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# I Affirm

#### Resolved: The appropriation of outer space by private entities is unjust.

# Framework

**The standard is minimizing material and structural violence. Prefer:**

1. **Addressing structural violence is a pre requisite to addressing other impacts – it is embedded into the framework of society.**

1. **Structural violence must come first in our impact calculus —there is an ethical obligation to address it.**

**Ansell 17** — David A. Ansell, Senior Vice President, Associate Provost for Community Health Equity, and Michael E. Kelly Professor of Medicine at Rush University Medical Center (Chicago), holds an M.D. from the State University of New York Upstate Medical University College of Medicine, 2017 (“American Roulette,” *The Death Gap: How Inequality Kills*, Published by the University of Chicago Press, ISBN 9780226428291, p. kindle 307-363)//Ak//recut

There are many different kinds of violence. Some are obvious: punches, attacks, gunshots, explosions. These are the kinds of interpersonal violence that we tend to hear about in the news. Other kinds of violence are intimate and emotional. But the **deadliest** and most thoroughgoing kind of violence is woven into the fabric of American society. It exists when some groups have more access to goods, resources, and opportunities than other groups, including health and life itself. This violence delivers **specific blows against particular bodies in particular neighborhoods**. This unequal advantage and violence is built into the very rules that govern our society. In the absence of this violence, **large numbers of Americans would be able to live fuller and longer lives**. This kind of violence is called structural violence, because it is embedded in the very laws, policies, and rules that govern day-to-day life.8 It is the cumulative impact of laws and social and economic policies and practices that render some Americans less able to access resources and opportunities than others. This inequity of advantage is not a result of the individual’s personal abilities but is built into the systems that govern society. Often it is a product of **racism**, **gender**, and **income inequality**. The diseases and premature mortality that Windora and many of my patients experienced were, in the words of Dr. Paul Farmer, “biological reflections of social fault lines.”9 As a result of these fault lines, a disproportional burden of illness, suffering, and premature mortality falls on certain neighborhoods, like Windora’s. Structural violence can overwhelm an individual’s ability to live a free, unfettered, healthy life. As I ran to evaluate Windora, I knew that her stroke was caused in part by lifelong exposure to suffering, racism, and economic deprivation. Worse, the poverty of West Humboldt Park that contributed to her illness is directly and inextricably related to the massive concentration of wealth and power in other neighborhoods just miles away in Chicago’s Gold Coast and suburbs. That concentration of wealth could not have occurred without laws, policies, and practices that favored some at the expense of others. Those laws, policies, and practices could not have been passed or enforced if access to political and economic power had not been concentrated in the hands of a few. Yet these political and economic structures have become so firmly entrenched (in habits, social relations, economic arrangements, institutional practices, law, and policy) that they have become part of the matrix of American society. The rules that govern day-to-day life were written to benefit a small elite at the expense of people like Windora and her family. These rules and structures are powerful destructive forces. The same structuresthat render life predictable, secure, comfortable, and pleasant for many destroy the lives of others like Windora through **suffering**, **poverty**, **ill health**, and **violence**. These structures are neither natural nor neutral. The results of structural violence can be very specific. In Windora’s case, stroke precursors like chronic stress, poverty, and uncontrolled hypertension run rampant in neighborhoods like hers. Windora’s illness was caused by neither her cultural traits nor the failure of her will. Her stroke was caused in part by inequity. She is one of the lucky ones, though, because even while structural violence ravages her neighborhood, it also abets the concentration of expensive stroke- intervention services in certain wealthy teaching hospitals like mine. If I can get to her in time, we can still help her. Income Inequality and Life Inequality Of course, Windora is not the only person struggling on account of structural violence. Countless neighborhoods nationwide are suffering from it, and people are dying **needlessly young** as a result. The magnitude of this excess mortality is mind-boggling. In 2009 my friend Dr. Steve Whitman asked a simple question, “How many extra black people died in Chicago each year, just because they do not have the same health outcomes as white Chicagoans?” When the Chicago Sun-Times got wind of his results, it ran them on the front page in bold white letters on a black background: “HEALTH CARE GAP KILLS 3200 Black Chicagoans and the Gap is Growing.” The paper styled the headline to look like the declaration of war that it should have been. In fact, we did find ourselves at warnot long ago, when almost 3,000 Americans were killed. That was September 11, 2001. That tragedy propelled the country to war. Yet when it comes to the premature deaths of urban Americans, no disaster area has been declared. No federal troops have been called up. No acts of Congress have been passed. Yet this disaster is **even worse**: those 3,200 black people were in Chicago alone, in just one year. Nationwide each year, more than **60,000** black people die prematurely because of inequality.10 While blacks suffer the most from this, it is not just an issue of racism, though racism has been a unique and powerful transmitter of violence in America for over four hundred years.11 Beyond racism, poverty and income inequality perpetuated by exploitative market capitalism are singular agents of transmission of **disease and early death**. As a result, there is a new and alarming pattern of declining life expectancy among white Americans as well. Deaths from drug overdoses in young white Americans ages 25 to 34 have exploded to levels not seen since the AIDS epidemic. This generation is the first since the Vietnam War era to experience higher death rates than the prior generation.12 White Americans ages 45 to 54 have experienced skyrocketing premature death rates as well, something not seen in any other developed nation.13 White men in some Appalachian towns live on average twenty years less than white men a half-day’s drive away in the suburbs of Washington, DC. Men in McDowell County, West Virginia, can look forward to a life expectancy only slightly better than that of Haitians.14 But those statistics reflect averages, and every death from structural violence is **a person**. When these illnesses and deaths are occurring one at a time in neighborhoods that society has decided not to care about—neighborhoods populated by poor, black, or brown people—they seem easy to overlook, especially if you are among the fortunate few who are doing incredibly well. The tide of prosperity in America has lifted some boats while others have swamped. Paul Farmer, the physician-anthropologist who founded Partners in Health, an international human rights agency, reflects on the juxtaposition of “unprecedented bounty and untold penury”: “It stands to reason that as beneficiaries of growing inequality, we do not like to be reminded of misery of squalor and failure. Our popular culture provides us with no shortage of anesthesia.”15 That people suffer and die prematurely because of inequality is **wrong**. It is wrong from an **ethical** perspective. It is wrong from a **fairness** perspective. And it is wrong because **we have the means to fix it**.

1. **Attempts to prioritize existential threats in the name of utilitarian calculus distorts our moral reasoning and ensures we will continue to ignore urgent structures of violence – you should over correct to resolve ongoing wrongs and refuse to be ethically blackmailed by the threat of large scale future impacts..**

**Olson ‘15** – prof of geography @ UNC Chapel Hill (Elizabeth, ‘Geography and Ethics I: Waiting and Urgency,’ Progress in Human Geography, vol. 39 no. 4, pp. 517-526)//Ak//recut

