Due to scope neglect, decision-makers are prone to treat existential risks in a similar way to problems which are less severe by many orders of magnitude. A wide range of other cognitive biases are likely to affect the evaluation of existential risks.75

#### **Nuke war doesn’t target population centers – no impact**

**Mueller 09** (Woody; 10/5/9; Woody Hayes Chair of National Security Studies, Professor of Political Science at Ohio State University, Cato Senior Fellow, and award winning author; Google Books, “Atomic Obsession: Nuclear Alarmism from Hiroshima to Al-Qaeda” p. 8)

To begin to approach a condition that can credibly justify applying such extreme characterizations as societal annihilation, a full-out attack with hundreds, probably thousands, of thermonuclear bombs would be required. Even in such extreme cases, the area actually devastated by the bombs' blast and thermal pulse effective would be limited: 2,000 1-MT explosions with a destructive radius of 5 miles each would directly demolish less than 5 percent of the territory of the United States, for example. Obviously, if major population centers were targeted, this sort of attack could inflict massive casualties. Back in cold war days, when such devastating events sometimes seemed uncomfortably likely, a number of studies were conducted to estimate the consequences of massive thermonuclear attacks. One of the most prominent of these considered several probabilities. The **most likely** scenario--one that could be perhaps considered at least to begin to approach the rational--was a "counterforce" strike in which well over 1,000 thermonuclear weapons would be targeted at America's ballistic missile silos, strategic airfields, and nuclear submarine bases in an effort to destroy the country’s strategic ability to retaliate. Since the attack **would not directly target population centers,** most of the ensuing deaths would be from radioactive fallout, and the study estimates that from **2 to 20 million**, depending mostly on wind, weather, and sheltering, **would perish** during the first month.15 That sort of damage, which would kill less than 10 percent of the population, might or might not be enough to trigger words like “annihilation.” 30

#### **There’s no nuclear winter. Prefer our study – it has 9 PhD’s with experts in every relevant scientific field.**

**Reisner et al. 18** [Jon Reisner](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Reisner%2C+Jon) - Climate and Atmospheric Sciences PhD at Los Alamos National Laboratory; [Gennaro D'Angelo](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=D%27Angelo%2C+Gennaro) – PhD [Los Alamos National Laboratory](https://www.researchgate.net/institution/Los_Alamos_National_Laboratory), [Theoretical Division](https://www.researchgate.net/institution/Los_Alamos_National_Laboratory/department/Theoretical_Division2) [Eunmo Koo](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Koo%2C+Eunmo) - Ph.D., Mechanical Engineering, University of California at Berkeley, Expertise: Atmospheric fluid dynamics, Modeling fluid-solid interactions, Fire spread in urban and wildland environment, Wind energy harvest, High-performance computing simulations; [Wesley Even](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Even%2C+Wesley) - Ph.D. Physics - Louisiana State University, Expertise: Computational Physics, Astrophysics [Matthew Hecht](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Hecht%2C+Matthew) – Expert in Climate and Ocean Modeling [Elizabeth Hunke](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Hunke%2C+Elizabeth) - Ph.D., Program in Applied Mathematics, University of Arizona, Expertise: Sea Ice Models; [Darin Comeau](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Comeau%2C+Darin) – PhD, Applied Mathematics, University of Arizona , Expert in High dimensional data analysis, statistical and predictive modeling, and uncertainty quantification, with particular applications to climate science, as well as process-based modeling of the cryosphere; [Randall Bos](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Bos%2C+Randall) – PhD, Expert in Nuclear Weapon Effects Modeling and Simulation [James Cooley](https://agupubs.onlinelibrary.wiley.com/action/doSearch?ContribAuthorStored=Cooley%2C+James) - Ph.D. -- Physics, University of Maryland, Expert in Weapon Physics, Emergency Response, Computational Physics, Verification, and Validation (2018). Climate impact of a regional nuclear weapons exchange: An improved assessment based on detailed source calculations. Journal of Geophysical Research: Atmospheres , 123 , 2752 – 2772. https://doi.org/10.1002/2017JD027331 Received 20 JUN 2017 Accepted 1 FEB 2018 Accepted article online 13 FEB 2018 Published online 14 MAR 2018 ©2018. The Authors. This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distri- bution in any medium, provided the original work is properly cited, the use is non-commercial and no modi fi cations or adaptations are made.] LHSBC

Abstract We present a multiscale study examining the impact of a regional exchange of nuclear weapons on global climate. Our models investigate **multiple phases of the effects of nuclear weapons** usage, including growth and rise of the nuclear fireball, ignition and spread of the induced fi restorm, and **comprehensive Earth system modeling** of the oceans, land, ice, and atmosphere. This study follows from the scenario originally envisioned by Robock, Oman, Stenchikov, et al. (2007, https://doi.org/10.5194/acp-7-2003-2007), based on the analysis of Toon et al. (2007, https://doi.org/10.5194/acp-7-1973-2007), which assumes a regional exchange between India and Pakistan of fi fty 15 kt weapons detonated by each side. We expand this scenario by modeling the processes that lead to production of black carbon, in order to re fi ne the black carbon forcing estimates of these previous studies. When the Earth system model is initiated with 5 × 10 9 kg of black carbon in the upper troposphere (approximately from 9 to 13 km), the impact on climate variables such as global temperature and precipitation in our simulations is similar to that predicted by previously published work. However, while our thorough simulations of the fi restorm produce about 3.7 × 10 9 kg of black carbon, we fi nd that the vast majority of the black carbon **never reaches an altitude above weather systems** (approximately 12 km). Therefore, our Earth system model simulations conducted with model-informed atmospheric distributions of black carbon produce signi fi cantly lower global climatic impacts than assessed in prior studies, as the carbon at lower altitudes is more **quickly removed from the atmosphere**. In addition, our model ensembles indicate that statistically signi fi cant effects on global surface temperatures are limited to the fi rst 5 years and are much smaller in magnitude than those shown in earlier works. None of the simulations produced a nuclear winter effect. We fi nd that the effects on global surface temperatures are not uniform and are concentrated primarily around the highest arctic latitudes, dramatically **reducing the global impact on human health and agriculture** compared with that reported by earlier studies. Our analysis demonstrates that the probability of significant global cooling from a limited exchange scenario as envisioned in previous studies is **highly unlikely**, a **conclusion supported by examination of natural analogs,** such as large forest fires and volcanic eruptions.

