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#### The collective effervescence the aff talks about is good!

#### CP: The appropriation of outer space by private entities through bounded first possession by landfall is just.

#### CP is the best system to develop Mars – common ownership chills first movers and is less efficient.

Collins 08 (Lecturer, The City Law School, City University, London, UK. B.A.Hon., J.D.(Toronto), M.Sc., B.C.L. (Oxford)), "EFFICIENT ALLOCATION OF REAL PROPERTY RIGHTS ON THE PLANET MARS" B.U. J. SCI. & TECH. L. [Vol.14:201, NCS, DOA 2/5/22, https://www.bu.edu/jostl/files/2015/02/Collins\_142.pdf

As an alternative to fixing future claims on Mars based upon a re-allocation of pre-existing ones, the most efficient mechanism of real property allocation of an un-owned res nullius planet Mars would be a limited form of first possession: the allotment of only a portion of land to the first arriving organization, not the entire surface of the planet. The size of the allocation would be set at the optimal level to encourage exploration and development while conserving land for future explorers. The first landers could claim all terrain, for example, within a hundred kilometer radius of their landing point subject to an increase if productive use is made of an even larger portion. The rest of the planet would remain un-owned and available to become possessed by subsequent explorers. This bounded first possession is in keeping with the language of the Outer Space Treaty and Moon Treaties that prohibit only sovereign claims to the celestial body, which could be interpreted to mean the planetary sphere itself. Such a credible interpretation reads in the word “entire” to the following provision for the purpose of clarity: “neither the entire surface or entire subsurface of the Moon [or Mars] shall become the property of any State”.”74 Partial allocation as described is just because landing on one minuscule portion of a world should not entitle a claimant to ownership of all of it, much of which may be left completely idle by the original explorer, resulting in an inefficient use of the planet’s resources. The problem of inefficient races to achieve the legal right to first possession will be avoided by this regime, as second and third place finishers will be rewarded with other plots of land on the surface. Consequently pre-mature and therefore non-productive missions will be avoided because there is no risk of exclusion for failing to land first; the marginal benefit of arriving second will be as high as the marginal benefit of arriving first. Of course, the pride engendered by first arrival, such as that generated by the first Moon landing, would help to encourage earlier Mars expeditions rather than later ones. Incentive to settle on Mars before others may similarly result from the fact that some regions of the planet could be more valuable than others. For example, just as the flat, northern hemisphere would may be more conducive for agriculture than the rugged southern hemisphere, the equatorial zone would probably hold greater value because of their warmer climates.75 Part of the concern of developing nations in espousing the Common Heritage principle for planetary bodies was that the planet’s resources would already be depleted by the time nations with weaker initial resource endowments (the developing world) are capable of exploiting the land on Mars.76 Plot ownership would address this concern since vast regions of Mars would likely remain un-owned for centuries, giving developing nations a chance to “catch up”. Private easements and restrictive covenants arrived at by bargaining among the landed owners (rather than through international political consensus) and enforced through private litigation would control competing land uses such as over exploitation or pollution in order to produce an efficient allocation of resources. At least in the early stages of colonization there would be no need to incur the cost of a special “Mars Court” to adjudicate such disputes. Instead, landowners could litigate in the courts of their choice on Earth, subject to that court’s own rules on taking jurisdiction. For example, an American corporation owning land on Mars could bring suit in nuisance against another American landowner in the Federal court of the United States.77 Disputes between sovereign landowners on Mars could similarly be brought in the International Court of Justice.78 Again, it is expected that such private land use adjudication among fewer parties should be less costly than public control of commonly held land through regulation.79 Moreover, bargaining among a limited number of initial owners should arrive at the most efficient manner of land use without the need to resort to lawsuits. Excessive land use regulation resulting from the need to satisfy all decision-makers could diminish the overall productivity of the land, especially if such regulations were imposed ex post after valuable resources had already been wasted. It is further expected that landowners on Mars would adopt the self-imposed obligation to engage in reasonable and productive use of that land in order to maximize the value of their own holdings. Such “injunctions against waste”80 would become more significant in later stages of settlement when vacant land on Mars had become scarcer. Accordingly, if a plot is not being used efficiently, for example, by an owner that held expertise in space travel but not in colonization, then title in the land could be transferred on the authority of a court, perhaps through the Common Law doctrine of adverse possession,81 to another party that had these skills and intentions. Should a terraforming project be undertaken – transforming the whole of Mars into an environment that could sustain life - landowners would have an incentive to “free ride” by not contributing resources to such an inherently communal project, allowing them to benefit from the labors of others without cost. Perhaps a mandatory fee could be imposed upon all residents by a court in order to address this problem – although it is unclear what legal precedent could be invoked to do so - in advance of the establishment of zoning or centralized governance on the planet.82 Market forces should provide, however, that a party not adding value to its land through development would have an incentive to sell or lease it to a party that would make a more productive use of it. Thus, the first explorers might wish simply to sell their claims as suggested above. To facilitate such bargaining among landowners, the establishment of a land registry system, which would set standardized plot dimensions and record transactions and would represent one of the few costs associated with private ownership of land on Mars, would be necessary.83 The recognition of bounded land claims on a planet appears already to be envisioned by the text of the Moon Treaty which as noted above, permits individual states to retain jurisdiction and control over their personal property, such as bases and equipment, that is brought to the moon.84 However, as noted above, the rights in such chattels are not equivalent to the full property rights exercised by terrestrial landowners since there is no exclusivity – treaty requires parties to allow others to use these equipment and facilities when requested.85 On one hand such compulsory property sharing is economically efficient because it would encourage further development by minimizing one of the costliest aspects of settlement. A subsequent arrival could benefit from existing infrastructure devoting resources to the more productive development of the region without redundant expenditure that would impede overall progress. However, the common property regime envisioned by the space treaties ignores the reality that without adequate compensation for such sharing there might be an incentive to free-ride by waiting for another explorer to incur the initial costs of establishing a Mars base with oxygen/fuel production facilities. It would therefore be more cost effective to be the second or third Mars colonizer, potentially inducing a strategic waiting game. To resolve this problem it should be permissible to charge a fee for the use of one’s facilities because such fees represent the fundamental economic gain of granting property rights in land on Mars. Developed land, such as land with a base upon it that could sustain human life, becomes valuable to subsequent visitors, and this can generate revenue that will offset the initial costs. Bargaining would naturally set the use fee at an optimal level that encouraged subsequent parties to land and make use of existing facilities and would not be too low to deter the initial landing and construction. Thus, the direction to share resources in the Moon Treaty might be unnecessary – sharing might increase wealth for all parties, much as land values increase in proportion to the rise in population of an area. Given that large scale inhabitation of Mars might only result from a catastrophe on Earth, there may be some need to incorporate the common law defense of necessity for emergency trespass, although this defense would not preclude the payment of reasonable compensation for use or damage to existing infrastructure.86

#### Colonization of Mars is feasible but requires investment incentive now. Ozone launch impacts happen after Mars colonization if there’s private appropriation.

Martin & Saydam 21

(BA Journalism University of Central Lancashire, Media & Content Coordinator for The University of New South Wales Serkan Saydam received his BSc, MSc and PhD degrees in Mining Engineering from the Dokuz Eylul University, Izmir, Turkey and completed his Postdoctoral Fellowship at the University of Witwatersrand, Johannesburg, South Africa. He then worked at De Beers for 3 years as project manager in Johannesburg, South Africa. Serkan joined the School of Mining Engineering as a Senior Lecturer in 2006 and was promoted to Associate Professor in 2012. Serkan then was then promoted to the Professorial role in 2017 and he is currently working as a Professor and Director of Research at the School of Minerals and Energy Resources Engineering at UNSW. A key focus of his research is to address the current needs and future challenges faced by the mining industry. These are generally very complex engineering problems, as mining environments become more extreme and constraints are imposed due to increasing social, environmental, and health and safety standards. His fields of research include ground control, mine planning & design, technology integration, new mining methods and off-Earth mining. In addition, he established research collaboration with NASA's Jet Propulsion Laboratory & Kennedy Space Center, and Luxembourg Space Agency as well more than 20 research organisations and universities globally. He has more than 250 publications and graduated 18 PhD students. Serkan is currently Fellow Member of Australian Institution of Mining and Metallurgy; President of the ISRM Commission on Planetary Rock Mechanics; Deputy Director of the Australian Centre for Space Engineering Research (ACSER) at UNSW; Deputy Secretary General and Council Member of the SOMP (The Society of Mining Professors). <https://newsroom.unsw.edu.au/news/science-tech/mars-settlement-likely-2050-says-unsw-expert-%E2%80%93-not-levels-predicted-elon-musk>, USNW Sydney Newsroom, 3/10/21, NCS, <https://newsroom.unsw.edu.au/news/science-tech/mars-settlement-likely-2050-says-unsw-expert-%E2%80%93-not-levels-predicted-elon-musk> brackets for spelling mistake