III The body and the emergency Though the body is often presumed to be the most basic unit where urgency might be detected, only some dictionaries link urgency and the body through a ‘medical’ reference to the compelling need to defecate or urinate.5 Focusing on the different meanings of urgency runs the risk of obscuring language categories, but pushing together the two definitions – urgency as the need to defecate and urinate, and urgency as overwhelming force – is useful here, because my aim is to illustrate that the ethical work of urgency has been hijacked by an hierarchical organization of scales of moral deliberation. Specifically, our research suggests that the urgent body is cast as subjective and impulsive, while larger scales, such as the region, state or society, emerge as the scale of a rational ethics. While these are not new arguments about states (Scott, 1998) and their institutions (Foucault, 1995), geographic insights into toileting and securitizations suggest that **technocratic practices both require and perpetuate an ethical distinction between the body and the large-scale future event**, **with the latter emerging as the only legitimate site of urgent claims and thus the dominant subject of moral reasoning**.In research related to contemporary global toileting, the defecating body’s status as a legitimate ethical concern is more likely to be acknowledged when **threatening the sanitation aims of cities and states**. This is perhaps most evident in large metropolitan areas where uneven access to toilets amplifies social inequalities and human suffering (McFarlane, 2013). Jewitt’s (2011) examination of waste management in India and other countries in the Global South reveals that taboos around feces often justify inequality in two ways; first, by creating conditions of precarity through taboos in discussing personal sanitation and toilet practices, and second, by justifying social exclusion on the basis of inferior sanitation practices. The lack of access to sanitation infrastructure can also provide reasons for excluding informally settled populations from ambitiously modernizing cities. In cities like Kampala, Uganda, planners, development workers, and community organizers frame those who cannot use modern toilet facilities as threatening (Terreni-Brown, 2014a). Terreni-Brown (2014b) describes a group of female migrants selling goods outside of a large, upscale mall in Kampala, and their strategies for balancing the lack of access to a toilet with the danger and humiliation of going in the area behind their street-side location. Their desperate pain, induced by waiting hours until they can finally return to a more private location, contrasts with complaints of city planners and NGO workers who point to moral lethargy in the informal settlements that puts the city at risk. The poor, illegal, marginalized body is not a reasonable scale of urgency, nor is it the product of a thoughtful weighing of circumstances; in the face of a morally rational prioritization of a future Kampala, these bodily urgencies literally have no place in the modern city. Though toileting might be thought of as a special case of bodily urgency, geographic research suggests that the body is increasingly set at odds with larger scale ethical concerns, especially **large-scale future events of forecasted suffering**. Emergency planning is a particularly good example in which the large-scale threats of future suffering can **distort moral reasoning**. Žižek (2006) lightly develops this point in the context of the war on terror, where in the presence of fictitious and real ticking clocks and warning systems, the urgent body must be **bypassed** because there are **bigger scales to worry about**:¶ What does this all-pervasive sense of urgency mean ethically? The pressure of events is so overbearing, the stakes are so high, that they necessitate a suspension of ordinary ethical concerns. After all, displaying moral qualms when the lives of millions are at stake plays into the hands of the enemy. (Žižek, 2006)¶ In the presence of large-scale future emergency, the urgency to secure the state, the citizenry, the economy, or the climate creates new scales and new temporal orders of response (see Anderson, 2010; Baldwin, 2012; Dalby, 2013; Morrissey, 2012), many of which treat the urgent body as impulsive and thus requiring management. McDonald’s (2013) analysis of three interconnected discourses of ‘climate security’ illustrates how bodily urgency in climate change is also recast as a menacing impulse that might require exclusion from moral reckoning. The logics of climate security, especially those related to national security, ‘can encourage perverse political responses that not only fail to respond effectively to climate change but may present victims of it as a threat’ (McDonald, 2013: 49). **Bodies that are currently suffering cannot be urgent**, because they are **excluded from the potential collectivity** that could be **suffering everywhere in some future time**. Similar bypassing of existing bodily urgency is echoed in writing about violent securitization, such as drone warfare (Shaw and Akhter, 2012), and also in **intimate scales** like the street and the school, especially in relation to race (Mitchell, 2009; Young et al., 2014).¶ As **large-scale urgent concerns are institutionalized**, the urgent body is increasingly **obscured through technical planning and coordination** (Anderson and Adey, 2012). The predominant characteristic of this institutionalization of large-scale emergency is a ‘**built-in bias for action’** (Wuthnow, 2010: 212) **that circumvents contingencies**. The urgent body is at best an assumed eventuality, one that will likely require another state of waiting, such as **triage** (e.g. Greatbach et al., 2005). Amin (2013) cautions that in much of the West, governmental need to provide evidence of laissez-faire governing on the one hand, and assurance of strength in facing a threatening future on the other, produces ‘just-in-case preparedness’ (Amin, 2013: 151) of neoliberal risk management policies. In the US, ‘personal ingenuity’ is built into emergency response at the expense of the poor and vulnerable for whom ‘[t]he difference between abjection and bearable survival’ (Amin, 2013: 153) will not be determined by emergency planning, but in the material infrastructure of the city.¶ In short, the urgencies of the body provide justifications for social exclusion of the most marginalized based on impulse and perceived threat, while **large-scale future emergencies effectively absorb the deliberative power of urgency into the institutions of preparedness and risk avoidance**. Žižek references Arendt’s (2006) analysis of the banality of evil to explain the current state of ethical reasoning under the war on terror, noting that people who perform morally reprehensible actions under the conditions of urgency assume a ‘tragic-ethic grandeur’ (Žižek, 2006) by sacrificing their own morality for the good of the state. But his analysis fails to note that bodies are today so rarely legitimate sites for claiming urgency. In the context of the **assumed priority of the large-scale future emergency**, the urgent body becomes **literally nonsense, a non sequitur** within societies, states and worlds that will **always be more urgent**.¶ If the important ethical work of urgency has been to identify that which must not wait, then the capture of the power and persuasiveness of urgency by large-scale future emergencies has consequences for the kinds of normative arguments we can raise on behalf of urgent bodies. How, then, might waiting compare as a normative description and critique in our own urgent time? Waiting can be categorized according to its purpose or outcome (see Corbridge, 2004; Gray, 2011), but it also modifies the place of the individual in society and her importance. As Ramdas (2012: 834) writes, ‘waiting … produces hierarchies which segregate people and places into those which matter and those which do not’. The segregation of waiting might produce effects that counteract suffering, however, and Jeffery (2008: 957) explains that though the ‘politics of waiting’ can be repressive, it can also engender creative political engagement. In his research with educated unemployed Jat youth who spend days and years waiting for desired employment, Jeffery finds that ‘the temporal suffering and sense of ambivalence experienced by young men can generate cultural and political experiments that, in turn, have marked social and spatial effects’ (Jeffery, 2010: 186). Though this is not the same as claiming normative neutrality for waiting, it does suggest that waiting is more ethically ambivalent and open than urgency.¶ In other contexts, however, our descriptions of waiting indicate a strong condemnation of its effects upon the subjects of study. Waiting can demobilize radical reform, **depoliticizing ‘the insurrectionary possibilities of the present by delaying the revolutionary imperative to a future moment that is forever drifting towards infinity’** (Springer, 2014: 407). Yonucu’s (2011) analysis of the self-destructive activities of disrespected working-class youth in Istanbul suggests that this sense of infinite waiting can lead not only to depoliticization, but also to a disbelief in the possibility of a future self of any value. Waiting, like urgency, can **undermine the possibility of self-care** two-fold, first by making people wait for essential needs, and again by reinforcing that waiting is ‘[s]omething to be ashamed of because it may be noted or taken as evidence of indolence or low status, seen as a symptom of rejection or a signal to exclude’ (Bauman, 2004: 109). This is why Auyero (2012) suggests that waiting creates an ideal state subject, providing ‘temporal processes in and through which political subordination is produced’ (Auyero, 2012: loc. 90; see also Secor, 2007). Furthermore, Auyero notes, it is not only political subordination, but the subjective effect of waiting that secures domination, as citizens and non-citizens find themselves ‘waiting hopefully and then frustratedly for others to make decisions, and in effect surrendering to the authority of others’ (Auyero, 2012: loc. 123).¶ Waiting can therefore function as a potentially important spatial technology of the elite and powerful, mobilized not only for the purpose of **governing individuals**, but also to **retain claims over moral urgency**. But there is **growing resistance** to the capture of claims of urgency by the elite, and it is important to note that even in cases where the material conditions of containment are currently impenetrable, arguments based on human value are at the forefront of **reclaiming urgency for the body**. In **detention centers, clandestine prisons, state borders and refugee camps**, geographers point to ongoing struggles against the ethical impossibility of bodily urgency and a rejection of states of waiting (see Conlon, 2011; Darling, 2009, 2011; Garmany, 2012; Mountz et al., 2013; Schuster, 2011). Ramakrishnan’s (2014) analysis of a Delhi resettlement colony and Shewly’s (2013) discussion of the enclave between India and Bangladesh describe people who refuse to give up their own status as legitimately urgent, even in the context of larger scale politics. Similarly, Tyler’s (2013) account of desperate female detainees stripping off their clothes to expose their humanness and suffering in the Yarl’s Wood Immigration Removal Centre in the UK suggests that demands for recognition are not just about politics, but also about the acknowledgement of humanness and the irrevocable possibility of being that which cannot wait. The continued existence of places like Yarl’s Wood and similar institutions in the USA nonetheless points to the challenge of exposing the urgent body as a moral priority when it is so easily hidden from view, and also reminds us that our research can help to explain the relationships between normative dimensions and the political and social conditions of struggle.¶ In closing, geographic depictions of waiting do seem to evocatively describe otherwise obscured suffering (e.g. Bennett, 2011), but it is striking how rarely these descriptions also use the language of urgency. Given the discussion above, what might be accomplished – and risked – by incorporating urgency more overtly and deliberately into our discussions of waiting, surplus and abandoned bodies? Urgency can clarify the implicit but understated ethical consequences and normativity associated with waiting, and encourage explicit discussion about harmful suffering. Waiting can be productive or unproductive for radical praxis, but urgency compels and requires response. Geographers could be instrumental in reclaiming the ethical work of urgency in ways that leave it open for critique, clarifying common spatial misunderstandings and representations. There is good reason to be thoughtful in this process, since moral outrage towards inhumanity can itself obscure differentiated experiences of being human, dividing up ‘those for whom we feel urgent unreasoned concern and those whose lives and deaths simply do not touch us, or do not appear as lives at all’ (Butler, 2009: 50). But when the urgent body is rendered as only waiting, both materially and discursively, it is just as easily cast as impulsive, disgusting, animalistic (see also McKittrick, 2006). Feminist theory insists that the urgent body, whose encounters of violence are ‘usually framed as **private, apolitical and mundane’** (Pain, 2014: 8), are as deeply **political, public, and exceptional** as other forms of violence (Phillips, 2008; Pratt, 2005). Insisting that **a suffering body, now, is that which cannot wait**, has the **ethical effect of drawing it into consideration alongside the political, public and exceptional scope of large-scale futures**. It may help us insist on the body, both as a single unit and a plurality, as a legitimate scale of normative priority and social care.¶ In this report, I have explored old and new reflections on the ethical work of urgency and waiting. Geographic research suggests a contemporary popular bias towards the urgency of large-scale futures, institutionalized in ways that further **obscure and discredit the urgencies of the body**. This bias also justifies the production of new **waiting places** in our material landscape, **places like the detention center** and the waiting room. In some cases, waiting is normatively neutral, even providing opportunities for alternative politics. In others, the technologies of waiting serve to manage potentially problematic bodies, leading to suspended suffering and even to extermination (e.g. Wright, 2013). One of my aims has been to suggest that **moral reasoning is important** both because it **exposes normative biases against subjugated people**, and because it potentially **provides routes toward struggle where claims to urgency seem to foreclose** the **possibilities** of alleviation of suffering. **Saving the world still should require a debate about whose world is being saved, when, and at what cost – and this requires a debate about what really cannot wait**. My next report will extend some of these concerns by reviewing how feelings of urgency, as well as hope, fear, and other emotions, have played a role in geography and ethical reasoning.¶ I conclude, however, by pulling together past and present. In 1972, Gilbert White asked why geographers were not engaging ‘the truly urgent questions’ (1972: 101) such as racial repression, decaying cities, economic inequality, and global environmental destruction. His question highlights just how much the discipline has changed, but it is also unnerving in its echoes of our contemporary problems. Since White’s writing, our moral reasoning has been stretched to consider the future body and the more-than-human, alongside the presently urgent body – topics and concerns that I have not taken up in this review but which will provide their own new possibilities for urgent concerns. My own hope presently is drawn from an acknowledgement that the **temporal characteristics of contemporary capitalism** can be interrupted in creative ways (Sharma, 2014), with the possibility of squaring the urgent body with our large-scale future concerns. **Temporal alternatives already exist in ongoing and emerging revolutions** and the disruption of claims of cycles and circular political processes (e.g. Lombard, 2013; Reyes, 2012). Though **calls for urgency will certainly be used to obscure evasion of responsibility** (e.g. Gilmore, 2008: 56, fn 6), they may **also serve as fertile ground for radical critique**, a truly fierce **urgency for now.**

# C1 – Debris

**Profit motives prevent private entities from being interested in the scope of the project that is needed**

**Phillips 20** [(Leigh, science writer and EU affairs journalist, and science writer for the Pacific Institute for Climate Solutions at the University of Victoria.) “We Don’t Need Elon Musk to Explore the Solar System,” May 8, 2021, https://jacobinmag.com/2021/05/elon-musk-space-exploration-mars-colonization//Ak /