#### **Superior studies- theirs are confirmation-bias laden and repeatedly disproven**

S. Fred **Singer 18**. Professor emeritus at the University of Virginia and a founding director and now chairman emeritus of the Science & Environmental Policy Project, specialist in atmospheric and space physics, founding director of the U.S. Weather Satellite Service, now part of NOAA, served as vice chair of the U.S. National Advisory Committee on Oceans &amp; Atmosphere, an elected fellow of several scientific societies, including APS, AGU, AAAS, AIAA, Sigma Xi, and Tau Beta Pi, and a senior fellow of the Heartland Institute and the Independent Institute. 6-27-2018. "Remember Nuclear Winter?." American Thinker. https://www.americanthinker.com/articles/2018/06/remember\_nuclear\_winter.html

**Nuclear Winter** burst on the academic scene in December 1983 with the publication of the hypothesis in the prestigious journal Science. It was accompanied by a study by Paul Ehrlich, et al. that hinted that it might cause the **extinction of human life** on the planet. MCANW stands for Medical Campaign Against Nuclear Weapons. Photo via Wellcome Images. The five authors of the Nuclear Winter hypothesis were labeled **TTAPS**, using the initials of their family names (T stands for Owen Toon and P stands for Jim Pollak, both Ph.D. students of Carl Sagan at Cornell University.) Carl Sagan himself was the main author and driving force. Actually, Sagan had scooped the Science paper by publishing the gist of the hypothesis in Parade magazine, which claimed a readership of 50 million! Previously, Sagan had briefed people in public office and elsewhere, so they were all primed for the popular reaction, which was tremendous. Many of today's readers may not remember Carl Sagan. He was a brilliant astrophysicist but also highly political. Imagine Al Gore, but with an excellent science background. Sagan had developed and narrated a television series called Cosmos that popularized astrophysics and much else, including cosmology, the history of the universe. He even suggested the possible existence of extraterrestrial intelligence and started a listening project called SETI (Search for Extraterrestrial Intelligence). SETI is still searching today and has not found any evidence so far. Sagan became a sort of icon; many people in the U.S. and abroad knew his name and face. Carl Sagan also had another passion: saving humanity from a general nuclear war, a laudable aim. He had been arguing vigorously and publicly for a "freeze" on the production of more nuclear weapons. President Ronald Reagan outdid him and negotiated a nuclear weapons reduction with the USSR. In the meantime, much excitement was stirred up by Nuclear Winter. **Study after study tried to confirm and expand the hypothesis**, led by the Defense Department (**DOD**), which took the hypothesis seriously and spent **millions of dollars** on various reports that **accepted** Nuclear Winter rather **uncritically**. The National Research Council (**NRC**) of the National Academy of Sciences published a report that put in **more quantitative detail**. It enabled critics of the hypothesis to **find flaws – and many did**. The names Russell **Seitz**, Dick **Wilson** (both of Cambridge, Mass.), Steve **Schneider** (Palo Alto, Calif.), and Bob **Ehrlich** (Fairfax, Va.) (no relation to Paul Ehrlich) come to mind. The hypothesis was **really "politics disguised as science**." The whole TTAPS scheme was **contrived to deliver the desired consequence**. It required the smoke layer to be of **just the right thickness, covering the whole Earth, and lasting for many months.** The Kuwait oil fires in 1991 produced a lot of smoke, but it **rained out** after a few days. I had a mini-debate with Sagan on the TV program Nightline and published a more critical analysis of the whole hypothesis in the journal Meteorology & Atmospheric Physics. I don't know if Carl ever saw my paper. But I learned a lot from doing this analysis that was useful in later global warming research. For example, the initial nuclear bursts **inject water vapor** into the stratosphere, which **turns into contrail-like cirrus clouds**. That actually leads to a strong initial **warming** and a "**nuclear summer**."

#### **Isolated island populations repopulate Earth after radiation and nuclear winter – bunkers and submarines expand the likelihood of survival**

**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.

#### **Extinction is inevitable from future technology — nanotech, our simulation gets shut down, AI, biotech, particle accelerators, and black swans**

Bruce **Sterling**, 6-1-20**18**, "When Nick Bostrom says “Bang”," WIRED, https://www.wired.com/beyond-the-beyond/2018/06/nick-bostrom-says-bang/

4.1 Deliberate **misuse of nanotechnology**

In a mature form, molecular nanotechnology will enable the construction of bacterium-scale self-replicating mechanical robots that can feed on dirt or other organic matter [22-25]. Such replicators could **eat up the biosphere** or destroy it by other means such as by poisoning it, burning it, or blocking out sunlight. A person of malicious intent in possession of this technology might cause the extinction of intelligent life on Earth by releasing such nanobots into the environment.[9]

The technology to produce a destructive nanobot seems considerably easier to develop than the technology to create an effective defense against such an attack (a global nanotech immune system, an “active shield” [23]). It is therefore likely that there will be a period of vulnerability during which this technology must be prevented from coming into the wrong hands. Yet the technology could prove hard to regulate, since it doesn’t require rare radioactive isotopes or large, easily identifiable manufacturing plants, as does production of nuclear weapons [23].

Even if effective defenses against a limited nanotech attack are developed before dangerous replicators are designed and acquired by suicidal regimes or terrorists, there will still be the danger of an arms race between states possessing nanotechnology. It has been argued [26] that molecular manufacturing would lead to both arms race instability and crisis instability, to a higher degree than was the case with nuclear weapons. Arms race instability means that there would be dominant incentives for each competitor to escalate its armaments, leading to a runaway arms race. Crisis instability means that there would be dominant incentives for striking first. Two roughly balanced rivals acquiring nanotechnology would, on this view, begin a massive buildup of armaments and weapons development programs that would continue until a crisis occurs and war breaks out, potentially causing global terminal destruction. That the arms race could have been predicted is no guarantee that an international security system will be created ahead of time to prevent this disaster from happening. The nuclear arms race between the US and the USSR was predicted but occurred nevertheless.

4.2 Nuclear holocaust[winter]

The US and Russia still have huge stockpiles of nuclear weapons. But would an all-out nuclear war really exterminate humankind? Note that: (i) For there to be an existential risk it suffices that we can’t be sure that it wouldn’t. (ii) The climatic effects of a large nuclear war are not well known (there is the possibility of a nuclear winter). (iii) Future arms races between other nations cannot be ruled out and these could lead to even greater arsenals than those present at the height of the Cold War. The world’s supply of plutonium has been increasing steadily to about two thousand tons, some ten times as much as remains tied up in warheads ([9], p. 26). (iv) Even if some humans survive the short-term effects of a nuclear war, it could lead to the collapse of civilization. A human race living under stone-age conditions may or may not be more resilient to extinction than other animal species.