Robotic mining that can provide water and fuel is the key to developing a colony on the red planet within the next 30 years. Mars will be colonised by humans by the year 2050, as long as autonomous mining processes quickly become more commercially viable. That’s the view of Professor Serkan Saydam from UNSW Sydney in the wake of the amazing landing on Mars by NASA’s Perseverance rover. Perseverance is expected to provide answers about whether forms of life ever existed on the red planet, but it is also designed to help address the challenges of future human expeditions there. Professor Saydam, from the School of Mineral Energy Resources Engineering, says the main focus in terms of creating a colony on Mars is finding water – and being able to extract it and process it using robots before humans land. “Everything is all about water,“ Prof. Saydam says. “You use water as a life support, plus also being able to separate out the hydrogen to use as an energy source. “The process for having humans on Mars will be to set up operations, go there and produce water with robots first, and then be able to extract the hydrogen to make the energy ready before people arrive. “Innovation in robotics and autonomous systems are clearly important so that we have the water ready and the hydrogen separated and ready for when human beings land. “At the moment, we don’t have ability to do it. There are significant research efforts, specifically here at UNSW under ACSER (Australian Centre for Space Engineering Research), about the best way to do it, but there is no consensus yet. It also depends on how many people we expect to be living on Mars. Is it five, or 5000, or 50,000, or even more?“ Entrepreneur Elon Musk has claimed he’s confident there will be a city of 1 million on Mars by 2050, transported there by 1000 Starships proposed by his SpaceX venture, with plans for up to three rocket launches per day. Prof. Saydam says that may be unrealistic in the specific timeframe, but admits that demand for travel and a potential colonisation of Mars is what’s needed to drive the technological developments required. “I think the technology is ready and we already have the knowledge, but the main problem is having the focus,“ says Prof. Saydam, who is organising an International Future Mining Conference in December 2021 that will feature former NASA astronaut Pamela Melroy and Honeybee Robotics vice-president Kris Zacny. “It’s a bigger question: ‘Why don’t we do that already on earth? Why are we still using human beings for physical work in mining here?’ We have huge experience in mining, but still heavily depend on humans. “One issue is that demand is not there. For companies to get involved in developing products (for Mars missions), they need to be able to produce minerals or something that can be used for manufacturing goods and then sell it. “At the moment, everything is just a cost and there is no revenue for companies.“ However, that could be starting to change. United Launch Alliance, a joint venture between Lockheed Martin and Boeing who are heavily invested in the rockets used to launch spaceships, has publicly announced they will pay $500 per kilogram for fuel – derived from water – supplied on the moon. That rises to $3000 per kilogram if the fuel is available in a low-earth orbit. “That immediately creates a market,“ Prof. Saydam says. “Plus, if Elon Musk does what he says and puts people on the surface of Mars in 20 years, then that also creates a market. “I believe a colony on Mars is going to happen, but between 2040 and 2050 is more feasible. This could be shortened depending on the technological advances that can reduce the costs or [form] from stronger motivation. “What I think will happen is that first of all we will do these activities on the moon and have a colony there. Then we can use the moon as a petrol station to get to Mars and beyond. “But before 2050, I think we will have settlements on both the moon and Mars.“

#### Life on earth is doomed – countless eventualities and unforeseen dangers.

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(Robinson Meyer is a staff writer at The Atlantic. He is the author of the newsletter The Weekly Planet, and a co-founder of the COVID Tracking Project at The Atlantic.), "Human Extinction Isn't That Unlikely", The Atlantic, 4/29/16, NCS, https://www.theatlantic.com/technology/archive/2016/04/a-human-extinction-isnt-that-unlikely/480444/

Nuclear war. Climate change. Pandemics that kill tens of millions. These are the most viable threats to globally organized civilization. They’re the stuff of nightmares and blockbusters—but unlike sea monsters or zombie viruses, they’re real, part of the calculus that political leaders consider everyday. A new report from the U.K.-based Global Challenges Foundation urges us to take them seriously. The nonprofit began its annual report on “global catastrophic risk” with a startling provocation: If figures often used to compute human extinction risk are correct, the average American is more than five times likelier to die during a human-extinction event than in a car crash. Partly that’s because the average person will probably not die in an automobile accident. Every year, one in 9,395 people die in a crash; that translates to about a 0.01 percent chance per year. But that chance compounds over the course of a lifetime. At life-long scales, one in 120 Americans die in an accident. Yet the risk of human extinction due to climate change—or an accidental nuclear war, or a meteor—could be much higher than that. The Stern Review, the U.K. government’s premier report on the economics of climate change, assumed a 0.1-percent risk of human extinction every year. That may sound low, but it adds up when extrapolated to century-scale. Across 100 years, that figure would entail a 9.5 percent chance of human extinction. And that number might even underestimate the risk. Another Oxford survey of experts from 2008 posited the annual extinction risk to be a higher figure, 0.2 percent. And the chance of dying from any major global calamity is also likely higher. The Stern Review, which supplies the 9.5-percent number, only assumed the danger of species-wide extinction. The Global Challenges Foundation’s report is concerned with all events that would wipe out more than 10 percent of Earth’s human population. “We don’t expect any of the events that we describe to happen in any 10-year period. They might—but, on balance, they probably won’t,” Sebastian Farquhar, the director of the Global Priorities Project, told me. “But there’s lots of events that we think are unlikely that we still prepare for.” For instance, most people demand working airbags in their cars and they strap in their seat-belts whenever they go for a drive, he said. We may know that the risk of an accident on any individual car ride is low, but we still believe that it makes sense to reduce possible harm. So what kind of human-level extinction events are these? The report holds catastrophic climate change and nuclear war far above the rest, and for good reason. On the latter front, it cites multiple occasions when the world stood on the brink of atomic annihilation. While most of these occurred during the Cold War, another took place during the 1990s, the most peaceful decade in recent memory: In 1995, Russian systems mistook a Norwegian weather rocket for a potential nuclear attack. Russian President Boris Yeltsin retrieved launch codes and had the nuclear suitcase open in front of him. Thankfully, Russian leaders decided the incident was a false alarm. Climate change also poses its own risks. As I’ve written about before, serious veterans of climate science now suggest that global warming will spawn continent-sized superstorms by the end of the century. Farquhar said that even more conservative estimates can be alarming: UN-approved climate models estimate that the risk of six to ten degrees Celsius of warming exceeds 3 percent, even if the world tamps down carbon emissions at a fast pace. “On a more plausible emissions scenario, we’re looking at a 10-percent risk,” Farquhar said. Few climate adaption scenarios account for swings in global temperature this enormous. Other risks won’t stem from technological hubris. Any year, there’s always some chance of a super-volcano erupting or an asteroid careening into the planet. Both would of course devastate the areas around ground zero—but they would also kick up dust into the atmosphere, blocking sunlight and sending global temperatures plunging. (Most climate scientists agree that the same phenomenon would follow any major nuclear exchange.) Yet natural pandemics may pose the most serious risks of all. In fact, in the past two millennia, the only two events that experts can certify as global catastrophes of this scale were plagues. The Black Death of the 1340s felled more than 10 percent of the world population. Eight centuries prior, another epidemic of the Yersinia pestis bacterium—the “Great Plague of Justinian” in 541 and 542—killed between 25 and 33 million people, or between 13 and 17 percent of the global population at that time. No event approached these totals in the 20th century. The twin wars did not come close: About 1 percent of the global population perished in the Great War, about 3 percent in World War II. Only the Spanish flu epidemic of the late 1910s, which killed between 2.5 and 5 percent of the world’s people, approached the medieval plagues. Farquhar said there’s some evidence that the First World War and Spanish influenza were the same catastrophic global event—but even then, the death toll only came to about 6 percent of humanity. The report briefly explores other possible risks: a genetically engineered pandemic, geo-engineering gone awry, an all-seeing artificial intelligence. Unlike nuclear war or global warming, though, the report clarifies that these remain mostly notional threats, even as it cautions: [N]early all of the most threatening global catastrophic risks were unforeseeable a few decades before they became apparent. Forty years before the discovery of the nuclear bomb, few could have predicted that nuclear weapons would come to be one of the leading global catastrophic risks. Immediately after the Second World War, few could have known that catastrophic climate change, biotechnology, and artificial intelligence would come to pose such a significant threat.