He opens the paper with a recognition that, at some point, if we stay on Earth, we will confront an eventual extinction event. “The alternative is to become a spacefaring civilization and a multi-planetary species.” He alights upon Mars as the obvious first option for establishing a “self-sustaining city — a city that is not merely an outpost, but which can become a planet in its own right.” He rejects Venus due to it being, as he correctly puts it, a super-high-pressure, hot acid bath. He rejects Mercury due to it being too close to the Sun, and the Moon for lack of atmosphere and its twenty-eight-day “day” (a Martian day, or “sol,” for comparison, is an Earthling-friendly 24.5 hours). And he rejects, at least for now, the moons of Jupiter or Saturn, as they are much harder to get to. Mars has more than its own share of habitability issues, but Musk does not mention them, other than to say that, while Mars is “a little cold” (in reality, -63ºC, or -81ºF, compared to Earth’s balmy 16ºC, or 57ºF), “we can warm it up.” The Martian atmosphere is “very helpful” because it’s primarily CO2, with some nitrogen and argon, meaning that “we can grow plants on Mars just by compressing the atmosphere.” Most cheery of all, Musk says it would be “quite fun” to be on Mars, because the gravity is about 38 percent that of Earth, making it easy to lift heavy things and “bound around.” Mars, as seen from space. (WikiImages via Pixabay) It’s all so simple. “We just need to change the populations because currently we have seven billion people on Earth and none on Mars.” And so the paper is primarily devoted to explaining how to solve that sole problem: how to lower the cost of a trip to Mars from the current roughly $10 billion per person down to the median cost of a house in the United States. By making rockets reusable, refilling in orbit, producing propellant on Mars, choosing the right propellant, and improving system design and performance, Musk reckons he can get the cost of a ticket down to $200,000, perhaps as little as $100,000. And Musk’s SpaceX has done a tremendous job so far of sharply reducing the cost of escaping Earth’s gravity well, primarily via deep vertical integration of the firm. It produces a whopping 70 percent of its components in-house, as opposed to the 1,200 different suppliers in the outsourced supply chain of its main competitor, the Boeing–Lockheed Martin partnership known as the United Space Alliance. Each of these suppliers extracts their own profit margin from every contract in the chain, jacking up the cost per launch to $460 million. SpaceX, by comparison, charges NASA and its other clients just $62 million per launch, and Musk says he has slashed the marginal cost of a reused Falcon 9 booster launch to a mere $15 million. Well done, Elon. Or, rather, well done to all the engineers, logistical experts, and other workers who have done most of the labor, allowing SpaceX to revolutionize the business model of getting to space. There is not really any mention of the enormous challenges of the atmosphere’s low pressure and toxic composition, the preponderance of deadly perchlorates in the soil, or the lack of magnetosphere to protect against solar and cosmic radiation. The current atmosphere of Mars is too thin to support most life: its pressure is only about 1 percent that of Earth. Only hypopiezotolerant microbes (those that live in low-pressure environments), such as ones that are lofted by winds into Earth’s stratosphere, would be able to survive. The atmosphere is also 95 percent carbon dioxide — fine for plants (if the pressure were able to be raised) but not for animals. Musk does say that once Mars is warmed up, “we would once again have a thick atmosphere and liquid oceans.” Bioremediation using bacteria to clean up perchlorates already occurs on Earth, but we are talking about an entire planet here. There is no discussion of how any of this might happen, over what time period, and who would pay for it. Same with the construction of an artificial magnetosphere. Dealing with the perchlorates alone would likely be profoundly more challenging and expensive than the relatively straightforward process of decarbonizing Earth’s economy. A 2018 NASA study found that there is insufficient CO2 and H2O from the Martian soil, polar ice caps, and minerals in the upper crust to get anywhere close to thickening the atmosphere and using it like a blanket to warm up the planet. All these sources combined would still only boost the pressure to about 7 percent of that of Earth. Carbon-bearing minerals deep in the crust might have enough CO2 to achieve the needed pressure, but nothing is known about their extent, and recovering them with current technology would be colossally energy intensive. Another idea is to direct comets or asteroids to crash into Mars and release their greenhouse gases that way. Again, these are fantastical ideas that will be impractical for many, many generations yet to come. NASA astronauts in space. (NASA) And there is likely no way of ever overcoming Mars’s low gravity. If you added all the mass of Venus to that of Mars, smashing the planets together, even then, you would still not quite achieve Earth’s gravity. It is true that we do not know what the physiological effects of 38 percent of Earth’s gravity are, either on humans or other life. We have two data points: Earth gravity, what we call 1G, and the 0G microgravity of the International Space Station (ISS). But from studies of astronauts who have spent extended periods aboard the ISS, we know that 0G is extremely bad for human health. Muscles atrophy. Tendons and ligaments begin to fail. Facial and finger muscles, which cannot be worked out via onboard gyms or treadmills, weaken. The spine lengthens, with astronauts gaining an inch or two in height and suffering from back pain. Bones demineralize, losing density at a rate of 1 percent per month. As Christopher Wanjek, a former NASA science writer and author of 2020 book Spacefarers — which is an optimistic volume on the viability of manned space travel — notes: “To visualize how bad that bone loss is, consider the fact that the major obstacle to fully recycling urine into drinking water on the ISS is that the filters get clogged daily with calcium deposits.” Wanjek writes how the rate of vision loss is such that a crew to Mars would need to pack eyeglasses with various prescriptions for “each phase of their gradual, inevitable, and permanent vision loss.” Kidneys get confused by blood not being where it’s supposed to be and think there is an excess, so they start to remove what they believe to be excess water. The blood thickens, driving a reduced production of red blood cells, which in turn drives anemia, shortness of breath, lethargy, and greater likelihood of infection. Perhaps worst of all, brain compression resulting from microgravity negatively impacts regions responsible for fine motor movement and executive function — deteriorations that could be permanent. A range of interventions, including exercise, drugs, and compression clothing can shave the sharp edges off some of these effects, but ultimately, the solution on a spacecraft is the simulation of gravity via centrifugal force — a spinning ship. This is not something that you can do with a whole planet. It is for this reason that Venus, with its gravity not too far off that of Earth, may actually be a better terraforming candidate than Mars — one day — despite its currently inhospitable atmosphere. The Real Business of SpaceX Isn’t Mars. One has to suspect that Musk knows all this. We have a hint of this when, at one point in his paper, Musk concedes that it will be difficult to fund his vision just by slashing the cost of getting to space. He admits that SpaceX expects to generate substantial cash flow from launching lots of satellites and servicing the International Space Station for NASA. Additional help for bankrolling the Mars project might come from the emergence of a market for really fast transportation of things or people around the world by rocket: cargo could be transported anywhere on Earth in forty-five minutes, and a trip from New York to Tokyo could take a mere twenty-five minutes (so long as takeoff and landing takes place where the tremendous noise, as he puts it in hip-CEO-speak, “is not a super-big deal”). As a result, one gets the impression by reading between the lines that a self-sustaining Martian city is all just an impressive marketing maneuver taking advantage of most people’s sense of adventure and wonder; of our species’ ancient need to wander and explore. The real business of SpaceX was never a Martian colony but rather servicing a mature satellite market, stealing government space contracts from the likes of Boeing, and kicking off a terrestrial rocket transport sector. The dream of Mars is, in this case, not really any different from the adman’s fiction of romance and aspiration that sells a can of Pepsi or a Jeep. The dream of Mars is, in this case, not really any different from the adman’s fiction of romance and aspiration that sells a can of Pepsi or a Jeep. None of this is to suggest that establishing an outpost on Mars for the purposes of scientific exploration should not be attempted, even in the next couple of decades. But an outpost, as Musk himself makes clear, does not approach a self-sustaining city, and still less a multi-planetary species. Because humans do need to exit Earth at some point in order to maintain the species, if we are to establish genuinely self-sustaining colonies, then terraforming will likely be necessary one day, as well as interstellar generation ships that take us to habitable exoplanets far beyond the solar system. For all of this, we will have to figure out how to take our ecology with us. We are not really the collection of individuals we thought we were, but rather are deeply embedded within our ecosystems. Indeed, each of us is a microbial ecosystem whose edges are vague. Where does the bacterial, fungal, and viral multitude that is “me” stop and my equally microbiological environment begin? This does not mean that Earth will be the only home we ever have, but it does mean that the antiseptic, forestless, riverless Starship Enterprise would leave its inhabitants very sick before too long. How much of our ecology do we need to take with us, though? We just don’t know yet. The science of ecology is very much still a young discipline. This is where fantastical science-fiction conceptions of vast ships made from hollowed out asteroids and packed with different biomes fills the gap of what we do not know. Likewise for novels like Becky Chambers’s To be Taught, if Fortunate, in which, instead of terraforming other worlds, adapting them to our needs, we genetically alter our bodies via “somaforming” to adapt ourselves to their conditions. Plainly, then, there is no rush for any of this, even as there is a moral imperative for us, one day in the distant future, to permanently exit Earth. Our colonization of other worlds is akin to the building of the grandest cathedral we have ever envisaged: a project that will take centuries, or more likely millennia, many millennia. This is nothing that a private company can deliver. There is no near-term return on investment; indeed, there is no aim of profitability at all, but rather of our species’ survival through the eons.

**The legal playing field right now allows private companies to claim resources in space – that is likely to be modeled by other countries and will culminate in systemic exploitation of outer space.**

Matt **Williams**,(reporter)12-11-20**17**, "Trump signs an executive order allowing mining the moon and asteroids," No Publication, https://phys.org/news/2020-04-trump-moon-asteroids.html//ak//

In 2015, the Obama administration signed the U.S. Commercial Space Launch Competitiveness Act (CSLCA, or H.R. 2262) into law. This bill was intended to "facilitate a pro-growth environment for the developing commercial space industry" by making it legal for American companies and citizens to own and sell resources that they extract from asteroids and off-world locations (like the moon, Mars or beyond).¶ On April 6th, the Trump administration took things a step further by signing an executive order that formally recognizes the rights of private interests to claim resources in space. This order, titled "Encouraging International Support for the Recovery and Use of Space Resources," effectively ends the decades-long debate that began with the signing of the Outer Space Treaty in 1967.¶ This order builds on both the CSLCA and Space Directive-1 (SD-1), which the Trump administration signed into law on December 11th, 2017. It establishes that "Americans should have the right to engage in commercial exploration, recovery, and use of resources in outer space, consistent with applicable law," and that the United States does not view space as a "global commons."¶ The Outer Space Treaty¶ This order puts an end to decades of ambiguity regarding commercial activities in space, which were technically not addressed by the Outer Space or Moon treaties. The former, formally known as "The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies", was signed by the U.S., the Soviet Union, and the U.K. in 1967 at the height of the Space Race.¶ Apollo 11’s Saturn V rocket prior to the launch July 16, 1969. Screenshot from the 1970 documentary “Moonwalk One.” Credit: NASA/Theo Kamecke/YouTube¶ The purpose of it was to provide a common framework governing the activities of all the major powers in space. In addition to banning the placement or testing of nuclear weapons in space, the Outer Space Treaty established that the exploration and use of outer space would be carried out for the benefit "of all mankind."¶ As of June 2019, the treaty has been signed by no less than 109 countries, while another 23 have signed it but have not yet completed the ratification process. At the same time, there has been an ongoing debate regarding the full meaning and implications of the treaty. Specifically, Article II of the treaty states: "Outer space, including the moon and other celestial bodies, is not subject to national appropriation by claim of sovereignty, by means of use or occupation, or by any other means."¶ As the language is specific to national ownership, there has never been a legal consensus on whether or not the treaty's prohibitions apply to private appropriation, as well. Because of this, there are those who argue that property rights should be recognized on the basis of jurisdiction rather than territorial sovereignty.¶ The Moon Treaty¶ Artist’s illustration of the new spacesuit NASA is designing for Artemis astronauts. It’s called the xEMU,, or Exploration Extravehicular Mobility Unit. Credit: NASA¶ Attempts to address this ambiguity led the United Nations to draft the supplemental "Agreement Governing the Activities of States on the Moon and Other Celestial Bodies" aka "The Moon Treaty" or "Moon Agreement." Like the Outer Space Treaty, this agreement stipulated that the moon should be used for the benefit of all humanity and that non-scientific activities should be governed by an international framework.¶ However, to date, only 18 countries have ratified the Moon Treaty, which does not include the U.S., Russia, or any other major power in space (save for India). In addition, only 17 of the 95 member states who signed the Outer Space Treaty have become signatories on the Moon Treaty. This latest order, titled "Executive Order on Encouraging International Support for the Recovery and Use of Space Resources," addresses this very issue, stating:¶ "Uncertainty regarding the right to recover and use space resources, including the extension of the right to commercial recovery and use of lunar resources, however, has discouraged some commercial entities from participating in this enterprise. Questions as to whether the 1979 Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (the "Moon Agreement") establishes the legal framework for nation states concerning the recovery and use of space resources have deepened this uncertainty, particularly because the United States has neither signed nor ratified the Moon Agreement."¶ The administration considers this act to be complimentary to SD-1, which emphasizes the importance of commercial partners in Project Artemis and NASA's plan to explore Mars and beyond. "Successful long-term exploration and scientific discovery of the moon, Mars, and other celestial bodies will require partnership with commercial entities to recover and use resources, including water and certain minerals, in outer space," the directive states.¶ Return to the moon¶ Infographic of the evolution of lunar activities on the surface and in orbit. Credit: NASA¶ After Artemis III accomplishes the long-awaited goal of sending the first astronauts to the moon since the end of the Apollo era, NASA's plans will shift toward the long-term aim of creating a "sustainable program" of lunar exploration. This will include the creation of the Lunar Gateway (an orbital habitat) as well as the Lunar Base Camp on the surface of the moon.¶ These two habitats and research stations will allow for long-term stays on the moon, a wide array of scientific experiments, and even the ability to conduct on-site refueling. Combined with a reusable lunar lander, lunar rovers and other non-expendable elements, they will also facilitate regular missions to the moon and an overall reduction in costs.¶ For years, prospectors and space mining companies like Planetary Resources and Deep Space Industries have been advocating for reforms that would allow for the commercial exploitation of space. Similarly, people like Peter Diamandis (founder of X Prize and HeroX) and science communicator Neil DeGrasse Tyson have been saying for years that the first trillionaires will make their fortunes from asteroid mining.¶ Incidentally, NASA and HeroX recently launched the "Honey, I Shrunk the NASA Payload" challenge, which is offering $160,000 to the team that can come up with a solution to miniaturize payloads to the point where they are "similar in size to a new bar of soap"—100 x 100 x 50 mm (3.9 x 3.9 x 1.9 inches) and weighing no more than 0.4 kg (0.8 lbs).¶ The purpose of this challenge is to significantly reduce the cost of sending payloads to the moon in support of future lunar missions. However, it could also enable a new generation of mini-rovers that would explore the lunar surface for resources. As the hosts indicate on the challenge site:¶ The JPL-led challenge is seeking tiny payloads no larger than a bar of soap for a miniaturized Moon rover. Credit: NASA¶ "We need to develop practical and affordable ways to identify and use lunar resources so that our astronaut crews can become more independent of Earth… Imagine a rover the size of your Roomba crawling the moon's surface. These small rovers developed by NASA and commercial partners provide greater mission flexibility and allow NASA to collect key information about the lunar surface."¶ It is not hard to imagine at all that miniature rover's would also enable commercial entities the ability to explore asteroids and the lunar surface for resources that could be harvested and processed for export back to Earth. However, not everyone is so excited by this recent move or the prospects that it entails.¶ Dissenting Views¶ In fact, Russia's space agency (Roscosmos) officially condemned the executive order and likened it to colonialism. These sentiments were summed up in a statement issued by Sergey Saveliev, Roscosmos' deputy director-general on international cooperation:¶ "Attempts to expropriate outer space and aggressive plans to actually seize territories of other planets hardly set the countries (on course for) fruitful cooperation. There have already been examples in history when one country decided to start seizing territories in its interest—everyone remembers what came of it."¶ Artist’s impression of a lunar base. Credit: Newspace2060¶ Saveliev is hardly alone in drawing parallels between the NewSpace industry (or Space Race 2.0) and the age of imperialism (ca. 18th to 20th century). Last year, Dr. Victor Shammas of the Work Research Institute at Oslo Metropolitan University and independent scholar Tomas Holen produced a study that appeared in Palgrave Communications (a publication maintained by the journal Nature).¶ Titled, "One giant leap for capitalist kind: private enterprise in outer space," Shammas and Holen assert that the commercial exploitation of space will benefit human beings disproportionately. At the heart of this effort are Elon Musk, Jeff Bezos, and other Silicon Valley-billionaires that—contrary to their humanist pretenses—are looking to expand their wealth while taking advantage of the fact that there is little to no oversight in this area.¶ "In this regard," they wrote, "SpaceX and related ventures are not so very different from maritime colonialists and the trader-exploiters of the British East India Company." For the record, the East India Company operated with impunity in India while it was under British rule, effectively making them the real governing authority over the nation and its people.¶ Credit: NASA/JPL/911Metallurgist/NeoMam Studios¶ Could asteroid mining, lunar mining, and other off-world concerns become the new colonialism? Could various companies staking claims to bodies, planets, and moons set off a period of conflict and cutthroat politics similar to what existed during the 18th to early 20th centuries? Or could this be the beginning of "post-scarcity" for humanity and an economic revolution?¶ And is this condemnation by Russian authorities merely an expression of lament because they don't feel well-positioned to take advantage and will that change if the Russian equivalent of a Musk or Bezos emerges? And what might we expect from countries like China and India that have been making significant strides in space for years?¶ All valid questions, and one which will have to be explored with greater energy and commitment now that the U.S. has officially declared that the moon and space are "open for business." It also wouldn't be surprising if certain charlatans try to push the whole "buy land on the moon" scam with greater vigor, too.