4.3 **We’re living in a simulation and it gets shut down**

A case can be made that the hypothesis that we are living in a computer simulation should be given a significant probability [27]. The basic idea behind this so-called “Simulation argument” is that vast amounts of computing power may become available in the future (see e.g. [28,29]), and that it could be used, among other things, to run large numbers of fine-grained simulations of past human civilizations. Under some not-too-implausible assumptions, the result can be that almost all minds like ours are simulated minds, and that we should therefore assign a significant probability to being such computer-emulated minds rather than the (subjectively indistinguishable) minds of originally evolved creatures. And if we are, we suffer the risk that the simulation may be shut down at any time. A decision to terminate our simulation may be **prompted by our actions** or by exogenous factors.

While to some it may seem frivolous to list such a radical or “philosophical” hypothesis next the concrete threat of nuclear holocaust, we must seek to base these evaluations on reasons rather than untutored intuition. Until a refutation appears of the argument presented in [27], it would intellectually dishonest to neglect to mention simulation-shutdown as a potential extinction mode.

4.4 **Badly programmed superintelligence**

When we create the first superintelligent entity [28-34], we might make a mistake and give it goals that lead it to annihilate humankind, assuming its enormous intellectual advantage gives it the power to do so. For example, we could mistakenly elevate a subgoal to the status of a supergoal. We tell it to solve a mathematical problem, and it complies by turning all the matter in the solar system into a giant calculating device, in the process killing the person who asked the question. (For further analysis of this, see [35].)

4.5 **Genetically engineered biological agent**

With the fabulous advances in genetic technology currently taking place, it may become possible for a tyrant, terrorist, or ~~lunatic~~ to create a doomsday virus, an organism that **combines long latency with high virulence and mortality** [36].

Dangerous viruses can even be spawned unintentionally, as Australian researchers recently demonstrated when they created a modified mousepox virus with 100% mortality while trying to design a contraceptive virus for mice for use in pest control [37]. While this particular virus doesn’t affect humans, it is suspected that an analogous alteration would increase the mortality of the human smallpox virus. What underscores the future hazard here is that the research was quickly published in the open scientific literature [38]. It is hard to see how information generated in open biotech research programs could be contained no matter how grave the potential danger that it poses; and the same holds for research in nanotechnology.

Genetic medicine will also lead to better cures and vaccines, but there is no guarantee that defense will always keep pace with offense. (Even the accidentally created mousepox virus had a 50% mortality rate on vaccinated mice.) Eventually, worry about biological weapons may be put to rest through the development of nanomedicine, but while nanotechnology has enormous long-term potential for medicine [39] it carries its own hazards.

4.6 **Accidental misuse of nanotechnology** (“gray goo”)

The possibility of accidents can never be completely ruled out. However, there are many ways of making sure, through responsible engineering practices, that species-destroying accidents do not occur. One could avoid using self-replication; one could make nanobots dependent on some rare feedstock chemical that doesn’t exist in the wild; one could confine them to sealed environments; one could design them in such a way that any mutation was overwhelmingly likely to cause a nanobot to completely cease to function [40]. Accidental misuse is therefore a smaller concern than malicious misuse [23,25,41].

However, the distinction between the accidental and the deliberate can become blurred. While “in principle” it seems possible to make terminal nanotechnological accidents extremely improbable, the actual circumstances may not permit this ideal level of security to be realized. Compare nanotechnology with nuclear technology. From an engineering perspective, it is of course perfectly possible to use nuclear technology only for peaceful purposes such as nuclear reactors, which have a zero chance of destroying the whole planet. Yet in practice it may be very hard to avoid nuclear technology also being used to build nuclear weapons, leading to an arms race. With large nuclear arsenals on hair-trigger alert, there is inevitably a significant risk of accidental war. The same can happen with nanotechnology: it may be pressed into serving military objectives in a way that carries unavoidable risks of serious accidents.

In some situations it can even be strategically advantageous to deliberately make one’s technology or control systems risky, for example in order to make a “threat that leaves something to chance” [42].

4.7 **Something unforeseen**

We need a catch-all category. It would be foolish to be confident that we have already imagined and anticipated all significant risks. Future technological or scientific developments may very well reveal novel ways of destroying the world.

Some foreseen hazards (hence not members of the current category) which have been excluded from the list of bangs on grounds that they seem too unlikely to cause a global terminal disaster are: solar flares, supernovae, black hole explosions or mergers, gamma-ray bursts, galactic center outbursts, supervolcanos, loss of biodiversity, buildup of air pollution, gradual loss of human fertility, and various religious doomsday scenarios. The hypothesis that we will one day become “illuminated” and commit collective suicide or stop reproducing, as supporters of VHEMT (The Voluntary Human Extinction Movement) hope [43], appears unlikely. If it really were better not to exist (as Silenus told king Midas in the Greek myth, and as Arthur Schopenhauer argued [44] although for reasons specific to his philosophical system he didn’t advocate suicide), then we should not count this scenario as an existential disaster. The assumption that it is not worse to be alive should be regarded as an implicit assumption in the definition of Bangs. Erroneous collective suicide is an existential risk albeit one whose probability seems extremely slight. (For more on the ethics of human extinction, see chapter 4 of [9].)

4.8 **Physics disasters**

The Manhattan Project bomb-builders’ concern about an A-bomb-derived atmospheric conflagration has contemporary analogues.

There have been speculations that future high-energy particle accelerator experiments may cause a breakdown of a metastable vacuum state that our part of the cosmos might be in, converting it into a “true” vacuum of lower energy density [45]. This would result in an expanding bubble of total destruction that would sweep through the galaxy and beyond at the speed of light, tearing all matter apart as it proceeds.

Another conceivability is that accelerator experiments might produce negatively charged stable “strangelets” (a hypothetical form of nuclear matter) or create a mini black hole that would sink to the center of the Earth and start accreting the rest of the planet [46].

These outcomes seem to be impossible given our best current physical theories. But the reason we do the experiments is precisely that we don’t really know what will happen. A more reassuring argument is that the energy densities attained in present day accelerators are far lower than those that occur naturally in collisions between cosmic rays [46,47]. It’s possible, however, that factors other than energy density are relevant for these hypothetical processes, and that those factors will be brought together in novel ways in future experiments.