#### Climate change is past the point of no return – even if we reduce to 0 emissions tomorrow the planet is still cooked.

Randers & Goluke 21

(Jørgen Randers (born 22 May 1945) is a Norwegian academic, professor emeritus of climate strategy at the BI Norwegian Business School,[1] and practitioner in the field of future studies.[2] His professional field encompasses model-based futures studies, scenario analysis, system dynamics, sustainability, climate, energy and ecological economics. He is also a full member of the Club of Rome, a company director, member of various not-for-profit boards, business consultant on global sustainability matters and author. His publications include the seminal work The Limits to Growth (co-author),[1] and Reinventing Prosperity. Associate Professor Ulrich Golüke has spent his professional life in business, academia, NGOs and as a freelancer. He is a system dynamicist by training and has worked for over thirty years with systems modelling (in shipping, health care, real estate, economics and climate change). He has taught system dynamics courses and supervised MSc students. He also used scenarios for strategy development, starting in the 1990ties with the World Business Council for Sustainable Development as the Director of the Scenario Unit and since 2000 as free-lancer. Clients have included Fortune 100 companies, universities, and foundations.) An earth system model shows self-sustained thawing of permafrost even if all man-made GHG emissions stop in 2020. Sci Rep 10, 18456 (2020). NCS <https://doi.org/10.1038/s41598-020-75481-z> An Author Correction to this article was published on 02 February 2021