**Increasing the number of satellites from private companies like SpaceX would massively increase the risk of dangerous space debris.**

**Scheer and Moss 20** [(Roddy Scheer and Doug Moss, ) “The Good, The Bad &amp; The Ugly: Satellites &amp; The Environment,” Emagazine https://www.newsbreak.com/news/2178042533743/the-good-the-bad-the-ugly-satellites-the-environment, 8-13-2020//Ak//

Putting satellites up into the ionosphere—the layer of our atmosphere extending from 50-600 miles above the surface where a high concentration of ions and free electrons facilitate the reflection of radio waves—isn’t anything new. The Soviets beat us to the punch when they launched the first satellite, Sputnik, in 1957, but these days there are over 9,000 satellites overhead, the majority from U.S. companies and government agencies. But with Elon Musk’s SpaceX poised to launch tens of thousands of new ones in the next few years, many people wonder whether putting all this technology overhead is such a good idea. One concern is that all this hardware eventually breaks down and shed parts. Peter Greenstreet of the Institute of Physics reports that this so-called “space junk” orbits at some 7.5 kilometers per second—so fast that even the tiniest pieces create a potential hazard for space stations and other man-made or natural objects making the same rounds.

#### That debris risks a nightmare scenario known as the Kessler syndrome – debris from private space flight ensures massive satellite destruction.

**Thompson 20** [(Clive, author of Coders: The Making of a New Tribe and the Remaking of the World, a columnist for Wired magazine, and a contributing writer to The New York Times Magazine) “Monetizing the Final Frontier The strange new push for space privatization,” December 3, 2020 <https://newrepublic.com/article/160303/monetizing-final-frontier>//ak //

“Physics tells us that two things can’t occupy the same space at the same time or else bad things happen,” Jah said dryly. Indeed, there’s already been one collision that produced sprawling orbital pollution. In 2009, a satellite owned by the U.S. firm Iridium slammed into a decommissioned Russian government satellite at more than 26,000 mph. The crash produced 2,300 pieces of debris, spraying off in all directions. And debris is a particularly gnarly problem in space, because when it’s traveling at thousands of miles an hour, even a marble-size chunk is like a bullet, capable of rendering a damaged satellite inoperable and unsteerable—the owner can no longer fire its boosters to guide it into a higher or lower orbit. There are currently an estimated 500,000 marble-size chunks up there. Decades of space travel by governments left plenty of refuse, ranging from parts of rocket boosters to stray bits of scientific experiments. One particularly grim vision of the future that haunts astronomers is the “Kessler syndrome,” proposed by the astrophysicist Donald Kessler in 1978. Kessler hypothesized that space clutter could reach a tipping point: One really bad collision could produce so much junk that it would trigger a chain reaction of collisions. This disaster scenario would leave hundreds of satellites eventually destroyed, and create a ring of debris that would make launching any new satellites impossible, forever. “Near space is finite—it’s a finite resource,” Jah said. “So now you have this growing trash problem that isn’t being remediated.... And if we exceed the capacity of the environment to carry all this traffic safely, then it becomes unusable.” That’s why a growing chorus of critics are already making the case that space is the next major environmental area to protect, after the oceans and land on Earth. “People seem to really treat resources in space as being infinite,” said Erika Nesvold, an astrophysicist who’s the cofounder of The JustSpace Alliance. “As we’ve seen, people don’t really intuitively understand exponential growth.” That’s the dilemma in a nutshell: The available room in the sky is limited, but the plans for growth are exponential. SpaceX isn’t the only New Space firm looking to toss up satellites. Satellite and rocket start-ups are now lining up en masse, atop new waves of investment. There are satellites geared up to connect to “the internet of things” so companies can communicate among proprietary networks of household devices. There are floating cameras pointing down—so as to gather “geospatial intelligence,” which is to say data streamed from “the vantage point you get from satellites looking down on Earth and giving us information about our planet,” as the venture capitalist Anderson told me. And new forms of satellite vision are emerging all the time, such as cameras that can see at night, or are specially designed to see agriculture. Experiments abound, and so satellite launches will inevitably multiply in their wake. Part of what makes near-Earth orbit so chaotic is that it is, at the moment, remarkably unregulated—not unlike the internet of the early ’90s. An American firm has to get permission from the Federal Communications Commission to launch a satellite, but once it’s in orbit, there’s no federal agency that can compel it to move out of the path of a collision. Satellite owners generally don’t like to move if they can avoid it, because their satellites have a limited amount of fuel; any movement decreases their usable lifespan. On top of that, there are dozens of nations shooting satellites into low-Earth orbit—but no international body coordinating their flight paths. Last fall, the European Space Agency realized one of SpaceX’s new Starlink satellites was on a dangerously close path to an ESA satellite. SpaceX said it had no plans to move the satellite; so the ESA decided to fire its thrusters and get clear. This high-stakes negotiation was conducted via email. What’s more, space debris is extremely hard to source. If a British satellite slams into yours, you can probably figure out who hit you. But if your satellite is wrecked by a random piece of junk, nobody has any clue where that debris came from. It is, in this way, a neat parallel to the problem of C02, where a ceaseless barrage of tiny commercial decisions creates a sprawling problem—one that’s all but designed to ensure that everyone who caused it can deny responsibility. And damage is asymmetric: A company with a small $60,000 satellite could smash into a wildly expensive one paid for by U.S. taxpayers. “A National Reconnaissance Office satellite is at least a billion dollars, if not more, so they have a lot more to lose if something hits a satellite,” Bhavya Lal, a researcher at the IDA Science and Technology Policy Institute, noted. “As more private activity starts to happen, there’s more chances of that loss of control, too.” One might dismiss all this anxiety as a sort of sci-fi version of hippie environmentalism—except that even the administrator of NASA is deeply worried about the chaos and destruction likely to be sown by commercial activity in near-Earth orbit. Jim Bridenstine, the Trump-appointed head of NASA, is as pro-market as one can be. He praises SpaceX every chance he gets; he talks about privatizing the space station. But when I asked him about the looming danger of space debris, during a press-conference call, he conceded that it’s a huge, unresolved issue.

#### Climate satellites are key to preventing the impacts of global warming, especially in developing countries, AND, policymakers need evidence from climate satellites to base their climate policies.

**Alonso 18** [(Elisa Jiménez Alonso, communications consultant with Acclimatise, climate resilience organization) “Earth Observation of Increasing Importance for Climate Change Adaptation,” Acclimatise, May 2, 2018, <https://www.acclimatise.uk.com/2018/05/02/earth-observation-of-increasing-importance-for-climate-change-adaptation/ak//>

Earth observation (EO) satellites are playing an increasingly important role in assessing climate change. By providing a constant and consistent stream of data about the state of the climate, EO is not just improving scientific outcomes but can also inform climate policy.¶ Managing climate-related risks effectively requires accurate, robust, sustained, and wide-ranging climate information. Reliable observational climate data can help scientists test the accuracy of their models and improve the science of attributing certain events to climate change. Information based on projections from models and historic data can help decision makers plan and implement adaptation actions.¶ Providing information in data-sparse regions¶ Ground-based weather and climate monitoring systems only cover about 30% of the Earth’s surface. In many parts of the world such data is incomplete and patchy due to poorly maintained weather stations and a general lack of such facilities.¶ EO satellites and rapidly improving satellite technology, especially data from open access programmes, offer a valuable source information for such **data-sparse regions**. This is especially important since countries and regions with a lack of climate data are often particularly vulnerable to climate change impacts.¶ International efforts for systematic observation¶ The importance of satellite-based observations is also recognised by the international community. Following the recommendations of the World Meteorological Organization’s (WMO) Global Climate Observing System (GCOS) programme, the UNFCCC strongly encourages countries that support space agencies with EO programmes to get involved in GCOS and support the programme’s implementation. The Paris Agreement highlights the need for and importance of effective and progressive responses to the threat of climate change based on the best available scientific knowledge. This implies that climate knowledge needs to be strengthened, which includes continuously improving systematic observations of the Earth’s climate.¶ To meet the need of such systematic climate observations, GCOS developed the concept of the Essential Climate Variable, or ECV. According to WMO, an ECV “is a physical, chemical or biological variable or a group of linked variables that critically contributes to the characterization of Earth’ s climate.” In 2010, 50 ECVs which would help the work of the UNFCCC and IPCC were defined by GCOS. The ECVs, which can be seen below, were identified due to their relevance for characterising the climate system and its changes, the technical feasibility of observing or deriving them on a global scale, and their cost effectiveness.¶ The 50 Essential Climate Variables as defined by GCOS.¶ One effort supporting the systemic observation of the climate is the European Space Agency’s (ESA) Climate Change Initiative (CCI). The programme taps into its own and its member countries’ EO archives that have been established in the last three decades in order to provide a timely and adequate contribution to the ECV databases required by the UNFCCC.¶ Robust evidence supporting climate risk management¶ Earth observation satellites can observe the entire Earth on a daily basis (polar orbiting satellites) or continuously monitor the disk of Earth below them (geostationary satellites) maintaining a constant watch of the entire globe. Sensors can target any point on Earth even the most remote and inhospitable areas which helps monitor deforestation in vast tropical forests and the melting of the ice caps.¶ Without insights offered by EO satellites there would not be enough evidence for decision makers to base their climate policies on, increasing the risk of **maladaptation**. Robust EO data is an invaluable resource for collecting climate information that can inform climate risk management and make it more effective.