The main reason for concern in the “physics disasters” category is the meta-level observation that discoveries of all sorts of weird physical phenomena are made all the time, so even if right now all the particular physics disasters we have conceived of were absurdly improbable or impossible, there could be other more realistic failure-modes waiting to be uncovered. The ones listed here are merely illustrations of the general case.

#### **Industrial civilization wouldn’t recover.**

Lewis **Dartnell 15**. UK Space Agency research fellow at the University of Leicester, working in astrobiology and the search for microbial life on Mars. His latest book is The Knowledge: How to Rebuild Our World from Scratch. 04-13-15. "Could we reboot a modern civilisation without fossil fuels? – Lewis Dartnell." Aeon. https://aeon.co/essays/could-we-reboot-a-modern-civilisation-without-fossil-fuels

**Imagine that the world as we know it ends tomorrow**. There’s a **global catastrophe**: a pandemic virus, an asteroid strike, or perhaps a **nuclear holocaust**. The **vast majority** of the human race **perishes**. Our civilisation collapses. The post-apocalyptic survivors find themselves in a devastated world of decaying, deserted cities and roving gangs of bandits looting and taking by force. **Bad as things sound, that’s not the end for humanity**. We **bounce back**. Sooner or later, **peace and order** emerge again, just as they have time and again through history. **Stable communities** take shape. They begin the agonising process of **rebuilding** their technological base from scratch. But here’s the question: how far could such a society rebuild? Is there **any chance**, for instance, that a post-apocalyptic society could **reboot a technological civilisation?** Let’s make the basis of this thought experiment a little more specific. Today, we have already consumed the **most** easily drainable **crude oil** and, particularly in Britain, much of the shallowest, **most** readily mined deposits of **coal**. **Fossil fuels are central** to the organisation of modern industrial society, just as they were central to its **development**. Those, by the way, are **distinct roles**: even if we could somehow do without fossil fuels now (which we can’t, quite), it’s a different question whether we **could have got to where we are without ever having had them**. So, would a society starting over on a planet stripped of its fossil fuel deposits have the chance to progress through its own Industrial Revolution? Or to phrase it another way, what might have happened if, for whatever reason, the Earth had never acquired its extensive underground deposits of coal and oil in the first place? Would our progress necessarily have halted in the 18th century, in a pre-industrial state? It’s easy to **underestimate** our current dependence on fossil fuels. In everyday life, their most visible use is the petrol or diesel pumped into the vehicles that fill our roads, and the coal and natural gas which fire the power stations that electrify our modern lives. But we also rely on a range of different industrial materials, and in most cases, high temperatures are required to transform the stuff we dig out of the ground or harvest from the landscape into something useful. You can’t smelt metal, make glass, roast the ingredients of concrete, or synthesise artificial fertiliser without a lot of heat. It is **fossil fuels** – coal, gas and oil – that provide most of this **thermal** energy. In fact, the problem is **even worse** than that. Many of the **chemicals** required in bulk to run the modern world, from pesticides to plastics, derive from the **diverse organic compounds in crude oil**. Given the dwindling reserves of crude oil left in the world, it could be argued that the most wasteful use for this limited resource is to simply burn it. We should be carefully preserving what’s left for the vital repertoire of valuable organic compounds it offers. But my topic here is not what we should do now. Presumably everybody knows that we must transition to a low-carbon economy one way or another. No, I want to answer a question whose interest is (let’s hope) more theoretical. Is the emergence of a technologically advanced civilisation necessarily contingent on the easy availability of ancient energy? Is it possible to build an industrialised civilisation without fossil fuels? And the answer to that question is: maybe – but it would be extremely difficult. Let’s see how. We’ll start with a natural thought. Many of our alternative energy technologies are already highly developed. Solar panels, for example, represent a good option today, and are appearing more and more on the roofs of houses and businesses. It’s tempting to think that a rebooted society could simply pick up where we leave off. Why couldn’t our civilisation 2.0 just start with renewables? Well, it could, in a very limited way. If you find yourself among the survivors in a post-apocalyptic world, you could **scavenge** enough **working solar panels** to keep your lifestyle electrified for a good long while. Without moving parts, photovoltaic cells require little maintenance and are remarkably resilient. They do deteriorate over time, though, from moisture penetrating the casing and from sunlight itself degrading the high-purity silicon layers. The electricity generated by a solar panel declines by about 1 per cent every year so, after a few generations, all our hand-me-down solar panels will have degraded to the point of uselessness. **Then what? New ones** would be **fiendishly difficult** to create from scratch. Solar panels are made from thin slices of **extremely** pure silicon, and although the raw material is common sand, it must be processed and refined using **complex** and precise techniques – the same technological capabilities, more or less, that we need for modern semiconductor electronics components. These techniques took a long time to develop, and would presumably take a long time to recover. So photovoltaic solar power would not be within the capability of a society early in the industrialisation process. Perhaps, though, we were on the right track by starting with electrical power. Most of our renewable-energy technologies produce electricity. In our own historical development, it so happens that the core phenomena of electricity were discovered in the first half of the 1800s, well after the early development of steam engines. Heavy industry was already committed to combustion-based machinery, and electricity has largely assumed a subsidiary role in the organisation of our economies ever since. But could that sequence have run the other way? Is there some developmental requirement that thermal energy must come first? On the face of it, it’s not beyond the bounds of possibility that a progressing society could construct electrical generators and couple them to simple windmills and waterwheels, later progressing to wind turbines and hydroelectric dams. In a world without fossil fuels, one might envisage an electrified civilisation that largely **bypasses combustion** engines, building its transport infrastructure around electric trains and trams for long-distance and urban transport. I say ‘largely’. We couldn’t get round it all together. When it comes to generating the white heat demanded by modern industry, there are **few good options but to burn stuff** While the electric motor could perhaps replace the coal-burning steam engine for mechanical applications, society, as we’ve already seen, also relies upon thermal energy to drive the essential chemical and physical transformations it needs. How could an industrialising society produce crucial building materials such as iron and steel, brick, mortar, cement and glass without resorting to deposits of coal? You can of course create heat from electricity. We already use electric ovens and kilns. Modern arc furnaces are used for producing cast iron or recycling steel. The problem isn’t so much that electricity can’t be used to heat things, but that for meaningful industrial activity you’ve got to generate prodigious amounts of it, which is challenging using only renewable energy sources such as wind and water. An alternative is to generate high temperatures using solar power directly. Rather than relying on photovoltaic panels, concentrated solar thermal farms use giant mirrors to focus the sun’s rays onto a small spot. The heat concentrated in this way can be exploited to drive certain chemical or industrial processes, or else to raise steam and drive a generator. Even so, it is difficult (for example) to produce the very high temperatures inside an iron-smelting blast furnace using such a system. What’s more, it goes without saying that the effectiveness of concentrated solar power depends strongly on the local climate. No, when it comes to generating the white heat demanded by modern industry, there are few good options but to burn stuff. But that doesn’t mean the stuff we burn necessarily has to be fossil fuels. Let’s take a quick detour into the pre-history of modern industry. Long before the adoption of coal, charcoal was widely used for smelting metals. In many respects it is superior: charcoal burns hotter than coal and contains far fewer impurities. In fact, coal’s impurities were a major delaying factor on the Industrial Revolution. Released during combustion, they can taint the product being heated. During smelting, sulphur contaminants can soak into the molten iron, making the metal brittle and unsafe to use. It took a long time to work out how to treat coal to make it useful for many industrial applications. And, in the meantime, charcoal worked perfectly well. And then, well, we stopped using it. In retrospect, that’s a pity. When it comes from a sustainable source, charcoal burning is essentially carbon-neutral, because it doesn’t release any new carbon into the atmosphere – not that this would have been a consideration for the early industrialists. But charcoal-based industry didn’t die out altogether. In fact, it survived to flourish in Brazil. Because it has substantial iron deposits but few coalmines, Brazil is the largest charcoal producer in the world and the ninth biggest steel producer. We aren’t talking about a cottage industry here, and this makes Brazil a very encouraging example for our thought experiment. The trees used in Brazil’s charcoal industry are mainly fast-growing eucalyptus, cultivated specifically for the purpose. The traditional