An earth system model shows self-sustained thawing of permafrost even if all man-made GHG emissions stop in 2020 Abstract The risk of points-of-no-return, which, once surpassed lock the world into new dynamics, have been discussed for decades. Recently, there have been warnings that some of these tipping points are coming closer and are too dangerous to be disregarded. In this paper we report that in the ESCIMO climate model the world is already past a point-of-no-return for global warming. In ESCIMO we observe self-sustained thawing of the permafrost for hundreds of years, even if global society stops all emissions of man-made GHGs immediately. We encourage other model builders to explore our discovery in their (bigger) models, and report on their findings. The thawing (in ESCIMO) is the result of a continuing self-sustained rise in the global temperature. This warming is the combined effect of three physical processes: (1) declining surface albedo (driven by melting of the Arctic ice cover), (2) increasing amounts of water vapour in the atmosphere (driven by higher temperatures), and (3) changes in the concentrations of the GHG in the atmosphere (driven by the absorption of CO2 in biomass and oceans, and emission of carbon (CH4 and CO2) from thawing permafrost). This self-sustained, in the sense of no further GHG emissions, thawing process (in ESCIMO) is a causally determined, physical process that evolves over time. It starts with the man-made warming up to the 1950s, leading to a rise in the amount of water vapour in the atmosphere—further lifting the temperature, causing increasing release of carbon from thawing permafrost, and simultaneously a decline in the surface albedo as the ice and snow covers melts. To stop the self-sustained warming in ESCIMO, enormous amounts of CO2 have to be extracted from the atmosphere. Introduction The possibility of points-of-no-return in the climate system has been discussed for two decades1,2,3. A point-of-no-return can be seen as a threshold which, once surpassed, fundamentally changes the dynamics of the climate system. For example, by triggering irreversible processes like thawing of the permafrost, drying of the rainforests, or acidification of surface waters. Recently, Lenton et al.4 summarized the global situation and warned that thresholds may be closer in time than commonly believed. The purpose of this article is to report that we have identified a point-of-no-return in our climate model ESCIMO—and that it is already behind us. ESCIMO is a “reduced complexity earth system” climate model5 which we run from 1850 to 2500. In ESCIMO the global temperature keeps rising to 2500 and beyond, irrespective of how fast humanity cuts the emissions of man-made greenhouse gas (GHG) emissions. The reason is a cycle of self-sustained thawing of the permafrost (caused by methane release), lower surface albedo (caused by melting ice and snow) and higher atmospheric humidity (caused by higher temperatures). This cycle appears to be triggered by global warming of a mere + 0.5 °C above the pre-industrial level. Method We used ESCIMO to simulate the development of the global climate system from 1850 to 2500 under different assumptions concerning the emission of man-made GHGes. ESCIMO is a system dynamics model that includes representations of the world’s atmosphere, oceans, forests (and other land types), biomass—and their interactions. It is described here5. The source code with documentation is available online6. In the first simulation reported here, “Scenario 1”, we assume that humanity reduces man-made GHG emissions to zero by 2100. In the second simulation, “Scenario 2”, we assume that emissions are cut much faster—to zero in 2020. In both cases man-made emissions remain zero thereafter. Results The result is shown in Fig. 1. In both scenarios the global temperature keeps rising for hundreds of years—to around + 3 °C in 2500—after a temporary decline in this century in conjunction with the decline in man-made emissions (Fig. 1c). The sea level rises monotonically to around + 3 m in 2500 (Fig. 1e). Figure 1 figure1 Man-made greenhouse gas (GHG) emissions (a), the global average surface temperature (c), sea level rise (e), and cumulative release of carbon from permafrost (g) in two scenarios from 1900 to 2500, generated by ESCIMO. Also shown are the concentration in the atmosphere of CO2 (b), CH4 (d), H2O (f), and surface albedo (h). Solid black curves show Scenario 1 where man-made GHG emissions are phased out by 2100. Black dotted curves show Scenario 2 where man-made GHG emissions are cut to zero in 2020. In both cases the global temperature keeps rising for hundreds of years after all man-made emissions have ceased. Full size image Scenario 1 Scenario 1 describes the result when we assume that man-made emissions peak in the 2030s and decline to zero in 2100 (see Fig. 1, solid lines). This is the “most likely” scenario as described here7. The historical part of the simulation (1850–2015) and the ensuing 60 years (2015–2075) are intuitive and understandable. Rising emissions of man-made GHGes lead to an increase in the concentration of GHGes in the atmosphere (Fig. 1b,d). This, in turn, leads to a rise in the global average surface temperature because GHG molecules block outgoing long-wave (heat) radiation from the surface. The warming is enhanced by the increased amount of water vapour which accumulates in a warmer atmosphere because H2O is a strong greenhouse gas which blocks other frequencies (Fig. 1f). The warming leads to rising sea levels because of thermal expansion and glacier run-off. Difficult to detect, but of great significance for the years beyond 2150, surface albedo starts a slow and smooth decline as the ice and snow cover melts, making the planet darker and leading to more absorption of short-wave (SW) radiation in the surface (Fig. 1h). In Scenario 1 the temperature passes a temporary peak around 2075 at + 2.3 °C above pre-industrial times. The temperature then falls for 75 years (2075–2150) to + 2 °C. There are two reasons: (a) the concentration of GHGs in the atmosphere declines, and (b) heat is used to melt on-land glaciers and Arctic ice. Furthermore, the concentration of CO2 declines (from its all-time peak of 450 ppm in 2050) through two processes: (a) CO2 is gradually absorbed in the ocean surface (and later transported into the deep ocean), and (b) CO2 is gradually absorbed in the biosphere. CO2 in the atmosphere is converted through photosynthesis into biomass in living matter and soils at a rate that is determined by the temperature and the amount of CO2 in the atmosphere. By 2150 all on-land snow and ice are gone in ESCIMO Scenario 1 (except in Greenland and Antarctica, which require thousands of years to melt). While the developments to 2150 are understandable, developments in ESCIMO beyond 2150 are more surprising (counter-intuitive). As shown in Fig. 1 the temperature once more starts rising. The surprising fact is that this rise takes place 50 years after man-made emissions have ceased, and after the concentration of CO2 in the atmosphere has been significantly reduced through absorption in oceans and biomass. The explanation (in ESCIMO) is as follows. While GHG concentrations—and thus their forcings—fall from 2070 to 2150, the effect of surface albedo continues on its smooth upward path throughout this period. Its time development is much slower than that of GHGes. It is the result of mainly Arctic ice melting—but it has enough ‘momentum’ to push the climate system back onto a path of rising temperatures, with its secondary effects of raising humidity and permafrost thawing, which then in turn help the system become warmer and warmer, even if man-made GHG emissions are zero. A cycle of self-reinforcing processes is established. See Fig. 2a. Figure 2 figure2 (a) The contribution to global warming (“energy radiation trapping”) from water vapour, CO2, CH4, other GHGes, and surface albedo in Scenario 1. After 2150 the main drivers are water vapour and CO2, with albedo in the third place. The contribution of CH4 is much smaller, while the other Montreal and Kyoto gases remain the fourth most important driver of the self-sustained warming and thawing of the permafrost. (b) The relative importance of water vapour in global warming in Scenario 1. After 2150 water vapor has approximately the same effect as the sum of all the other GHGes. Historically, from 1850 to 2000, the ratios in the ESCIMO base run fall well within the uncertainty band reported by Cess, Rind, Hansen and Ramanathan and Inamdar cited earlier. Full size image This cycle consists of decreasing surface albedo, increasing water vapour feedback and increasing thawing of the permafrost, releasing carbon (both as CH4 and CO2), resulting in even further temperature rises, and so on. In a highly coupled feedback model like ESCIMO it is the chain of events, closing in on itself, that matters. Even after no more man-made GHG are emitted, this cycle/chain continues on its own. The process is self-sustaining, at least until all carbon is released from permafrost and all ice is melted. Scenario 2 Scenario 2 (see Fig. 1, dotted curves) was made to check whether humanity could avoid continuing warming from the self-sustained chain of circumstances of decreasing ocean albedo, increasing water vapour feedback and increasing thawing of the permafrost by cutting man-made GHG emissions earlier than in Scenario 1. The answer is no. Figure 1 (dotted curves) shows that even if all man-made GHG emissions were (unrealistically) cut to zero in 2020, the temperature starts rising again after 2150—as a result of the cycle of self-sustaining processes of decreasing albedo, thawing of the permafrost and increasing water vapour feedback. Discussion Unexpected result The unexpected result in Scenarios 1 and 2 is that the global temperature keeps rising for centuries after man-made GHG emissions of are brought to zero. Even more surprising, at first glance, is the fact that the temperature keeps rising after the concentration of CO2 in the atmosphere has declined back to the pre-industrial level through absorption in the deep ocean, biomass and soil. In both cases the explanation (in ESCIMO) rests in the joint action of albedo, carbon (both as CH4 and CO2) from thawing permafrost, and water vapour in warm air—which together ensure that the temperature stays high even when the concentration of CO2 declines. Some additional comments help explain: The planet gets darker: the role of albedo As temperature rises, ice and snow are melted, making the planet darker. Between 2070 and 2300, for example, the average ocean albedo (in ESCIMO) declines from 0.080 to 0.067, and the surface albedo from 0.127 to 0.117, see Supplement Figure 15. As a result, more short-wave radiation is absorbed. In ESCIMO about 1.7 Wm−2—which is enough to trigger and drive significant change in the delicately balanced, global climate system. Water vapour feedback Water vapour exists in the atmosphere because of the balance between evaporation, which increases with temperature, and precipitation from the atmosphere, which also increases with temperature. H2O is not held in the atmosphere because of CO2, or any other GHG. This means that water vapour, and its warming effect, will not disappear when the CO2 concentration declines back to pre-industrial levels—as long as the temperature stays high enough. Comparing the effect of GHGs, albedo and water vapour on the energy balance of earth The relative importance of albedo, water vapour, and release of carbon from permafrost over time can be illustrated in terms of the “radiative forcing” each contributes. There are two ways to estimate radiative forcings, one, using the IPCC8 formulas for GHGs, and two, deducing the radiative forcing from changes in the long-wave radiation back to space (LW-ToA). The first works well, at least historically, for CO2, CH4, N2O and the other greenhouse gases (We show the result of calculating GHG radiative forcing in ESCIMO using the IPCC formulas in Supplement Figure 16), but not for climate feedbacks like water vapour and albedo. For water vapour, “radiative forcing” is generally not used (IPCC8, pg. 666), because it modifies the forcing of other forcing agents (Ramanathan and Inamdar9, pg. 121). Instead, using the effectiveness in absorbing thermal radiation of GHGs, including H2O and albedo, is an acceptable proxy for estimating their “radiative forcing”. This approach was used by Hansen et al.10, Rind11 and Ramanathan and Inamdar9, who built on the conceptual work of Cess12. Figure 2a compares the “radiative forcings”, defined as Ga, i.e. the difference between LWToA clear sky radiation and LW cloudy ToA radiation, normalized to 1850 (for detail, see Rind11, pg. 260) of CO2, CH4, other GHGes, water vapour and surface albedo. “The observed value of Ga = 146 Wm−2 K−1; clouds increase the value by about 33 Wm−2 K−1 (Raval and Ramanathan13).” The values for ESCIMO in 1995 are