**Space debris affects developing countries more – climate change and falling debris ravages countries who played no role in creating this crisis.**

Anél Ferreira**-Snyman**, March 20**13**, [Professor of Law, [University of South Africa](https://scholar.google.com/citations?view_op=view_org&hl=en&org=10976511949285581406)],Institute of Foreign and Comparative Law, https://www.jstor.org/stable/pdf/23644687.pdf?refreqid=excelsior%3Aa1967e39b015b325681ae4df0973545c//Ak//

As African states realise the socio-economic and human security benefits of space applications and thus become increasingly involved in space activities, the issue of space debris will inevitably also become a greater concern for these states. The consequences of damage as a result of satellites being involved in accidents with space debris will be especially serious for the developing states which have limited resources.175 There is also a possibility of environmental damage on the territories of the developing states as a result of falling space debris. It is, therefore, imperative that more African states (including states not involved in space activities) become parties to and comply with the space treaties. They should further increase their representation in the UNCOPUOS in order to have stronger bargaining power and influence in this Committee, by presenting a united African position on space issues.17 which is based on the idea of international equity, environmental degradation has its origin mainly in industrialised countries and they should, therefore, be primarily responsible for eradicating environmental pollution. These countries usually also have greater capacity to respond to environmental problems and they should, therefore, assist developing countries in accessing relevant resources and technologies to achieve sustainable development.179 As a result of the difference in the social, economic, and ecological circumstances of states, the environmental standards applied to industrialised and developing countries cannot be the same, hence the need for a differentiated approach.180 In the context of outer space, non-space-faring nations insist that the space faring nations (thus mainly industrialised countries) that have caused (and continue to cause) the current levels of space pollution, should bear the main responsibility to improve the situation, so as to guarantee the possibility of future space activity (including that of developing states). Space-faring nations are obviously in a better position to take the necessary action in this regard.181 Although the principle of 'common but differentiated responsibilities' is not included in any of the outer space treaties, Viikari submits that the space sector might be more receptive to the principle in future in view of the general movement towards creating multilateral accountability.182 She suggests the creation of a space fund as an expression of the ideals of common but differentiated responsibilities. The fund can be used for the benefit of future generations. Such a fund is in conformity with the notion, referred to earlier, that states are the trustees of mankind's common¶ resources

**Climate change is responsible for devastating consequences that disproportionately target marginalized populations in developing countries – it is the largest structural violence impact.**

(Abrahm **Lustgarten, 2020**- senior environmental reporter at ProPublica, “HOW CLIMATE MIGRATION WILL RESHAPE AMERICA,” 15 September 2020, New York Times, https://www.nytimes.com/interactive/2020/09/15/magazine/climate-crisis-migration-america.html)//ak//