method for creating charcoal is to pile chopped staves of air-dried timber into a great dome-shaped mound and then cover it with turf or soil to restrict airflow as the wood smoulders. The Brazilian enterprise has scaled up this traditional craft to an industrial operation. Dried timber is stacked into squat, cylindrical kilns, built of brick or masonry and arranged in long lines so that they can be easily filled and unloaded in sequence. The largest sites can sport hundreds of such kilns. Once filled, their entrances are sealed and a fire is lit from the top. The skill in charcoal production is to allow just enough air into the interior of the kiln. There must be enough combustion heat to drive out moisture and volatiles and to pyrolyse the wood, but not so much that you are left with nothing but a pile of ashes. The kiln attendant monitors the state of the burn by carefully watching the smoke seeping out of the top, opening air holes or sealing with clay as necessary to regulate the process. Brazil shows how the raw materials of modern civilisation can be supplied without reliance on fossil fuels Good things come to those who wait, and this wood pyrolysis process can take up to a week of carefully controlled smouldering. The same basic method has been used for millennia. However, the ends to which the fuel is put are distinctly modern. Brazilian charcoal is trucked out of the forests to the country’s blast furnaces where it is used to transform ore into pig iron. This pig iron is the basic ingredient of modern mass-produced steel. The Brazilian product is exported to countries such as China and the US where it becomes cars and trucks, sinks, bathtubs, and kitchen appliances. Around two-thirds of Brazilian charcoal comes from sustainable plantations, and so this modern-day practice has been dubbed ‘green steel’. Sadly, the final third is supplied by the non-sustainable felling of primary forest. Even so, the Brazilian case does provide an example of how the raw materials of modern civilisation can be supplied without reliance on fossil fuels. Another, related option might be wood gasification. The use of wood to provide heat is as old as mankind, and yet simply burning timber only uses about a third of its energy. The rest is lost when gases and vapours released by the burning process blow away in the wind. Under the right conditions, even smoke is combustible. We don’t want to waste it. Better than simple burning, then, is to drive the thermal breakdown of the wood and collect the gases. You can see the basic principle at work for yourself just by lighting a match. The luminous flame isn’t actually touching the matchwood: it dances above, with a clear gap in between. The flame actually feeds on the hot gases given off as the wood breaks down in the heat, and the gases combust only once they mix with oxygen from the air. Matches are fascinating when you look at them closely. Wartime gasifier cars could achieve about 1.5 miles per kilogram. Today’s designs improve upon this To release these gases in a controlled way, bake some timber in a closed container. Oxygen is restricted so that the wood doesn’t simply catch fire. Its complex molecules decompose through a process known as pyrolysis, and then the hot carbonised lumps of charcoal at the bottom of the container react with the breakdown products to produce flammable gases such as hydrogen and carbon monoxide. The resultant ‘producer gas’ is a versatile fuel: it can be stored or piped for use in heating or street lights, and is also suitable for use in complex machinery such as the internal combustion engine. More than a million gasifier-powered cars across the world kept civilian transport running during the oil shortages of the Second World War. In occupied Denmark, 95 per cent of all tractors, trucks and fishing boats were powered by wood-gas generators. The energy content of about 3 kg of wood (depending on its dryness and density) is equivalent to a litre of petrol, and the fuel consumption of a gasifier-powered car is given in miles per kilogram of wood rather than miles per gallon. Wartime gasifier cars could achieve about 1.5 miles per kilogram. Today’s designs improve upon this. But you can do a lot more with wood gases than just keep your vehicle on the road. It turns out to be suitable for any of the manufacturing processes needing heat that we looked at before, such as kilns for lime, cement or bricks. Wood gas generator units could easily power agricultural or industrial equipment, or pumps. Sweden and Denmark are world leaders in their use of sustainable forests and agricultural waste for turning the steam turbines in power stations. And once the steam has been used in their ‘Combined Heat and Power’ (CHP) electricity plants, it is piped to the surrounding towns and industries to heat them, allowing such CHP stations to approach 90 per cent energy efficiency. Such plants suggest a marvellous vision of industry wholly weaned from its dependency on fossil fuel. Is that our solution, then? Could our rebooting society run on **wood**, supplemented with electricity from renewable sources? Maybe so, if the **population** was **fairly small**. But **here’s the catch**. These options all presuppose that our survivors are able to **construct efficient steam turbines, CHP stations and internal combustion engines**. We **know how to do** all **that**, of course – but in the event of a civilisational collapse, **who is to say that the knowledge won’t be lost? And if it is, what are the chances that our descendants could reconstruct it?** In our own history, the first successful application of steam engines was in pumping out coal mines. This was a setting in which fuel was already abundant, so it didn’t matter that the first, primitive designs were terribly inefficient. The increased output of coal from the mines was used to first smelt and then forge more iron. Iron components were used to construct further steam engines, which were in turn used to pump mines or drive the blast furnaces at iron foundries. And of course, steam engines were themselves employed at machine shops to construct yet more steam engines. It was only once steam engines were being built and operated that subsequent engineers were able to devise ways to increase their efficiency and shrink fuel demands. They found ways to reduce their size and weight, adapting them for applications in transport or factory machinery. In other words, there was a positive feedback loop at the very core of the industrial revolution: the production of coal, iron and steam engines were all mutually supportive. In a world without readily mined coal, would there ever be the opportunity to test profligate prototypes of steam engines, even if they could mature and become more efficient over time? How feasible is it that a society could attain a **sufficient understanding of thermodynamics, metallurgy and mechanics** to make the precisely interacting components of an internal combustion engine, without first **cutting its teeth** on **much simpler external combustion engines** – the separate boiler and cylinder-piston of steam engines? It took a lot of energy to develop our technologies to their present heights, and presumably it would take a lot of energy to do it again. Fossil fuels are out. That means our future society will need an **awful lot of timber**. An industrial revolution without coal would be, at a minimum, very difficult In a temperate climate such as the UK’s, an acre of broadleaf trees produces about four to five tonnes of biomass fuel every year. If you cultivated fast-growing kinds such as willow or miscanthus grass, you could quadruple that. The trick to maximising timber production is to employ coppicing – cultivating trees such as ash or willow that resprout from their own stump, becoming ready for harvest again in five to 15 years. This way you can ensure a sustained supply of timber and not face an energy crisis once you’ve deforested your surroundings. But here’s the thing: coppicing was already a well-developed technique in pre-industrial Britain. It couldn’t meet all of the energy requirements of the burgeoning society. The central problem is that woodland, even when it is well-managed, competes with other land uses, principally agriculture. The double-whammy of development is that, as a society’s population grows, it requires more farmland to provide enough food and **also greater timber production** for **energy**. The two needs **compete** for largely the same land areas. We know how this played out in **our own past**. From the mid-16th century, Britain responded to these factors by **increasing the exploitation of its coal fields** – essentially harvesting the energy of ancient forests beneath the ground without compromising its agricultural output. The same energy provided by one hectare of coppice for a year is provided by about five to 10 tonnes of coal, and it can be dug out of the ground an awful lot quicker than waiting for the woodland to regrow. It is this limitation in the supply of thermal energy that would pose the biggest problem to a society trying to industrialise without easy access to fossil fuels. This is true in our **post-apocalyptic scenario**, and it would be equally true in any counterfactual world that never developed fossil fuels for whatever reason. For a society to stand any chance of industrialising under such conditions, it would have to focus its efforts in certain, very favourable natural environments: not the coal-island of 18th-century Britain, but perhaps areas of Scandinavia or Canada that combine fast-flowing streams for hydroelectric power and large areas of forest that can be harvested sustainably for thermal energy. Even so, an industrial revolution without coal would be, at a minimum, **very difficult**. Today, use of fossil fuels is actually growing, which is worrying for a number of reasons too familiar to rehearse here. Steps towards a low-carbon economy are vital. But we should also recognise how pivotal those accumulated reservoirs of thermal energy were in getting us to where we are. Maybe we could have made it the hard way. A slow-burn progression through the stages of mechanisation, supported by a combination of renewable electricity and sustainably grown biomass, might be possible after all. Then again, it might not. We’d better hope we can secure the future of our own civilisation, because we might have scuppered the chances of any society to follow in our wake.