Ga = 148 Wm−2 K−1; clouds increase the value by about 30 Wm−2 K−1. Surface albedo affects the SW radiation balance at the surface. Thus, to estimate the “radiative forcing” of surface albedo, we follow a similar logic as for water vapour: we compare the SW reflection of the surface at timet to the SW reflection of the surface at time1850. The surface albedos are shown in Supplement Figure 15. Land albedo in ESCIMO rises ever so slightly in historical times, recreating the negative LUC “forcing” reported by IPCC. The ocean albedo in ESCIMO drops, because of the melting of the arctic ice. The declining albedo leads to an increase in the amount of short-wave radiation absorbed in the surface. The “radiative forcing of delta albedo” in the ESCIMO base run is shown in Fig. 2a dotted curve. Numerically, it rises from 0.8 Wm−2 in 2070 to 2.6 Wm−2 in 2300 in the ESCIMO base run, an increase of 1.7 Wm−2. Thus, the drop in albedo is the trigger of the resumed self-sustained thawing of the permafrost after 2150, aided in the real world, and in ESCIMO, by water vapour and the consequent continued release of carbon from the thawing permafrost. Match with other models We have compared ESCIMO with other models, with particular focus on the assumptions that are driving the self-sustained thawing of the permafrost. In ESCIMO we assume that the permafrost melts as a consequence of the transfer of heat from the atmosphere to the frozen soil. We assume that the rate of heat transfer is proportional to the temperature difference between air and frozen soil. Furthermore, we assume that the resulting tundra, after some delay, will start absorbing CO2 through photosynthesis once plants start establishing themselves on the formerly frozen ground. The absorption rate depends on the temperature and the concentration of CO2 in the atmosphere (CO2 stimulates plant growth). Needless to say, the causal mechanisms included in ESCIMO are very aggregate and far from a detailed description of the complex thawing process in the real permafrost. In order to check whether our assumptions lead to reasonable results, we compared the output from ESCIMO with the output from other models, as reported in McGuire et al.14. The comparison is halting, since the temperature path in Scenario 1 differs from the path in the RCP4.5 scenario, which the other models use. We found that ESCIMO Scenario 1 generates a thawing of 2 million km2 of permafrost by 2300, compared to 3–5 in other models. And that ESCIMO Scenario 1 releases an accumulated 175 billion tons of carbon (GtC), all from thawing permafrost, by 2300, compared to plus 66–minus 70 in other models. Sadly, ESCIMO is not sufficiently regionalized to generate numbers for the amount of carbon which is absorbed in the vegetation that forms on the formerly frozen ground (which is 8–244 GtC in other models). ESCIMO only gives numbers for the extra carbon absorbed in all tundra, which, in ESCIMO, does not overlap one-to-one with formerly frozen ground, both old and new, which is 200 GtC. The uptake is due to accelerated humus formation fuelled by increased carbon uptake in the biomass of tundra during the period of high CO2 concentration. The comparison with other models seems to indicate that ESCIMO in Scenario 1 releases more carbon than other models, but it needs further investigation to decide whether this is because the RCP4.5 scenario differs from Scenario 1 in the centuries beyond 2100. Sensitivity analysis We did a conventional sensitivity analysis to verify that the self-sustained thawing of the permafrost is a robust phenomenon in ESCIMO—in other words, we checked that the continuing rise in the global average temperature does not depend on a very specific choice of the parameter values that determine the strength of the various processes in the model system. There are many (ca 100) such parameters in ESCIMO. They all have independent physical meaning, and each got a numerical value based on information from the literature. To do the sensitivity analysis, we first randomly picked 14 uncertain parameters from the model. Next, we independently sampled all 14 parameters from random uniform distributions with ranges of plus minus 10% around their standard value for 200 sensitivity runs. Figure 3 shows the result, for Scenarios 1 (a) and 2 (b). The grey band includes 75% of the 200 runs, for the central variable in ESCIMO, namely the temperature increase relative to 1850. Figure 3 figure3 Sensitivity of the global average temperature to variation in parameter values in ESCIMO, for Scenarios 1 and 2. Sensitivity analysis of 14 randomly chosen uncertain parameters from the model. Sampled independently using Latin-Hypercube sampling from random uniform distributions with ranges of plus minus 10% around their standard value for 200 sensitivity runs. For the parameters see Supplement Table 1. Graph to the left shows Scenario 1 where man-made GHG emissions are phased out by 2100. Graph to the right shows Scenario 2 where man-made GHG emissions are cut to zero in 2020. Parameter variation does change absolute values but does not eliminate the broad pattern of self-sustained thawing of the permafrost. The thick curve in the centre of the shaded area is the mean of the 200 runs. The shaded area covers 75% of all runs. Full size image Our conclusion is that parameter variation has a strong effect on the absolute level of the future temperature in ESCIMO. But much more important, Fig. 3 shows that moderate variation in parameter values does not remove the self-sustained thawing of the permafrost. The impact of the sensitivity experiment on five additional variables is shown in Supplement Figures 1 and 2. This broad pattern of development (in system dynamics language: this behaviour mode) remains the same. This is consistent with the system dynamics literature, which argues that it is normally not possible to predict future events in complex systems, while it is possible to say something meaningful about future dynamics (future behaviour modes). It is, of course, simple to come up with parameter changes that remove the self-sustained thawing of the permafrost—especially if those changes are made in what we already know are the most sensitive parts of ESCIMO, namely the equations that describe water vapour, albedo and clouds. But much more important, it is not simple to find parameter combinations that do so, while still being able to recreate the observed history from 1850 to 2015, as the standard parameter set in ESCIMO does. We also did some further sensitivity analyses with parameters of special relevance for the study of permafrost thawing, as described below. Further experiments to explore what it takes to stop the self-sustained thawing of the permafrost We did further experiments with parameter variation, in order to study the robustness of the self-sustained thawing of the permafrost. We chose to vary three parameters that have significant influence on the self-sustained thawing process in ESCIMO. In Fig. 4 we show the effect of varying these three parameters. Our conclusion is that the effect on absolute rate of permafrost thawing is significant, but that the pattern of self-sustained warming persists. Figure 4 figure4 Sensitivity of the global average temperature to changes in three parameters that are central in permafrost thawing. (1) The fraction of carbon that is converted (by bacteria) from CH4 to CO2 before it leaves the thawing permafrost. (a,b) The shaded area includes 75% of the resulting runs. (2) The slope of the rate of thawing of the permafrost that results from a given temperature. (c,d) The shaded area includes 75% of the resulting runs. (3) The slope of the future relationship between additional blocking of outgoing radiation and additional water vapour in the atmosphere—for values of humidity beyond what has been observed this far. (e,f) The detail about how we change the slope is given in Supplement Fiure 10. Full size image Figure 4 shows the effect on the global temperature, Supplement Figures 3–9 and 11–12 show the effects of each experiment for each scenario on five additional variables. Supplement Figure 10 gives details about the effect of changing the relationship between blocking and the amount of H2O in the atmosphere. Our experiments involved the following three parameters: 1. The fraction of carbon that is converted (by bacteria) from CH4 to CO2 before it leaves the thawing permafrost. The fraction of carbon that is released as CH4 in the real world is still unknown (Schneider von Deimling et al.15, Turetsky et al.16), so we explored the entire physically possible range from 0 (i.e. all carbon released from permafrost is released as CO2) to 1 (i.e. all carbon released from permafrost is released as CH4). See Fig. 4a,b and Supplement Figures 3 and 4. Since Lawrence et al.17 report a fraction between 2.5% for dry soil and 12% for wet soil we also re-ran our sensitivity analysis bounded by 0 and 15% to highlight this restricted range. See Supplement Figures 5, 6 and 7. Our choice of all carbon released from permafrost thawing being released as methane for our base case results from the fact that we originally worked on ESCIMO between 2000 and 2015. At the time, we assumed, falsely as it turns out, that all carbon released from thawing permafrost is released as methane. As reported above, in this paper we run sensitivity analysis where we changed the fraction of carbon released as methane from 0 to 100%, i.e. the entire physically possible range. And we run sensitivity analysis where we changed the fraction of carbon released as methane from 0 to 15%, i.e. around the currently assumed value of around 10%. In all the runs, the characteristic behaviour of self-sustained (in the sense of no more man-made GHG emissions) temperature rise is maintained. 2. The slope of the rate of thawing of the permafrost that results from a given temperature. In ESCIMO, the rate of thawing permafrost is measured in km2 per year. At our chosen reference temperature (4 °C) we assume that 12.500 km2 per year is melted to all depth18,19,20. To calculate the rate of thawing at other temperatures we multiply with the following linear relationship: Effectoftemperature(dimensionless)=1+slope(dimensionless)×(Globalaveragesurfacetemperaturet(∘C)÷Globalaveragesurfacetemperature1850(∘C)−1) See Fig. 4c,d and Supplement Figures 8 and 9. 3. The slope of the future relationship between additional blocking of outgoing radiation as a function of additional water vapour in the atmosphere—for values of humidity beyond what has been observed this far. To make this extrapolation we use the following 3rd order polynomial function: Fractionblocked=−0.2842∗humidity3+1.8244∗humidity2−3.7148∗humiditiy+2.4523 where the unit for humidity is g/kg. The historical part of the relationship has been calibrated to actual global average temperature. For detail, see Supplement Figure 10. See Fig. 4e,f and Supplement Figures 11 and 12. Summary of the three parameter changes The chosen parameter variations do impact the rate of self-sustained thawing of the permafrost and its feedback effect on global temperature. But they do not stop the self-sustained thawing of the permafrost. We believe that the reason for these results in ESCIMO is the importance of surface albedo rise, H2O blocking of long wave radiation and methane release from permafrost. As Fig. 2 above shows, we are seeing in ESCIMO a regime change from man-made emission driven warming until about 2200 to albedo and water-vapour driven warming beyond 2150. Remedial action We did experiments with ESCIMO (see Supplement Figure 13) to explore (contra-factually) in what year man-made emissions must stop to avoid self-reinforcing thawing of the permafrost. The answer is that all man-made emissions would have had to be cut to zero sometime between 1960 and 1970—when global warming was still below some + 0.5 °C. Finally, we explored another strategy to stop self-sustained thawing. We asked how much CO2 humanity must remove from the atmosphere every year from 2020 in order to avoid self-sustained temperature rise in the centuries ahead. The answer, in ESCIMO, proved to be at least 33 GtCO2e per year, for example through direct CO2 capture or biomass CCS (see Supplement Figure 14 (a) and (b)). In other words, building 33.000 big CCS plants and keep them running for ever. This is technically feasible but would be hugely expensive. Cheaper opportunities exist to stop self-sustained global warming (through various forms of geo-engineering), but these will have unintended and undesired side effects beyond lowering the temperature. Conclusion Self-sustained thawing of the permafrost is a robust phenomenon in ESCIMO. It only disappears when man-made emissions are stopped counterfactually as early as in the 1960es. Or by choosing parameter values that do not recreate historical developments. We encourage other model builders to explore these conclusions in their models, and report on their findings.