August besieged **California** with a heat unseen in generations. A surge in air-conditioning broke the state’s electrical grid, leaving a population already ravaged by the coronavirus to work remotely by the dim light of their cellphones. By midmonth, the state had **recorded** possibly **the hottest temperature ever measured on earth — 130 degrees in Death Valley** — and an otherworldly storm of lightning had cracked open the sky. From Santa Cruz to Lake Tahoe, thousands of bolts of electricity exploded down onto withered grasslands and forests, some of them already hollowed out by climate-driven infestations of beetles and kiln-dried by the worst five-year drought on record. Soon, **California was on fire.** Over the next two weeks, 900 blazes incinerated six times as much land as all the state’s 2019 wildfires combined, forcing 100,000 people from their homes. Three of the largest fires in history burned simultaneously in a ring around the San Francisco Bay Area. Another fire burned just 12 miles from my home in Marin County. I watched as towering plumes of smoke billowed from distant hills in all directions and air tankers crisscrossed the skies. Like many Californians, I spent those weeks worrying about what might happen next, wondering how long it would be before an inferno of 60-foot flames swept up the steep, grassy hillside on its way toward my own house, rehearsing in my mind what my family would do to escape. But I also had a longer-term question, about what would happen once this unprecedented fire season ended. Was it finally time to leave for good? I had an unusual perspective on the matter. For two years, I have been studying how climate change will influence global migration. My sense was that **of all the devastating consequences of a warming planet** — changing landscapes, pandemics, mass extinctions — [**the potential movement of hundreds of millions of climate refugees across the planet**](https://www.nytimes.com/interactive/2020/07/23/magazine/climate-migration.html) **stands to be among the most important**. I traveled across four countries to witness how rising temperatures were driving climate refugees away from some of the poorest and hottest parts of the world. I had also helped create an enormous computer simulation to analyze how global demographics might shift, and now I was working on a data-mapping project about migration here in the United States. So it was with some sense of recognition that I faced the fires these last few weeks. In recent years, summer has brought a season of fear to California, with ever-worsening wildfires closing in. But this year felt different. The hopelessness of the pattern was now clear, and the pandemic had already uprooted so many Americans. Relocation no longer seemed like such a distant prospect. Like the subjects of my reporting, climate change had found me, its indiscriminate forces erasing all semblance of normalcy. Suddenly I had to ask myself the very question I’d been asking others: Was it time to move? I am far from the only American facing such questions**. This summer has seen more fires, more heat, more storms — all of it making life increasingly untenable** in larger areas of the nation. Already, **droughts** regularly **threaten** food **crops across the West, while destructive floods inundate towns and fields from the Dakotas to Maryland,** [collapsing dams in Michigan](https://www.nytimes.com/2020/05/21/climate/dam-failure-michigan-climate-change.html) and [raising the shorelines of the Great Lakes](https://www.nytimes.com/2019/08/24/us/great-lakes-water-levels.html#:~:text=Though%20water%20levels%20have%20always,warmer%20temperatures%20and%20increased%20evaporation.&text=MICH.,-CANADA). **Rising seas and increasingly violent hurricanes are making thousands of miles of American shoreline nearly uninhabitable**. As California burned, Hurricane Laura pounded the Louisiana coast with 150-mile-an-hour winds, killing at least 25 people; it was the 12th named storm to form by that point in 2020, another record. Phoenix, meanwhile, endured 53 days of 110-degree heat — 20 more days than the previous record. For years, Americans have avoided confronting these changes in their own backyards. The decisions we make about where to live are distorted not just by politics that play down climate risks, but also by expensive subsidies and incentives aimed at defying nature. In much of the developing world, vulnerable people will attempt to flee the emerging perils of global warming, seeking cooler temperatures, more fresh water and safety. But here **in the United States, people have largely gravitated toward environmental danger, building along coastlines** from New Jersey to Florida and settling across the cloudless deserts of the Southwest. I wanted to know if this was beginning to change. Might Americans finally be waking up to how climate is about to transform their lives? And if so — if a great domestic relocation might be in the offing — was it possible to project where we might go? To answer these questions**, I interviewed more than four dozen experts: economists and demographers, climate scientists and insurance executives, architects and urban planners, and I mapped out the danger zones that will close in on Americans over the next 30 years.** The maps for the first time combined exclusive climate data from the Rhodium Group, an independent data-analytics firm; wildfire projections modeled by United States Forest Service researchers and others; and data about America’s shifting climate niches, an evolution of work first published by The Proceedings of the National Academy of Sciences last spring. (See a detailed analysis of the maps.) What I found was a nation on the cusp of a great transformation. Across the United States, some **162 million people** — nearly one in two — **will** most likely **experience a decline in the quality of their environment, namely more heat and less water**. For 93 million of them, the changes could be particularly severe, and by 2070, our analysis suggests, if carbon emissions rise at extreme levels, at least four million Americans could find themselves living at the fringe, in places decidedly outside the ideal niche for human life. **The cost of resisting the new climate reality is mounting.** Florida officials have already acknowledged that defending some roadways against the sea will be unaffordable. And the nation’s federal flood-insurance program is for the first time requiring that some of its payouts be used to retreat from climate threats across the country. It will soon prove too expensive to maintain the status quo. By 2070, some 28 million people across the country could face Manhattan-size megafires. In Northern California, they could become an annual event. Then what? One influential 2018 study, published in The Journal of the Association of Environmental and Resource Economists, suggests **that one in 12 Americans in the Southern half of the country will move toward California, the Mountain West or the Northwest** over the next 45 years because of climate influences alone. **Such a shift** in population **is likely to increase poverty and widen the gulf between the rich and the poor. It will accelerate rapid**, perhaps chaotic, **urbanization of cities ill-equipped for the burden, testing their capacity to provide basic services** and amplifying existing inequities. **It will** eat away at prosperity, **deal**ing **repeated economic blows to coastal**, rural and Southern **regions**, **which could in turn push entire communities to the brink of collapse. This** process **has already begun in** rural **Louisiana and** coastal **Georgia, where low-income and Black and Indigenous communities face environmental change on top of poor health and extreme poverty**. Mobility itself, global-migration experts point out, is often a reflection of relative wealth, and as some move, **many** others **will be left behind.** Those who stay risk becoming trapped as the land and the society around them ceases to offer any more support. There are signs that the message is breaking through. Half of Americans now rank climate as a top political priority, up from roughly one-third in 2016, and three out of four now describe climate change as either “a crisis” or “a major problem.” This year, Democratic caucusgoers in Iowa, where tens of thousands of acres of farmland flooded in 2019, ranked climate second only to health care as an issue. A poll by researchers at Yale and George Mason Universities found that even Republicans’ views are shifting: One in three now think climate change should be declared a national emergency. **Policymakers**, having left America unprepared for what’s next, now **face brutal choices about which communities to save** — often at exorbitant costs — **and which to sacrifice. Their decisions will** almost inevitably make the nation more **divide**d, **with those worst off relegated to a nightmare future** in which they are left to fend for themselves. Nor will these disruptions wait for the worst environmental changes to occur. **The wave begins when individual perception of risk starts to shift**, when the environmental threat reaches past the least fortunate and rattles the physical and financial security of broader, wealthier parts of the population. It begins when even places like California’s suburbs are no longer safe. **It has already begun**. Let’s start with some basics. Across the country, it’s going to get hot. Buffalo may feel in a few decades like Tempe, Ariz., does today, and Tempe itself will sustain 100-degree average summer temperatures by the end of the century**. Extreme humidity** from New Orleans to northern Wisconsin **will** make summers increasingly unbearable, **turn**ing otherwise seemingly survivable **heat waves into debilitating health threats.** **Fresh water will** also **be in short supply**, not only in the West but also in places like Florida, Georgia and Alabama, where droughts now regularly wither cotton fields. **By 2040**, according to federal government projections, **extreme water shortages will be** nearly **ubiquitous** west of Missouri. The Memphis Sands Aquifer, a crucial water supply for Mississippi, Tennessee, Arkansas and Louisiana, is already overdrawn by hundreds of millions of gallons a day. Much of the Ogallala Aquifer — which supplies nearly a third of the nation’s irrigation groundwater — could be gone by the end of the century. **It can be difficult to see the challenges clearly because so many factors are in play**. At least **28 million Americans are likely to face megafires** like the ones we are now seeing in California, in places like Texas and Florida and Georgia. At the same time, **100 million Americans** — largely in the Mississippi River Basin from Louisiana to Wisconsin — **will increasingly face humidity so extreme that working outside** or playing school sports **could cause heatstroke. Crop yields will be decimated** from Texas to Alabama and all the way north through Oklahoma and Kansas and into Nebraska. **The challenges are so widespread and so interrelated that Americans seeking to flee one could well run into another.** I live on a hilltop, 400 feet above sea level, and my home will never be touched by rising waters. But by the end of this century, if the more extreme projections of eight to 10 feet of sea-level rise come to fruition, the shoreline of San Francisco Bay will move three miles closer to my house, as it subsumes some 166 square miles of land, including a high school, a new county hospital and the store where I buy groceries. The freeway to San Francisco will need to be raised, and to the east, a new bridge will be required to connect the community of Point Richmond to the city of Berkeley. The **Latino, Asian and Black communities who live in the most-vulnerable low-lying districts will be displaced first**, but research from Mathew Hauer, a sociologist at Florida State University who published some of the first modeling of American climate migration in the journal Nature Climate Change in 2017, suggests that the toll will eventually be far more widespread: Nearly one in three people here in Marin County will leave, part of the roughly 700,000 who his models suggest may abandon the broader Bay Area as a result of sea-level rise alone. From Maine to North Carolina to Texas, **rising sea levels are not just chewing up shorelines but** also **raising rivers and swamping** the subterranean **infrastructure** of coastal communities, making a stable life there all but impossible. Coastal high points will be cut off from roadways, amenities and escape routes, and even far inland, saltwater will seep into underground drinking-water supplies. Eight of the nation’s 20 largest metropolitan areas — Miami, New York and Boston among them — will be profoundly altered, indirectly affecting some 50 million people. Imagine large concrete walls separating Fort Lauderdale condominiums from a beachless waterfront, or dozens of new bridges connecting the islands of Philadelphia. Not every city can spend $100 billion on a sea wall, as New York most likely will. Barrier islands? Rural areas along the coast without a strong tax base? They are likely, in the long term, unsalvageable. In all, Hauer projects that 13 million Americans will be forced to move away from submerged coastlines. Add to that the people contending with wildfires and other risks, and the number of Americans who might move — though difficult to predict precisely — could easily be tens of millions larger. Even 13 million climate migrants, though, would rank as the largest migration in North American history. The Great Migration — of six million Black Americans out of the South from 1916 to 1970 — transformed almost everything we know about America, from the fate of its labor movement to the shape of its cities to the sound of its music. What would it look like when twice that many people moved? What might change? Americans have been conditioned not to respond to geographical climate threats as people in the rest of the world do. It is natural that rural Guatemalans or subsistence farmers in Kenya, facing drought or scorching heat, would seek out someplace more stable and resilient. Even a subtle environmental change — a dry well, say — can mean life or death, and without money to address the problem, migration is often simply a question of survival. By comparison, **Americans** are richer, often much richer, and more insulated from the shocks of climate change. They **are distanced from the food and water sources they depend on, and they are part of a culture that sees every problem as capable of being solved by money. So even as the average flow of the Colorado River — the water supply for 40 million Western Americans and the backbone of the nation’s vegetable and cattle farming** — has declined for most of the last 33 years, the population of Nevada has doubled. At the same time, **more than 1.5 million people have moved to the Phoenix metro area, despite its dependence on that same river** (and the fact that temperatures there now regularly hit 115 degrees). Since Hurricane Andrew devastated Florida in 1992 — and even as that state has become a global example of the threat of sea-level rise — more than five million people have moved to Florida’s shorelines, driving a historic boom in building and real estate. The sense that money and technology can overcome nature has emboldened Americans. Where money and technology fail, though, it inevitably falls to government policies — and government subsidies — to pick up the slack. Thanks to federally subsidized canals, for example, water in part of the Desert Southwest costs less than it does in Philadelphia. The federal National Flood Insurance Program has paid to rebuild houses that have flooded six times over in the same spot. And federal agriculture aid withholds subsidies from farmers who switch to drought-resistant crops, while paying growers to replant the same ones that failed. Farmers, seed manufacturers, real estate developers and a few homeowners benefit, at least momentarily, but the gap between what the climate can destroy and what money can replace is growing. Perhaps no market force has proved more influential — and more misguided — than the nation’s property-insurance system. From state to state, readily available and affordable policies have made it attractive to buy or replace homes even where they are at high risk of disasters, systematically obscuring the reality of the climate threat and fooling many Americans into thinking that their decisions are safer than they actually are. Part of the problem is that most policies look only 12 months into the future, ignoring long-term trends even as insurance availability influences development and drives people’s long-term decision-making. Even where insurers have tried to withdraw policies or raise rates to reduce climate-related liabilities, state regulators have forced them to provide affordable coverage anyway, simply subsidizing the cost of underwriting such a risky policy or, in some cases, offering it themselves. The regulations — called Fair Access to Insurance Requirements — are justified by developers and local politicians alike as economic lifeboats “of last resort” in regions where climate change threatens to interrupt economic growth. While they do protect some entrenched and vulnerable communities, the laws also satisfy the demand of wealthier homeowners who still want to be able to buy insurance. At least 30 states, including Louisiana, Massachusetts, North Carolina and Texas, have developed so-called FAIR plans, and today they serve as a market backstop in the places facing the highest risks of climate-driven disasters, including coastal flooding, hurricanes and wildfires. In an era of climate change, though, such policies amount to a sort of shell game, meant to keep growth going even when other obvious signs and scientific research suggest that it should stop. That’s what happened in Florida. Hurricane Andrew reduced parts of cities to landfill and cost insurers nearly $16 billion in payouts. Many insurance companies, recognizing the likelihood that it would happen again, declined to renew policies and left the state. So the Florida Legislature created a state-run company to insure properties itself, preventing both an exodus and an economic collapse by essentially pretending that the climate vulnerabilities didn’t exist. As a result, Florida’s taxpayers by 2012 had assumed liabilities worth some $511 billion — more than seven times the state’s total budget — as the value of coastal property topped $2.8 trillion. Another direct hurricane risked bankrupting the state. Florida, concerned that it had taken on too much risk, has since scaled back its self-insurance plan. But the development that resulted is still in place. On a sweltering afternoon last October, with the skies above me full of wildfire smoke, I called Jesse Keenan, an urban-planning and climate-change specialist then at Harvard’s Graduate School of Design, who advises the federal Commodity Futures Trading Commission on market hazards from climate change. Keenan, who is now an associate professor of real estate at Tulane University’s School of Architecture, had been in the news last year for projecting where people might move to — suggesting that Duluth, Minn., for instance, should brace for a coming real estate boom as climate migrants move north. But like other scientists I’d spoken with, Keenan had been reluctant to draw conclusions about where these migrants would be driven from. Last fall, though, as the previous round of fires ravaged California, his phone began to ring, with private-equity investors and bankers all looking for his read on the state’s future. Their interest suggested a growing investor-grade nervousness about swiftly mounting environmental risk in the hottest real estate markets in the country. It’s an early sign, he told me, that the momentum is about to switch directions. “And **once this flips**,” he added, “**it’s likely to flip very quickly.”** In fact, the correction — a newfound respect for the destructive power of nature, coupled with a sudden disavowal of Americans’ appetite for reckless development — had begun two years earlier, when a frightening surge in disasters offered a jolting preview of how the climate crisis was changing the rules. On October 9, 2017, a wildfire blazed through the suburban blue-collar neighborhood of Coffey Park in Santa Rosa, Calif., virtually in my own backyard. I awoke to learn that more than 1,800 buildings were reduced to ashes, less than 35 miles from where I slept. Inchlong cinders had piled on my windowsills like falling snow. The Tubbs Fire, as it was called, shouldn’t have been possible. Coffey Park is surrounded not by vegetation but by concrete and malls and freeways. So insurers had rated it as “basically zero risk,” according to Kevin Van Leer, then a risk modeler from the global insurance liability firm Risk Management Solutions. (He now does similar work for Cape Analytics.) But Van Leer, who had spent seven years picking through the debris left by disasters to understand how insurers could anticipate — and price — the risk of their happening again, had begun to see other “impossible” fires. After a 2016 fire tornado ripped through northern Canada and a firestorm consumed Gatlinburg, Tenn., he said, “alarm bells started going off” for the insurance industry. What Van Leer saw when he walked through Coffey Park a week after the Tubbs Fire changed the way he would model and project fire risk forever. Typically, fire would spread along the ground, burning maybe 50 percent of structures. In Santa Rosa, more than 90 percent had been leveled. “The destruction was complete,” he told me. Van Leer determined that **the fire had jumped through the forest canopy, spawning 70-mile-per-hour winds that kicked a storm of embers into the modest homes of Coffey Park, which burned at an acre a second as homes ignited spontaneously from the radiant heat. It was the kind of thing that might never have been possible if California’s autumn winds weren’t getting fiercer and drier every year, colliding with intensifying, climate-driven heat and ever-expanding development. “It’s hard to forecast something you’ve never seen before,**” he said. For me, **the awakening to imminent climate risk** came with California’s rolling power blackouts last fall — an effort to pre-emptively avoid the risk of a live wire sparking a fire — which **show**ed me that all my notional perspective about **climate risk and** my own **life choices** were **on a collision course**. After the first one, all the food in our refrigerator was lost. When power was interrupted six more times in three weeks, we stopped trying to keep it stocked. All around us, small fires burned. Thick smoke produced fits of coughing. Then, as now, I packed an ax and a go-bag in my car, ready to evacuate. As former Gov. Jerry Brown said, it was beginning to feel like the “new abnormal.” It was no surprise, then, that California’s property insurers — having watched 26 years’ worth of profits dissolve over 24 months — began dropping policies, or that California’s insurance commissioner, trying to slow the slide, placed a moratorium on insurance cancellations for parts of the state in 2020. In February, the Legislature introduced a bill compelling California to, in the words of one consumer advocacy group, “follow the lead of Florida” by mandating that insurance remain available, in this case with a requirement that homeowners first harden their properties against fire. At the same time, participation in California’s FAIR plan for catastrophic fires has grown by at least 180 percent since 2015, and in Santa Rosa, houses are being rebuilt in the very same wildfire-vulnerable zones that proved so deadly in 2017. Given **that a new study projects a 20 percent increase in extreme-fire-weather days by 2035**, such practices suggest a special form of climate negligence. It’s only a matter of time before homeowners begin to recognize the unsustainability of this approach. Market shock, when driven by the sort of cultural awakening to risk that Keenan observes, can strike a neighborhood like an infectious disease, with fear spreading doubt — and devaluation — from door to door. It happened that way in the foreclosure crisis. By 2060 in Florida and elsewhere, the costs of sea-level rise and hurricanes will be compounded by knock-on economic challenges, from growing crime to falling productivity. Keenan calls the practice of drawing arbitrary lending boundaries around areas of perceived environmental risk “bluelining,” and indeed many of the neighborhoods that banks are bluelining are the same as the ones that were hit by the racist redlining practice in days past. This summer, climate-data analysts at the First Street Foundation released maps showing that **70 percent more buildings in the United States were vulnerable to flood risk than previously thought; most of the underestimated risk was in low-income neighborhoods**. Such neighborhoods see little in the way of flood-prevention investment. My Bay Area neighborhood, on the other hand, has benefited from consistent investment in efforts to defend it against the ravages of climate change. That questions of livability had reached me, here, were testament to Keenan’s belief that the bluelining phenomenon will eventually affect large majorities of equity-holding middle-class Americans too, with broad implications for the overall economy, starting in the nation’s largest state. Under the radar**, a new class of dangerous debt — climate-distressed mortgage loans — might already be threatening the financial system.** Lending data analyzed by Keenan and his co-author, Jacob Bradt, for a study published in the journal Climatic Change in June shows that small **banks are liberally making loans on environmentally threatened homes, but then quickly passing them along to federal mortgage backers**. At the same time, they have all but stopped lending money for the higher-end properties worth too much for the government to accept, suggesting that the banks are knowingly passing climate liabilities along to taxpayers as stranded assets. Once home values begin a one-way plummet, it’s easy for economists to see how entire communities spin out of control. The tax base declines and the school system and civic services falter, creating a negative feedback loop that pushes more people to leave. Rising insurance costs and the perception of risk force credit-rating agencies to downgrade towns, making it more difficult for them to issue bonds and plug the springing financial leaks. Local banks, meanwhile, keep securitizing their mortgage debt, sloughing off their own liabilities. Keenan, though, had a bigger point: All the structural disincentives that had built Americans’ irrational response to the climate risk were now reaching their logical endpoint**. A pandemic-induced economic collapse will** only **heighten** the vulnerabilities **and speed the transition**, reducing to nothing whatever thin margin of financial protection has kept people in place. Until now, the market mechanisms had essentially socialized the consequences of high-risk development. But as the costs rise — and the insurers quit, and the bankers divest, and the farm subsidies prove too wasteful, and so on **— the full weight of responsibility will fall on individual people**. And that’s when the real migration might begin. As I spoke with Keenan last year, I looked out my own kitchen window onto hillsides of parkland, singed brown by months of dry summer heat. This was precisely the land that my utility, Pacific Gas & Electric, had three times identified as such an imperiled tinderbox that it had to shut off power to avoid fire. It was precisely the kind of wildland-urban interface that all the studies I read blamed for heightening Californians’ exposure to climate risks. I mentioned this on the phone and then asked Keenan, “Should I be selling my house and getting — ” He cut me off: “Yes.” Americans have dealt with climate disaster before. The Dust Bowl started after the federal government expanded the Homestead Act to offer more land to settlers willing to work the marginal soil of the Great Plains. Millions took up the invitation, replacing hardy prairie grass with thirsty crops like corn, wheat and cotton. Then, entirely predictably, came the drought. From 1929 to 1934, crop yields across Texas, Oklahoma, Kansas and Missouri plunged by 60 percent, leaving farmers destitute and exposing the now-barren topsoil to dry winds and soaring temperatures. The resulting dust storms, some of them taller than skyscrapers, buried homes whole and blew as far east as Washington. The disaster propelled an exodus of some 2.5 million people, mostly to the West, where newcomers — “Okies” not just from Oklahoma but also Texas, Arkansas and Missouri — unsettled communities and competed for jobs. Colorado tried to seal its border from the climate refugees; in California, they were funneled into squalid shanty towns. Only after the migrants settled and had years to claw back a decent life did some towns bounce back stronger. The places migrants left behind never fully recovered. Eighty years later, Dust Bowl towns still have slower economic growth and lower per capita income than the rest of the country. **Dust Bowl survivors and their children are less likely to go to college and more likely to live in poverty. Climatic change made them poor, and it has kept them poor ever since. A Dust Bowl event will most likely happen again**. The Great Plains states today provide nearly half of the nation’s wheat, sorghum and cattle and much of its corn; the farmers and ranchers there export that food to Africa, South America and Asia**. Crop yields**, though, **will drop sharply with every degree of warming. By 2050,** researchers at the University of Chicago and the NASA Goddard Institute for Space Studies found**, Dust Bowl-era yields will be the norm**, even as demand for scarce water jumps by as much as 20 percent. **Another extreme drought would drive near-total crop losses worse than the Dust Bowl, kneecapping the broader economy**. At that point, the authors write, “abandonment is one option.” Corn and soy production will decrease with every degree of warming. By 2060, parts of Texas may experience a drop in yields of more than 92 percent. Projections are inherently imprecise, but the gradual changes to America’s cropland — plus the steady baking and burning and flooding — suggest that we are already witnessing a slower-forming but much larger replay of the Dust Bowl that will destroy more than just crops. In 2017, Solomon Hsiang, a climate economist at the University of California, Berkeley, led an analysis of the economic impact of climate-driven changes like rising mortality and rising energy costs, finding that **the poorest counties** in the United States — mostly across the South and the Southwest — **will** in some extreme cases **face damages** equal to **more than a third of their gross domestic products**. The 2018 National Climate Assessment also warns that the U.S. economy over all could contract by 10 percent. That kind of loss typically drives people toward cities, and researchers expect that trend to continue after the Covid-19 pandemic ends. In 1950, less than 65 percent of Americans lived in cities. By 2050, only 10 percent will live outside them, in part because of climatic change. By 2100, Hauer estimates, Atlanta, Orlando, Houston and Austin could each receive more than a quarter million new residents as a result of sea-level displacement alone, meaning it may be those cities — not the places that empty out — that wind up bearing the brunt of America’s reshuffling. The World Bank warns that **fast-moving climate urbanization leads to rising unemployment, competition for services and deepening poverty**. So what will happen to Atlanta — a metro area of 5.8 million people that may lose its water supply to drought and that our data also shows will face an increase in heat-driven wildfires? Hauer estimates that hundreds of thousands of climate refugees will move into the city by 2100, swelling its population and stressing its infrastructure. Atlanta — where poor transportation and water systems contributed to the state’s C+ infrastructure grade last year — already suffers greater income inequality than any other large American city**, making it a virtual tinderbox for social conflict.** One in 10 households earns less than $10,000 a year, and rings of extreme poverty are growing on its outskirts even as the city center grows wealthier. Atlanta has started bolstering its defenses against climate change, but in some cases this has only exacerbated divisions. When the city converted an old Westside rock quarry into a reservoir, part of a larger greenbelt to expand parkland, clean the air and protect against drought, the project also fueled rapid upscale growth, driving the poorest Black communities further into impoverished suburbs. That Atlanta hasn’t “fully grappled with” such challenges now, says Na’Taki Osborne Jelks, chair of the West Atlanta Watershed Alliance, means that with more people and higher temperatures, “the city might be pushed to what’s manageable.” So might Philadelphia, Chicago, Washington, Boston and other cities with long-neglected systems suddenly pressed to expand under increasingly adverse conditions. Once you accept that climate change is fast making large parts of the United States nearly uninhabitable, the future looks like this: With time, **the bottom half of the country grows inhospitable, dangerous and hot.** Something like **a tenth of the people who live in the South** and the Southwest — from South Carolina to Alabama to Texas to Southern California — decide to **move north** in search of a better economy and a more temperate environment. **Those who stay behind are disproportionately poor and elderly**. In these places**, heat alone will cause** as many as **80** additional **deaths per 100,000 people** — the nation’s opioid crisis, by comparison, produces 15 additional deaths per 100,000. **The most affected people, meanwhile, will pay 20 percent more for energy, and their crops will yield half as much food or in some cases virtually none at all**. That collective burden will drag down regional incomes by roughly 10 percent, amounting to one of the largest transfers of wealth in American history, as people who live farther north will benefit from that change and see their fortunes rise. The millions of people moving north will mostly head to the cities of the Northeast and Northwest, which will see their populations grow by roughly 10 percent, according to one model. Once-chilly places like Minnesota and Michigan and Vermont will become more temperate, verdant and inviting. Vast regions will prosper; just as Hsiang’s research forecast that Southern counties could see a tenth of their economy dry up, he projects that others as far as North Dakota and Minnesota will enjoy a corresponding expansion. Cities like Detroit, Rochester, Buffalo and Milwaukee will see a renaissance, with their excess capacity in infrastructure, water supplies and highways once again put to good use. One day, it’s possible that a high-speed rail line could race across the Dakotas, through Idaho’s up-and-coming wine country and the country’s new breadbasket along the Canadian border, to the megalopolis of Seattle, which by then has nearly merged with Vancouver to its north. Sitting in my own backyard one afternoon this summer, my wife and I talked through the implications of this looming American future. The facts were clear and increasingly foreboding. Yet there were so many intangibles — a love of nature, the busy pace of life, the high cost of moving — that conspired to keep us from leaving. Nobody wants to migrate away from home, even when an inexorable danger is inching ever closer. They do it when there is no longer any other choice.