#### **Nuclear war prevents existential biosphere implosion**

**Caldwell 16** -- Joseph George Caldwell is a mathematical statistician and systems and software engineer. He is author of articles and books on divers topics (e.g., population, environment, statistics, economics, politics, defense and music, including The Late Great United States (2008); Can America Survive? (1999); How to Stop the IRS and Solve the Deficit Problem (The Value-Added Tax: A New Tax System for the United States) (1987); How to Play the Guitar by Ear (for mathematicians and physicists) (2000). See Internet website http://www.foundationwebsite.org to view these and other articles. He holds a BS degree in Mathematics from Carnegie Mellon University in Pittsburgh, Pennsylvania, and a PhD degree in Statistics from the University of North Carolina at Chapel Hill, Chapel Hill, North Carolina. http://www.foundationwebsite.org/#PlanetaryManagement

Observation.  Earth is undergoing the sixth mass planetary species extinction (see Richard Leakey's and Roger Lewin's book, The Sixth Extinction).  Unlike earlier mass species extinctions, the current mass species extinction is being caused entirely by human activity.  The rate of planetary species extinction is directly proportional to the total amount of industrial production, which is directly proportional to the planetary human population times the average rate of production (or rate of consumption or standard of living) per person.  All nations strive to increase industrial production (or consumption or standard of living) for their people.  Many nations, such as the US, strive for increased population ("a large population is a king's glory").  Given the human propensity for industrial production (and, in general, "growth" in all things), the only way to reduce the rate of planetary species extinction is to reduce the global human population.  The only known level of global human population that lived in harmony (balance, slowly changing equilibrium) with the biosphere was a few million people.  Ergo: In order for the mass planetary species extinction to cease, it appears that the planetary human population must decline to a few million people.

Mission Statement.  At the end of the Petroleum Age, the human population of Earth will fall to a few million -- the number sustainable by the current flux of solar energy.  It appears quite possible that large-scale economic activity may soon destroy the ecological balance of the biosphere in which the human species evolved and on which it is dependent for its continued survival.  The Foundation website is committed to trying to avert this human-caused destruction of a human-friendly biosphere and the consequent extinction of mankind.  It is committed to the establishment of a long-term-sustainable "double nickel" human population consisting of five million spatially concentrated high-tech people and five million spatially dispersed hunter-gatherers.  The purpose of the high-tech population is to assure that the global population of Earth is limited to a total of ten million people (a level that is known to have lived in harmony with the biosphere for millions of years).  The purpose of the hunter-gatherer population is to assure that a local catastrophic event does not cause the extinction of mankind.