#### Space col brings infinite expected value – outweighs.

Baum 16

[Seth D. Baum, Executive Director of the Global Catastrophic Risk Institute, “The Ethics of Outer Space: A Consequentialist Perspective,” 2016, Springer, pp. 115-116, EA]

Space colonization is notable because it may be able to bring utterly immense increases in intrinsic value. Early colonies might start small, given that other planets and moons have inhospitable environments. However, it may be possible to build large indoor colonies or create more hospitable outdoor environments (i.e., terraforming). Even just on other planets and moons in the Solar System, space colonies could multiply the total area available for human habitation. And there are many more planets around other stars, as ongoing research on exoplanets is now learning. One recent study estimates 22 % of Sun-like stars have Earth-like exoplanets (Petigura et al. 2013), implying billions to tens of billions of potentially habitable planets across the galaxy. Opportunities at any given star may also be quite a bit greater than those available only on planets. Earth only receives about one two-billionth of the Sun’s radiation. To collect all the Sun’s radiation, humanity would need a Dyson swarm (named after Dyson 1960), which is a series of structures that surrounds a star, collecting its radiation to power a civilization. A Dyson swarm around the Sun could potentially enable a civilization a billion times larger than is possible on Earth. Likewise, Dyson swarms around one billion stars would bring humanity approximately 1018 (one billion–billion) times more energy per unit time. Space colonies could also increase the amount of time available for human civilization. Earth will remain habitable for a few billion more years (O’Malley-James et al. 2014). Stars will continue shining for about 1014 more years (Adams 2008). That gives us an additional 105 times more energy, for a total of 1023 times more energy than is available on Earth. After the stars fade, other energy sources may be available. And even if our current universe eventually becomes uninhabitable, it may be possible to move to other universes (Kaku 2005). The physics here is speculative, but it cannot be ruled out, and hence there is a nonzero chance of a literally infinite opportunity for space colonization (Baum 2010a). Whether the opportunity is infinite or merely, say, 1023 times larger than what can be done on Earth, the opportunity is clearly immense. As long as space colonization is an improvement (Sect. 8.3.1), then it would seem that the consequentialist should prioritize space colonization. The sooner space colonization begins, the more of its immense opportunity can be gained. Indeed, Ćirković (2002) estimates 5 × 1046 human lifetimes are lost for every century in which space colonization is delayed.

### Case

#### Prefer objective indicators – human cognition drastically inflates the importance of perception in analysis.

Pinker 19

(Steven Pinker is an experimental cognitive psychologist and a popular writer on language, mind, and human nature. His books include "The Language Instinct," "How the Mind Works," and "The Blank Slate."Pinker is the Johnstone Family Professor of Psychology at Harvard University, and his academic specializations are visual cognition and developmental linguistics. His experimental subjects include mental imagery, shape recognition, visual attention, children's language development, regular and irregular phenomena in language, the neural bases of words and grammar, as well as the psychology of cooperation and communication, including euphemism, innuendo, emotional expression, and common knowledge.), “One thing to change: Anecdotes aren’t data”, The Harvard Gazette, 6/21/19, NCS, https://news.harvard.edu/gazette/story/2019/06/focal-point-harvard-professor-steven-pinker-says-the-truth-lies-in-the-data/

QUESTION: What is one thing wrong with the world that you would change, and why? Too many leaders and influencers, including politicians, journalists, intellectuals, and academics, surrender to the cognitive bias of assessing the world through anecdotes and images rather than data and facts. Our president assumed office with a dystopian vision of American “carnage” in an era in which violent crime rates were close to historical lows. His Republican predecessor created a massive new federal department and launched two destructive wars to protect Americans against a hazard, terrorism, that most years kills fewer people than bee stings and lightning strikes. In the year after the 9/11 attacks, 1,500 Americans who were scared away from flying perished in car crashes, unaware that a Boston-LA air trip has the same risk as driving 12 miles. One death from a self-driving Tesla makes worldwide headlines, but the 1.25 million deaths each year from human-driven vehicles don’t. Small children are traumatized by school drills that teach them how to hide from rampage shooters, who have an infinitesimal chance of killing them compared with car crashes, drownings, or, for that matter, non-rampage killers, who slay the equivalent of a Sandy Hook and a half every day. Several heavily publicized police shootings have persuaded activists that minorities are in mortal danger from racist cops, whereas three analyses (two by Harvard faculty, Sendhil Mullainathan and Roland Fryer) have shown no racial bias in police shootings. “How do we change this destructive statistical illiteracy and disdain for data?” Many people are convinced that the country is irredeemably racist, sexist, homophobic, and sexually assaultive, whereas all of these scourges are in steady decline (albeit not quickly enough). People on both the right and left have become cynical about global institutions because they think that the world is becoming poorer and more war-torn, whereas in recent decades global measures of extreme poverty and battle deaths have plummeted. People are terrified of nuclear power (the most scalable form of carbon-free energy) because of images of Three Mile Island (which killed no one), Fukushima (which killed no one; the deaths were caused by the tsunami and a panicked, unnecessary evacuation), and Chernobyl (which killed fewer people than are killed by coal every day). They imagine that fossil fuels can be replaced by solar energy, without doing the math on how many square miles would have to be tiled with solar panels to satisfy the world’s vastly growing thirst for electricity. And they think that voluntary sacrifices, like unplugging laptop chargers, are a sensible way to deal with climate change. How do we change this destructive statistical illiteracy and disdain for data? We need to make “factfulness” (as Hans, Ola, and Anna Rosling call it) an inherent part of the culture of education, journalism, commentary, and politics. An awareness of the infirmity of unaided human intuition should be part of the conventional wisdom of every educated person. Guiding policy or activism by conspicuous events, without reference to data, should come to be seen as risible as guiding them by omens, dreams, or whether Jupiter is rising in Sagittarius.

#### 1. Cap solves the environment – CCS link turns every impact.

Graciela ‘16 (/16 – Professor of Economics and of Statistics at Columbia University and Visiting Professor at Stanford University, and was the architect of the Kyoto Protocol carbon market (being interviewed by Marcus Rolle, freelance journalist specializing in environmental issues and global affairs, “Reversing Climate Change: Interview with Graciela Chichilnisky,” http://www.globalpolicyjournal.com/blog/01/09/2016/reversing-climate-change-interview-graciela-chichilnisky)//cmr