# C2 - Tourism

**Space tourism is skyrocketing, and it fills the orbit with debris**

**Moore 21** (Mr. Moore earned a Ph.D. in Economics from the University of California, Irvine. He holds a Master's in Economics from the University of California, Irvine and a Master's in History from California State University, Chico.) Education 21, 10-13-2021, "Adrian Moore, Author at Reason Foundation," Reason Foundation, <https://reason.org/author/adrian-moore/> //GHS CR

With [Richard Branson](https://thehill.com/person/richard-branson) and [Jeff Bezos](https://thehill.com/people/jeffrey-jeff-bezos) soaring into suborbital space, three U.S. flights to the International Space Station (ISS) in July, and SpaceX [delivering 88 satellites to orbit in the last six weeks](https://www.cnn.com/2021/06/30/tech/spacex-rideshare-transporter-2-missions-scn/index.html), space traffic is surging. And this is just the beginning of increased commercial and governmental activity in space. August will see several more trips to the ISS and more launches of satellites. Additionally, the Biden administration signed an [agreement](https://spacenews.com/nasa-and-esa-sign-agreement-on-climate-science-cooperation/) with the European Space Agency to use more satellites to address climate change through earth science research. This increased space traffic serves a wide array of purposes and represents vast investments by the private space industry and government. But these investments are going to increasingly be jeopardized by the massive amount of space junk already circling Earth. There’s plenty of room to fly up there, but, believe it or not, NASA estimates there are already [23,000 pieces of debris larger than 10 centimeters and over 500,000 pieces of smaller junk in orbit.](https://reason.org/policy-brief/u-s-space-traffic-management-and-orbital-debris-policy/) This space junk, or orbital debris, travels at high speeds and even a small piece can cause serious damage or destruction if it hits a spacecraft or satellite. The space debris includes thousands of dead and retired satellites, parts of spacecraft from decades of missions, items exploded in warfare testing, and more. Dodging space junk is a regular requirement for spacecraft in orbit. The International Space Station had to maneuver [25 times between 1999 and 2018](https://www.dailymail.co.uk/sciencetech/article-8761867/ISS-initiates-avoid-space-debris.html) to avoid collisions, and it had to dodge debris [three times in 2020](https://www.dailymail.co.uk/sciencetech/article-8761867/ISS-initiates-avoid-space-debris.html). Monitoring this debris is going to be a major issue as private space travel and the space economy grow. In 2019, the [global space economy amounted to about $366 billion](https://sia.org/news-resources/state-of-the-satellite-industry-report/). Of this, $271 billion was in the satellite industry and $123 billion was directly in satellite services. As the world increasingly becoming reliant on satellites U.S. and global satellite businesses bear the brunt of the failure to track and remove orbital debris. As Sen. [John Hickenlooper](https://thehill.com/people/john-hickenlooper) (D-Colo.), chair of the Senate Commerce Committee’s Subcommittee on Science and Space, said recently, we need to be proactive on space debris “[rather than learning by a terrible accident … but we don’t quite have the sense of urgency we need](https://www.c-span.org/video/?513433-1/senator-john-hickenlooper-space-policy).” Urgency means committing to better space traffic management, and tracking and removing orbital debris. Orbital debris management is not well organized within the government. Right now, the Department of Defense (DOD) does most tracking of space debris for the U.S. out of the need to protect military satellites and national security interests. NASA has its own less advanced systems for tracking debris. However, orbital debris management is not just about tracking debris anymore. It is also about forming collision warning systems and safely managing traffic in space. To do this efficiently, we need a civil repository for all orbital debris components, [something that many commercial space companies have already created on their own](https://www.axios.com/space-junk-tracking-business-a365462b-a82e-4926-849b-5f292dd1b164.html) to stay aware of orbital debris and help protect their satellites in space. Tracking debris may be a national security priority, but providing space traffic control is not really in the Defense Department’s mission. We should be utilizing the private sector’s expertise and advancements in this area. For example, Astroscale has contracts with both the Japanese and European space agencies to develop orbital debris removal capability. And responsibility for developing collision warnings and space traffic management [would be best suited for the Office of Space Commerce](https://reason.org/policy-brief/u-s-space-traffic-management-and-orbital-debris-policy/), an office with existing connections to the commercial space industry, NASA and DOD. Partnering with the debris tracking and removal systems private companies are developing while freeing up DOD to focus on military awareness and NASA to focus on research and development would be the most efficient way forward. If the government works with private industry through strategic public-private partnerships, the U.S. can best address the threats posed by orbital debris and create sustainable policies for safe space exploration.