Donald Trump Has Raised the Likelihood of a Near-Term Global Nuclear War.  Donald Trump has called (22 December 2016) for an expansion of the US nuclear warfare capability.  The consensus appears to be that his comments have increased the likelihood of nuclear war, or made it likely that such a war will occur sooner.

I am an expert on global nuclear warfare and ballistic missile defense.  My book [Can America Survive?](http://www.foundationwebsite.org/canam4x.htm) describes several exemplar global-nuclear-warfare attacks.  If a global nuclear war were to occur, *the human-caused sixth mass species extinction would end.*  The US and China would likely not survive, but Russia might.  (Reasons why the US would likely not survive but Russia might are discussed in my book, [The Late Great United States](http://www.foundationwebsite.org/TheLateGreatUnitedStates.htm).)

Complex societies do not decline gracefully; they collapse catastrophically.  (See Joseph A. Tainter's book, The Collapse of Complex Societies.)  As long as the Petroleum Age continues, the human population decline can be held off, and there is no strong incentive for global nuclear war.  Global nuclear war will likely occur as the Petroleum Age ends and nations compete for shrinking energy resources.  Many people pray that global nuclear war does not occur.  It is very likely to occur.  The only real uncertainty is when.

Since an estimated thirty thousand species are made extinct each year because of human industrial activity, the sooner this activity ends, the sooner the Sixth Extinction will end, the more species will remain, and the higher the likelihood of long-term human survival.  Our present high-population civilization is crucially dependent on massive amounts of energy, and it will collapse as the energy runs out.  Recurrent solar energy and nuclear energy cannot replace the high levels of petroleum energy.  When petroleum reserves exhaust, human population will decline (whether a global nuclear war occurs or not).

With Respect to the Long-Term Survival of Mankind, *if* Global *Nuclear War Is to Occur, then Sooner Is Better than Later.  The longer the petroleum era lasts,* the greater the damage to the biosphere, and *the greater the chance of human extinction.*  The only thing that really matters in the long term is the ecological state of the planet when the global industrial era comes to an end, and the mass extinction ends.  As long as high human population levels continue, the mass species extinction continues.  From the viewpoint of long-term survival of mankind, if global nuclear warfare does occur, then sooner is definitely better than later.

#### **Growth causes a global toxification crisis - risks extinction**

**Ehrlichand Ehrlich 13** [Paul R. Ehrlich, Professor of Biology and President of the Center for Conservation Biology at Stanford University, and Adjunct Professor at the University of Technology, Sydney, Anne H. Ehrlich, Senior Research Scientist in Biology at Stanford and focuses her research on policy issues related to the environment, “Can a collapse of global civilization be avoided?”, Proc Biol Sci. Mar 7, 2013; 280(1754), \\wyo-bb]

Another possible threat to the continuation of civilization is global toxification. Adverse symptoms of exposure to synthetic chemicals are making some scientists increasingly nervous about effects on the human population [77–79]. Should a global threat materialize, however, no planned mitigating responses (analogous to the ecologically and politically risky ‘geoengineering’ projects often proposed to ameliorate climate disruption [80]) are waiting in the wings ready for deployment. Much the same can be said about aspects of the epidemiological environment and the prospect of epidemics being enhanced by rapid population growth in immune-weakened societies, increased contact with animal reservoirs, high-speed transport and the misuse of antibiotics [81]. Nobel laureate Joshua Lederberg had great concern for the epidemic problem, famously stating, ‘The survival of the human species is not a preordained evolutionary program’ [82, p. 40]. Some precautionary steps that should be considered include forbidding the use of antibiotics as growth stimulators for livestock, building emergency stocks of key vaccines and drugs (such as Tamiflu), improving disease surveillance, expanding mothballed emergency medical facilities, preparing institutions for imposing quarantines and, of course, moving as rapidly as possible to humanely reduce the human population size. It has become increasingly clear that security has many dimensions beyond military security [83,84] and that breaches of environmental security could risk the end of global civilization.

#### Nuclear war solves climate change – NASA models.

Charles Q. Choi 11, Science Journalist Citing NASA, in National Geographic [‘Small Nuclear War Could Reverse Global Warming for Years’, <http://news.nationalgeographic.com/news/2011/02/110223-nuclear-war-winter-global-warming-environment-science-climate-change/>, 11/19/16]//AR

Today, with the United States the only standing superpower, nuclear winter is little more than a nightmare. But nuclear war remains a very real threat—for instance, between developing-world nuclear powers, such as India and Pakistan. To see what climate effects such a regional nuclear conflict might have, scientists from NASA and other institutions modeled a war involving a hundred Hiroshima-level bombs, each packing the equivalent of 15,000 tons of TNT—just 0.03 percent of the world's current nuclear arsenal. (See a National Geographic magazine feature on weapons of mass destruction.) The researchers predicted the resulting fires would kick up roughly five million metric tons of black carbon into the upper part of the troposphere, the lowest layer of the Earth's atmosphere. In NASA climate models, this carbon then absorbed solar heat and, like a hot-air balloon, quickly lofted even higher, where the soot would take much longer to clear from the sky. (Related: "'Nuclear Archaeologists' Find World War II Plutonium.") Reversing Global Warming? The global cooling caused by these high carbon clouds wouldn't be as catastrophic as a superpower-versus-superpower nuclear winter, but "the effects would still be regarded as leading to unprecedented climate change," research physical scientist Luke Oman said during a press briefing Friday at a meeting of the American Association for the Advancement of Science in Washington, D.C. Earth is currently in a long-term warming trend. After a regional nuclear war, though, average global temperatures would drop by 2.25 degrees F (1.25 degrees C) for two to three years afterward, the models suggest. At the extreme, the tropics, Europe, Asia, and Alaska would cool by 5.4 to 7.2 degrees F (3 to 4 degrees C), according to the models. Parts of the Arctic and Antarctic would actually warm a bit, due to shifted wind and ocean-circulation patterns, the researchers said. After ten years, average global temperatures would still be 0.9 degree F (0.5 degree C) lower than before the nuclear war, the models predict

#### **No famine – mushrooms, chickens, cattle, rabbits, tropics, and fish**

**Denkenberger et al. 17** {International Journal of Disaster Risk Reduction, Global Catastrophic Risk Institute. 1-5-2017. “Feeding Everyone if the Sun is Obscured and Industry is Disabled [Shut Down].” https://www-sciencedirect-com.proxy.lib.umich.edu/science/article/pii/S2212420916305453}//JM

For combined sun blocking and industrial failure scenarios, the reduced output of conventional agriculture would present a threat of causing mass starvation. This study showed that one solution in the short term is extracting edible calories from killed leaves using distributed mechanical processes. Then a constrained food web could be formed where part of the remainder from this could be fed to chickens, and the rest coupled with leaf litter could have mushrooms grown on it. A second group of solutions is growing mushrooms on dead trees and the residue going to cellulose digesting animals such as cattle and rabbits. Typically, in these catastrophes the sun is not blocked completely, so some agriculture would be possible based off of existing farming in extreme environments (e.g. growing UV and cold tolerant crops in the tropics). Furthermore, the cooling climate would cool the upper layer of the ocean, causing upwelling of nutrient-rich deep ocean water. This would facilitate algae growth in the ocean, feeding fish; retrofitting of ships to be sail powered could enable significant fishing. The results of this study show these solutions could enable the feeding of everyone given minimal preparation, and this preparation should be a high priority now.