GC: Green capitalism is a new economic system that values the natural resources on which human survival depends. It fosters a harmonious relationship with our planet, its resources and the many species it harbors. It is a new type of market economics that addresses both equity and efficiency. Using carbon negative technology™ it helps reduce carbon in the atmosphere while fostering economic development in rich and developing nations, for example in the U S., EU, China and India. How does this work? In a nutshell Green Capitalism requires the creation of global limits or property rights nation by nation for the use of the atmosphere, the bodies of water and the planet’s biodiversity, and the creation of new markets to trade these rights from which new economic values and a new concept of economic progress emerges updating GDP as is now generally agreed is needed. Green Capitalism is needed now to help avert climate change and achieve the goals of the 2015 UN Paris Agreement, which are very ambitious and universally supported but have no way to be realized within the Agreement itself. The Carbon Market and its CDM play critical roles in the foundation of Green Capitalism, creating values to redefine GDP. These are needed to remain within the world’s “CO2 budget” and avoid catastrophic climate change. As I see it, the building blocks for Green Capitalism are then as follows; (1) Global limits nation by nation in the use of the planet’s atmosphere, its water bodies and biodiversity - these are global public goods. (2) New global markets to trade these limits, based on equity and efficiency. These markets are relatives of the Carbon Market and the SO2 market. The new market create new measures of economic values and update the concept of GDP. (3) Efficient use of Carbon Negative Technologies to avert catastrophic climate change by providing a smooth transition to clean energy and ensuring economic prosperity in rich and poor nations. These building blocks have immediate practical implications in reversing climate change and can assist the ambitious aims of Paris COP21 become a reality. MR: What is the greatest advantage of the new generation technologies that can capture CO2 from the air? GC: These technologies build carbon negative power plants, such as Global Thermostat, that clean the atmosphere of CO2 while producing electricity. Global Thermostat is a firm that is commercializing a technology that takes CO2 out of air and uses mostly low cost residual heat rather than electricity to drive the capture process, making the entire process of capturing CO2 from the atmosphere very inexpensive. There is enough residua heat in a coal power plant that it can be used to capture twice as much CO2 as the plant emits, thus transforming the power plant into a “carbon sink.” For example, a 400 MW coal plant that emits 1 million tons of CO2 per year can become a carbon sink absorbing a net amount of 1 million tons of CO2 instead. Carbon capture from air can be done anywhere and at any time, and so inexpensively that the CO2 can be sold for industrial or commercial uses such as plastics, food and beverages, greenhouses, bio-fertilizers, building materials and even enhanced oil recovery, all examples of large global markets and profitable opportunities. Carbon capture is powered mostly by low (85°C) residual heat that is inexpensive, and any source will do. In particular, renewable (solar) technology can power the process of carbon capture. This can help advance solar technology and make it more cost-efficient. This means more energy, more jobs, and it also means economic growth in developing nations, all of this while cleaning the CO2 in the atmosphere. Carbon negative technologies can literally transform the world economy. MR: One final question. You distinguish between long-run and short-run strategies in the effort to reverse climate change. Would carbon negative technologies be part of a short-run strategy? GC: Long-run strategies are quite different from strategies for the short-run. Often long-run strategies do not work in the short run and different policies and economic incentives are needed. In the long run the best climate change policy is to replace fossil fuel sources of energy that by themselves cause 45% of the global emissions, and to plant trees to restore if possible the natural sources and sinks of CO2. But the fossil fuel power plant infrastructure is about 87% of the power plant infrastructure and about $45-55 trillion globally. This infrastructure cannot be replaced quickly, certainly not in the short time period in which we need to take action to avert catastrophic climate change. The issue is that CO2 once emitted remains hundreds of years in the atmosphere and we have emitted so much that unless we actually remove the CO2 that is already there, we cannot remain long within the carbon budget, which is the concentration of CO2 beyond which we fear catastrophic climate change. In the short run, therefore, we face significant time pressure. The IPCC indicates in its 2014 5th Assessment Report that we must actually remove the carbon that is already in the atmosphere and do so in massive quantities, this century (p. 191 of 5th Assessment Report). This is what I called a carbon negative approach, which works for the short run. Renewable energy is the long run solution. Renewable energy is too slow for a short run resolution since replacing a $45-55 trillion power plant infrastructure with renewable plants could take decades. We need action sooner than that. For the short run we need carbon negative technologies that capture more carbon than what is emitted. Trees do that and they must be conserved to help preserve biodiversity. Biochar does that. But trees and other natural sinks are too slow for what we need today. Therefore, negative carbon is needed now as part of a blueprint for transformation. It must be part of the blueprint for Sustainable Development and its short term manifestation that I call Green Capitalism, while in the long run renewable sources of energy suffice, including Wind, Biofuels, Nuclear, Geothermal, and Hydroelectric energy. These are in limited supply and cannot replace fossil fuels. Global energy today is roughly divided as follows: 87% is fossil, namely natural gas, coal, oil; 10% is nuclear, geothermal, and hydroelectric, and less than 1% is solar power — photovoltaic and solar thermal. Nuclear fuel is scarce and nuclear technology is generally considered dangerous as tragically experienced by the Fukushima Daichi nuclear disaster in Japan, and it seems unrealistic to seek a solution in the nuclear direction. Only solar energy can be a long term solution: Less than 1% of the solar energy we receive on earth can be transformed into 10 times the fossil fuel energy used in the world today. Yet we need a short-term strategy that accelerates long run renewable energy, or we will defeat long-term goals. In the short term as the IPCC validates, we need carbon negative technology, carbon removals. The short run is the next 20 or 30 years. There is no time in this period of time to transform the entire fossil infrastructure — it costs $45-55 trillion (IEA) to replace and it is slow to build. We need to directly reduce carbon in the atmosphere now. We cannot use traditional methods to remove CO2 from smokestacks (called often Carbon Capture and Sequestration, CSS) because they are not carbon negative as is required. CSS works but does not suffice because it only captures what power plants currently emit. Any level of emissions adds to the stable and high concentration we have today and CO2 remains in the atmosphere for years. We need to remove the CO2 that is already in the atmosphere, namely air capture of CO2 also called carbon removals. The solution is to combine air capture of CO2 with storage of CO2 into stable materials such as biochar, cement, polymers, and carbon fibers that replace a number of other construction materials such as metals. The most recent BMW automobile model uses only carbon fibers rather than metals. It is also possible to combine CO2 to produce renewable gasoline, namely gasoline produced from air and water. CO2 can be separated from air and hydrogen separated from water, and their combination is a well-known industrial process to produce gasoline. Is this therefore too expensive? There are new technologies using algae that make synthetic fuel commercially feasible at competitive rates. Other policies would involve combining air capture with solar thermal electricity using the residual solar thermal heat to drive the carbon capture process. This can make a solar plant more productive and efficient so it can out-compete coal as a source of energy. In summary, the blueprint offered here is a private/public approach, based on new industrial technology and financial markets, self-funded and using profitable greenmarkets, with securities that utilize carbon credits as the “underlying” asset, based on the KP CDM, as well as new markets for biodiversity and water providing abundant clean energy to stave off impending and actual energy crisis in developing nations, fostering mutually beneficial cooperation for industrial and developing nations. The blueprint proposed provides the two sides of the coin, equity and efficiency, and can assign a critical role for women as stewards for human survival and sustainable development. My vision is a carbon negative economy that represents green capitalism in resolving the Global Climate negotiations and the North–South Divide. Carbon negative power plants and capture of CO2 from air and ensure a clean atmosphere together innovation and more jobs and exports: the more you produce and create jobs the cleaner becomes the atmosphere. In practice, Green Capitalism means economic growth that is harmonious with the Earth resources.

#### Capitalism has drastically reduced structural violence by every empirical metric.

Swan 20

Josh Swan (Policy and Data Analyst for the City Region Economic and Development Institute of the University of Birmingham). “Capitalism and its Impact on Global Living Standards.” City REDI. 18 March 202. JDN. <https://blog.bham.ac.uk/cityredi/capitalism-and-its-impact-on-global-living-standards/>

Fundamentally, it must be said straight away that capitalism has been, and still is, an incredibly overwhelming positive force for the world and is easily the most successful economic system that has ever been produced. Since the time of Karl Marx, the embourgeoisement of populations has led to greater financial and social security, as well as fulfilling careers that were once reserved for the elite. With the right saving plan, many will buy their own home, start their own business, save for their pension and enjoy unprecedented levels of leisure time. Just in case you are still not convinced why this is the single greatest economic system ever invented, let us examine the past. Technology has created more jobs than it has destroyed in the colossal world population boom in the last 144 years. Work is more fulfilling as dull jobs have been automated and creative careers becoming more numerous. Incredible advances in medicine, accountancy and professional services were made under capitalism, and essential products like the television have seen a 98% fall in real-price since 1950. Some would say this is a prerequisite to materialism; the making of commodities to fulfil our happiness and needs. You may say, so what if televisions have fallen in value meaning every family, including poor families that live in a home, can afford one? This isn’t a real argument to say it is the best system in the world… this hasn’t made a huge difference to reprimanding the suffering of Humankind. Well, is it enough to say capitalism has dramatically reduced child mortality rates and vastly increased the lifespan of old age? If that was not so then how would we explain an exponential world population increase? Whilst medical science has been credited for a positive difference with these two areas, the innovative nature of capitalism and the wealth it generated was able to fund and foster scrutiny of medical ideas which led to successful research. For example, in the Soviet Union, the goal of the central planners was to “catch up with and surpass the West”. Despite the Soviet Union in 1986 having a population 14% larger than the United States, they had 73% more hospitals than the US (23,100 vs 6229), 69% more beds for patients, 48% more physicians and 99% more midwives. However, the average life expectancy was 64 and 73 for males and females in the Soviet Union compared to 71 and 78 for males and females in the United States. It may be telling that despite far fewer staff and hospitals, the United States outspent the Soviets by more than $184 billion in 1979 ($645 billion in today’s money) and the US government paid less than half this amount compared to the 92% share the Soviet Union planners contributed. Capitalism enabled the United States to mobilise and efficiently allocate its resources, as well as create far more efficient hospitals than its rival and was able to show a clear health benefit to its population as a result. Other areas of living standards have skyrocketed such as education (and female education), skills, information and social mobility. But most of all, capitalism as a form of trade and enterprise has been the engine in the immense reduction of world absolute poverty as The Guardian writes “In the past 200 years, extreme poverty has collapsed from a whopping 94% of the entire world population to less than 10% today”. 60,000 people are escaping extreme poverty every day because of trade. But if capitalism is so good, why are there huge swathes of populations still poor and suffering today? Capitalism isn’t the cause of this poverty but rather that there is a lack of capitalism that affects these areas. Government corruption, war, political instability and other structural problems prevent power being placed into the markets and operating efficiently in these areas.

#### Cap solves war- studies prove

Julian **Adorney 13,** economic historian, entrepreneur, and contributor for the Ludwig von Mises Institute. He’s citing Professor McDonald who teaches courses on international relations theory, international political economy, and international security at University of Texas at Austin. (, Foundation for Economic Education, “Want Peace? Promote Free Trade”, 10/15, [http://www.fee.org/the\_freeman/detail/want-peace-promote-free-trade](http://www.fee.org/the_freeman/detail/want-peace-promote-free-trade)//jk)

Frédéric Bastiat famously claimed that “if goods don’t cross borders, soldiers will." Bastiat argued that free trade between countries could reduce international conflict because trade forges connections between nations and gives each country an incentive to avoid war with its trading partners. If every nation were an economic island, the lack of positive interaction created by trade could leave more room for conflict. Two hundred years after Bastiat, libertarians take this idea as gospel. Unfortunately, not everyone does. But as recent research shows, the historical evidence confirms Bastiat’s famous claim. To Trade or to Raid In “Peace through Trade or Free Trade?” professor Patrick J. McDonald, from the University of Texas at Austin, empirically tested whether greater levels of protectionism in a country (tariffs, quotas, etc.) would increase the probability of international conflict in that nation. He used a tool called dyads to analyze every country’s international relations from 1960 until 2000. A dyad is the interaction between one country and another country: German and French relations would be one dyad, German and Russian relations would be a second, French and Australian relations would be a third. He further broke this down into dyad-years; the relations between Germany and France in 1965 would be one dyad-year, the relations between France and Australia in 1973 would be a second, and so on. Using these dyad-years, McDonald analyzed the behavior of every country in the world for the past 40 years. His analysis showed a negative correlation between free trade and conflict: The more freely a country trades, the fewer wars it engages in. Countries that engage in free trade are less likely to invade and less likely to be invaded. The Causal Arrow Of course, this finding might be a matter of confusing correlation for causation. Maybe countries engaging in free trade fight less often for some other reason, like the fact that they tend also to be more democratic. Democratic countries make war less often than empires do. But McDonald controls for these variables. Controlling for a state’s political structure is important, because democracies and republics tend to fight less than authoritarian regimes. McDonald also controlled for a country’s economic growth, because countries in a recession are more likely to go to war than those in a boom, often in order to distract their people from their economic woes. McDonald even controlled for factors like geographic proximity: It’s easier for Germany and France to fight each other than it is for the United States and China, because troops in the former group only have to cross a shared border. The takeaway from McDonald’s analysis is that protectionism can actually lead to conflict. McDonald found that a country in the bottom 10 percent for protectionism (meaning it is less protectionist than 90 percent of other countries) is 70 percent less likely to engage in a new conflict (either as invader or as target) than one in the top 10 percent for protectionism. Protectionism and War Why does protectionism lead to conflict, and why does free trade help to prevent it? The answers, though well-known to classical liberals, are worth mentioning. First, trade creates international goodwill. If Chinese and American businessmen trade on a regular basis, both sides benefit. And mutual benefit disposes people to look for the good in each other. Exchange of goods also promotes an exchange of cultures. For decades, Americans saw China as a mysterious country with strange, even hostile values. But in the 21st century, trade between our nations has increased markedly, and both countries know each other a little better now. iPod-wielding Chinese teenagers are like American teenagers, for example. They’re not terribly mysterious. Likewise, the Chinese understand democracy and American consumerism more than they once did. The countries may not find overlap in all of each other’s values, but trade has helped us to at least understand each other. Trade helps to humanize the people that you trade with. And it’s tougher to want to go to war with your human trading partners than with a country you see only as lines on a map. Second, trade gives nations an economic incentive to avoid war. If Nation X sells its best steel to Nation Y, and its businessmen reap plenty of profits in exchange, then businessmen on both sides are going to oppose war. This was actually the case with Germany and France right before World War I. Germany sold steel to France, and German businessmen were firmly opposed to war. They only grudgingly came to support it when German ministers told them that the war would only last a few short months. German steel had a strong incentive to oppose war, and if the situation had progressed a little differently—or if the German government had been a little more realistic about the timeline of the war—that incentive might have kept Germany out of World War I. Third, protectionism promotes hostility. This is why free trade, not just aggregate trade (which could be accompanied by high tariffs and quotas), leads to peace. If the United States imposes a tariff on Japanese automobiles, that tariff hurts Japanese businesses. It creates hostility in Japan toward the United States. Japan might even retaliate with a tariff on U.S. steel, hurting U.S. steel makers and angering our government, which would retaliate with another tariff. Both countries now have an excuse to leverage nationalist feelings to gain support at home; that makes outright war with the other country an easier sell, should it come to that. In socioeconomic academic circles, this is called the Richardson process of reciprocal and increasing hostilities; the United States harms Japan, which retaliates, causing the United States to retaliate again. History shows that the Richardson process can easily be applied to protectionism. For instance, in the 1930s, industrialized nations raised tariffs and trade barriers; countries eschewed multilateralism and turned inward. These decisions led to rising hostilities, which helped set World War II in motion. These factors help explain why free trade leads to peace, and protectionism leads to more conflict. Free Trade and Peace One final note: McDonald’s analysis shows that taking a country from the top 10 percent for protectionism to the bottom 10 percent will reduce the probability of future conflict by 70 percent. He performed the same analysis for the democracy of a country and showed that taking a country from the top 10 percent (very democratic) to the bottom 10 percent (not democratic) would only reduce conflict by 30 percent. Democracy is a well-documented deterrent: The more democratic a country becomes, the less likely it is to resort to international conflict. But reducing protectionism, according to McDonald, is more than twice as effective at reducing conflict than becoming more democratic. Here in the United States, we talk a lot about spreading democracy. We invaded Iraq partly to “spread democracy.” A New York Times op-ed by Professor Dov Ronen of Harvard University claimed that “the United States has been waging an ideological campaign to spread democracy around the world” since 1989. One of the justifications for our international crusade is to make the world a safer place. Perhaps we should spend a little more time spreading free trade instead. That might really lead to a more peaceful world.

#### Mass launch inevitable—but in the aff world it will be public

Seedhouse 18 [Erik, editor at the Encyclopedia Britannica, “Space Tourism” https://www.britannica.com/explore/space/space-tourism/]

Space tourism, recreational space travel, either on established government-owned vehicles such as the Russian Soyuz and the International Space Station (ISS) or on a growing number of vehicles fielded by private companies. Since the flight of the world’s first space tourist, American businessman Dennis Tito, on April 28, 2001, space tourism has gained new prominence as more suborbital and orbital tourism opportunities have become available. Orbital space tourism The advent of space tourism occurred at the end of the 1990s with a deal between the Russian company MirCorp and the American company Space Adventures Ltd. MirCorp was a private venture in charge of the space station Mir. To generate income for maintenance of the aging space station, MirCorp decided to sell a trip to Mir, and Tito became its first paying passenger. However, before Tito could make his trip, the decision was made to deorbit Mir, and—after the intervention of Space Adventures Ltd.—the mission was diverted to the ISS. Tito, who paid $20 million for his flight on the Russian spacecraft Soyuz TM-32, spent seven days on board the ISS and is considered the world’s first space tourist. However, given the arduous training required for his mission, Tito objected to the use of the word tourist, and since his flight the term spaceflight participant has been more often used to distinguish commercial space travelers from career astronauts.

#### That’s net worse for the environment—capitalism is uniquely environmentally friendly (graciella 19)

#### TURN—private ownership is key to space accessibility for developing nations

Reinstein 99

Ezra J. Reinstein (JD, Associate at Kirkland & Ellis), Owning Outer Space, 20 Nw. J. Int'l L. & Bus. 59 (1999). JDN. https://scholarlycommons.law.northwestern.edu/njilb/vol20/iss1/7

The changes to the OST proposed in this essay would encourage and hasten the conversion of potential wealth-in-space into actual wealth-on-Earth. As already argued, bringing wealth into a system is an absolute good, aiding all humanity (however indirectly), including developing nations. But there is another, more direct way in which low-tech nations can benefit. As ownership rights boost the incentive to exploit outer space's resources, more developers will jump at the chance. And the more people jumping at the chance and flying up into space to glean the space-borne profits, **the cheaper and safer it will become** to carry out such space projects. That is, the more profitable it becomes to exploit space, the greater the impetus will be to develop new technology that permits easier access to space. And among the prime beneficiaries of more accessible space travel will be those nations -- the developing, low-tech nations -- who are currently not space-capable. This, of course, will work with, and be facilitated by, the openness of plans under the UNSER system. **We should not force the space-capable** nations **to share their wealth** (as is required by the Moon Treaty, and as developing nations are pushing for in interpreting the OST), for to do so would discourage exploitation and space travel, and thus make space projects less regular, and thus less affordable and safe. Instead, by supporting the development of new technology in **an efficient, free market** environment, we thereby give developing nations the chance to go into space on their own. In this way we can increase everyone's access to space. And that's one of the designated goals of the OST itself.