#### **Not extinction---bounces back, in the meantime wear glasses and sunscreen!**

**Martin 82** [Brian Martin (Professor of Social Sciences @ the University of Wollongong) December 1982 “The global health effects of nuclear war” Current Affairs Bulletin, Vol. 59, No. 7, pp. 14-26, online @ http://www.uow.edu.au/arts/sts/bmartin/pubs/82cab/index.html, loghry]

Another major threat to ozone comes from nuclear explosions. Nitric oxide is produced essentially by the 'burning' of nitrogen in the atmosphere, and this occurs whenever air temperatures are sufficiently hot: in automobile engines, in aircraft engines and in nuclear explosions. Studies of the creation of oxides of nitrogen by nuclear explosions were first undertaken as part of the SST debate, to determine whether the nuclear weapons tests in the 1950s and 1960s had reduced observed ozone levels.[28] It was only in 1974 that John Hampson made a point which had been overlooked, namely that large-scale nuclear war could cause a major and disastrous reduction in ozone levels.[29] Calculations made in the mid-1970s assuming large nuclear arsenals with many high-yield explosions concluded that reductions of ozone could reach 50 per cent or more in the northern hemisphere, with smaller reductions in the southern hemisphere.[30] But since the number of high-yield weapons in present nuclear arsenals is now smaller, much less oxides of nitrogen would be deposited in the stratosphere by nuclear war than assumed in earlier calculations, and so significant ozone reductions are unlikely.[31] This conclusion remains tentative. The actual behaviour of stratospheric ozone is quite complicated, involving many chemical compounds and numerous chemical reactions, the changing effects of temperature, the angle and intensity of sunlight, and the effect of air motions. Computer models of the effects of nuclear war on ozone are able to take into account only a part of this complexity, and new information about chemical reaction rates in particular have led in the past to periodic revisions in the calculated effects of added oxides of nitrogen. If significant ozone reduction did occur, the most important direct effect on humans would be an increase in skin cancer. However, this is seldom lethal, and could be avoided by reducing exposure to sunlight. Potentially more serious would be effects on crops.[32] Some of the important grains, for example, are sensitive to uv. Whether the net effects on crop yields would be significant is hard to estimate. But whatever the reduction in ozone, ozone levels would return pretty much to normal after a few years.[9] It seems unlikely that in the context of a major nuclear war the changes in uv alone would be of serious concern. In particular, the threat of human extinction raised by Jonathan Schell in The Fate of the Earth,[33] based mostly on effects of increased uv from ozone reduction, seems very small indeed. It is sometimes claimed that nuclear war could destroy ozone to such an extent that humans and animals would be blinded by excess uv. Even if large numbers of high-yield weapons were exploded, this possibility seems very unlikely except for a contribution to snow blindness in the far north. Stratospheric ozone can never be completely removed, but at most reduced greatly. Even if a 50 per cent or more reduction in ozone occurred - and as noted this seems improbable with present nuclear arsenals - protection from uv for humans could be obtained from sunglasses or just ordinary glasses, which absorb uv. For animals, the following considerations are relevant. Ozone levels vary considerably from place to place and from time to time, both seasonally and daily (sometimes by up to 50 per cent). Sunlight at the equator typically passes through only half as much ozone as at the mid-latitudes, yet animals at the equator are not known to go blind more often than elsewhere. Furthermore, most ozone reductions from a nuclear war would be in the mid and high latitudes, where ozone levels are higher to start with and where the 'path length' of sunlight through ozone is increased due to its oblique angle of incidence. But this does not mean complacency is warranted, as the concerns of John Hampson illustrate.

#### **The ozone layer doesn’t matter**

**Ridley 14**. DPhil from Oxford, Fellow of the Academy of Medical Sciences, The Times. September 15, 2014. “The ozone hole isn’t fixed. But that’s no worry”, http://www.thetimes.co.uk/tto/opinion/columnists/article4206440.ece

How much damage did the ozone hole ever threaten to do anyway? It is fascinating to go back and read what the usual hyperventilating eco-exaggerators said about ozone thinning in the 1980s. As a result of the extra ultraviolet light coming through the Antarctic ozone hole, southernmost parts of Patagonia and New Zealand see about 12 per cent more UV light than expected. This means that the weak September sunshine, though it feels much the same, has the power to cause sunburn more like that of latitudes a few hundred miles north. Hardly Armageddon. The New York Times reported “an increase in Twilight Zone-type reports of sheep and rabbits with cataracts” in southern Chile. Not to be outdone, Al Gore wrote that “hunters now report finding blind rabbits; fisherman catch blind salmon”. Zoologists briefly blamed the near extinction of many amphibian species on thin ozone. Melanoma in people was also said to be on the rise as a result. This was nonsense. Frogs were dying out because of a fungal disease spread from Africa — nothing to do with ozone. Rabbits and fish blinded by a little extra sunlight proved to be as mythical as unicorns. An eye disease in Chilean sheep was happening outside the ozone-depleted zone and was caused by an infection called pinkeye — nothing to do with UV light. And melanoma incidence in people actually levelled out during the period when the ozone got thinner. Then remember that the ozone hole appears when the sky is dark all day, and over an uninhabited continent. Even if it persists into the Antarctic spring and spills north briefly, the hole allows 50 times less ultraviolet light through than would hit your skin at the equator at sea level (let alone at a high altitude) in the tropics. So it would be bonkers to worry about UV as you sailed round Cape Horn in spring, say, but not when you stopped at the Galapagos: the skin cancer risk is 50 times higher in the latter place.