**Debris is systematically destroying the upper atmosphere and ozone layer – key causes of pollution and climate change.**

**Pultarova 21**

(Tereza is a London-based science and technology journalist, aspiring fiction writer and amateur gymnast. Originally from Prague, the Czech Republic, she spent the first seven years of her career working as a reporter, script-writer and presenter for various TV programmes of the Czech Public Service Television. She later took a career break to pursue further education and added a Master's in Science from the International Space University, France, to her Bachelor's in Journalism and Master's in Cultural Anthropology from Prague's Charles University. She worked as a reporter at the Engineering and Technology magazine, freelanced for a range of publications including Live Science, Space.com, Professional Engineering, Via Satellite and Space News and served as a maternity cover science editor at the European Space Agency.) Tereza Pultarova 21, 7-26-2021, "The rise of space tourism could affect Earth's climate in unforeseen ways, scientists worry," Space, https://www.space.com/environmental-impact-space-tourism-flights //GHS CR

According to Dallas Kasaboski, principal analyst at the space consultancy Northern Sky Research, a single Virgin Galactic suborbital space tourism flight, lasting about an hour and a half, can generate as much pollution as a 10-hour trans-Atlantic flight. Some scientists consider that disconcerting, in light of Virgin Galactic’s ambitions to fly paying tourists to the edge of space several times a day. "Even if the suborbital tourism market is launching at a fraction of the number of launches compared to the rest of the [tourism] industry, each of their flights has a much higher contribution, and that could be a problem," Kasaboski told Space.com. Virgin Galactic's rockets are, of course, not the only culprits. All rocket motors burning hydrocarbon fuels generate soot, Maggi said. Solid rocket engines, such as those used in the past in the boosters of NASA's [space shuttle](https://www.space.com/16726-space-shuttle.html), burn metallic compounds and emit aluminum oxide particles together with hydrochloric acid, both of which have a damaging effect on the atmosphere. The BE-3 engine that powers Blue Origin's New Shepard suborbital vehicle, on the other hand, combines liquid hydrogen and liquid oxygen to create thrust. The BE-3 is not a big polluter compared to other rocket engines, emitting mainly water along with some minor combustion products, [experts say](https://www.livescience.com/new-shepard-emissions.html). Rockets pollute the otherwise pristine upper layers of the atmosphere. (Image credit: NASA) Too little is known For Karen Rosenlof, senior scientist at the Chemical Sciences Laboratory at the U.S. National Oceanic and Atmospheric Administration (NOAA), the biggest problem is that rockets pollute the higher layers of the atmosphere — the stratosphere, which starts at an altitude of about 6.2 miles (10 kilometers), and the mesosphere, which goes upward from 31 miles (50 km). "You are emitting pollutants in places where you don't normally emit it," Rosenlof told Space.com. "We really need to understand. If we increase these things, what is the potential damage?" So far, the impact of rocket launches on the atmosphere has been negligible, according to Martin Ross, an atmospheric scientist at the Aerospace Corporation who often works with Rosenlof. But that's simply because there have not been that many launches. "The amount of fuel currently burned by the space industry is less than 1% of the fuel burned by aviation," Ross told Space.com. "So there has not been a lot of research, and that makes sense. But things are changing in a way that suggests that we should learn about this in more detail." Northern Sky Research predicts that the number of space tourism flights will skyrocket over the next decade, from maybe 10 a year in the near future to 360 a year by 2030, Kasaboski said. This estimate is still far below the growth rate that space tourism companies like Virgin Galactic and [Blue Origin](https://www.space.com/topics/blue-origin) envision for themselves. "Demand for suborbital tourism is extremely high," Kasaboski said. "These companies virtually have customers waiting in a line, and therefore they want to scale up. Ultimately, they would want to fly multiple times a day, just like short-haul aircraft do." The rate of rocket launches delivering satellites into orbit is expected to grow as well. But Kasaboski sees bigger potential for growth in space tourism. "It's like the difference between a cargo flight and a passenger flight," Kasaboski said. "There's a lot more passengers that are looking to fly." The problem is, according to Ross, that the scientific community has no idea and not enough data to tell at what point rocket launches will start having a measurable effect on the planet's climate. At the same time, the stratosphere is already changing as the number of rocket launches sneakily grows. "The impacts of these [rocket-generated] particles are not well understood even to an order of magnitude, the factor of 10," Ross said. "The uncertainty is large, and we need to narrow that down and predict how space might be impacting the atmosphere." Solid rocket boosters, such as those used in the past to launch NASA's space shuttle, generate ozone-damaging substances. (Image credit: NASA/Bill Ingalls) Space shuttle's ozone holes So far, the only direct measurements of the effects of rocket launches on chemical processes in the atmosphere come from the space shuttle era. In the 1990s, as the world was coming together to salvage the [damaged ozone layer](https://www.space.com/39315-nasa-satellite-shows-healing-ozone-hole.html), NASA, NOAA and the U.S. Air Force put together a campaign that looked at the effects of the emissions from the space shuttle's solid fuel boosters on ozone in the stratosphere. "In the 1990s, there were significant concerns about chlorine from solid rocket motors," Ross said. "Chlorine is the bad guy to ozone in the stratosphere, and there were some models which suggested that ozone depletion from solid rocket motors would be very significant." The scientists used NASA's [WB 57](https://www.nasa.gov/centers/langley/multimedia/iotw-wb57.html) high-altitude aircraft to fly through the plumes generated by the space shuttle rockets in Florida. Reaching altitudes of up to 60,000 feet (19 km), they were able to measure the chemical reactions in the lower stratosphere just after the rockets' passage. "One of the fundamental questions was how much chlorine is being made in these solid rocket motors and in what form," David Fahey, the director of the Chemical Sciences Laboratory at NOAA, who led the study, told Space.com. "We measured it several times and then analyzed the results. At that time, there were not enough space shuttle launches to make a difference globally, but locally one could deplete the ozone layer due to this diffuse plume [left behind by the rocket]." The space shuttle retired 10 years ago, but rockets generating ozone-damaging substances continue launching humans and satellites to space today. In fact, in 2018, in its latest [Scientific Assessment of Ozone Depletion](https://csl.noaa.gov/assessments/ozone/2018/), which comes out every four years, the World Meteorological Organization included rockets as a potential future concern. The organization called for more research to be done as the number of launches is expected to increase. Rocket planes inject pollutants into very high altitudes. (Image credit: Virgin Galactic) Worse than geoengineering Rosenlof's team studies the broader effects of human-made substances in the higher layers of the atmosphere using powerful NOAA supercomputers. The work is akin to predicting the proverbial butterfly effect, the influence of minuscule changes in the chemistry of the air tens of miles above Earth on climate and weather patterns on the ground. For her, black carbon, or soot, emitted by rockets burning hydrocarbon fuels, is of particular concern. "The problem with soot is that it absorbs ultraviolet light, and that means that it could heat the stratosphere," Rosenlof said. "When you start heating the stratosphere, the layer above the troposphere [closest to the ground], you start changing the motion in the stratosphere. You are changing the energy transfer, and that could actually affect what is happening on the ground." Rosenlof points out that many of the particles generated by some rockets have been of interest to scientists due to the possible effects they could have on the global climate in a different context — that of [geoengineering](https://www.space.com/36431-harvard-researchers-geoengineer-earth-atmosphere.html), the deliberate tampering with the atmosphere with the aim of stopping or mitigating global warming. Rosenlof [recently co-authored a paper](https://www.space.com/self-levitating-soot-geoengineering-fights-global-warming) that used the same powerful NOAA supercomputers to model what the scientists call a climate intervention. The team was interested in the climate effects of dispersing sulfur dioxide particles, which are known to reflect light away from Earth, in combination with soot (which is also part of rocket emissions) in the lower stratosphere. Soot absorbs energy from sunlight and pushes the sulfur dioxide aerosol particles to a higher altitude by warming up the surrounding air. At that higher altitude, the sulfur dioxide can start its climate-cooling work. The experiment modeled what would happen when 1.1 million tons of sunlight-reflecting sulfur dioxide mixed with 11,000 tons of black carbon were released in the upper troposphere by aircraft over a 10-day period. The study didn't find any significant negative effects on weather on Earth. Yet, those results do not dispel Rosenlof's concerns about the possible risks associated with the growing number of rocket launches. Altering the jet stream "Black carbon in the geoengineering experiment that we did isn't as high as the stuff from these rockets," she said. "The problem is that the higher you go, the longer something lasts. Neither of them is ideal, because either of them would produce heating in places where we don't have heating right now." According to Maggi, the soot particles generated by hybrid rocket engines are extremely small and light-weight. In fact, when he and his colleagues tried to measure the soot output of hybrid rocket engines in a laboratory, they couldn't reliably do it with precision because of the particles' minuscule size. "We were able to measure the particle output from solid rocket motors," Maggi said. "These are about a micron in size, and there [are] a lot of them. But because they are large, they fall to the ground more quickly. In hybrid rocket engines, we were not able to collect the soot from the plume because it's extremely fine, a few nanometres in size." Maggi fears these particles could, in fact, stay in the stratosphere forever. "They have the same size as the carbon emitted by aircrafts," Maggi said. "And we know that there is a layer of carbon in the atmosphere at the flight level of aircrafts which is staying there. It's very likely that particles coming from rocket motors will do the same." The accumulation of these particles over years and decades is what worries the scientists. Just as the current climate crisis started relatively slowly as the amount of carbon released into the atmosphere grew, the pollution in the stratosphere may only start causing harm some years down the road. Rosenlof added that in the long term, injecting pollutants into the stratosphere could alter the polar jet stream, change winter storm patterns or affect average rainfall. "You might go from 25 inches [64 centimeters] a year to 20 inches [51 cm] a year in some places, which maybe doesn't sound like that big of a deal unless you are a farmer trying to grow your wheat right there," Rosenlof said. "Then a subtle change in rainfall can impact your crop yields." Work to be done For this reason, Fahey says, it is critical that scientific work starts now to evaluate the future risks. "There is this fundamental gap where we just don't have the numbers, and that means that the science is limited because we have this lack of information," he said. "We feel it is part of our responsibility [at NOAA] to assess the impact of human activity on the stratosphere. Rockets are a principal and unique source [of stratospheric pollution], the launch frequencies are increasing and the effects are accumulating." Fahey envisions a wider research program that would analyze the emissions and impacts of individual types of rocket engines and fuels on the stratosphere. The data could be used in Rosenlof's models to better predict the effects in accordance with the expected growth of the number of launches. Fahey, however, says that a political decision would have to come first to provide NOAA and its partners with funding that would enable them to take the high-altitude aircraft to the sky again and gather the data. The good news is, he added, that the U.S. Congress seems to be aware of the problem and things might soon start to move. "We would like to see a national program run by NOAA or the Air Force that would develop a database with basic emission characteristics of modern propulsion systems based on observations," he said. "We could gather some data in ground tests but also in the same way that we did with the space shuttle — by flying through the plumes just after launch."

**This pollution is unique – it can’t be fixed and is hugely impactful on the ozone layer.**

**Prinn et al. 05**

(He served as one of the Lead Authors in the Fourth Assessment of the Intergovernmental Panel on Climate Change (IPCC) published in 2007. He has served as Chairman for Atmospheric and Hydrospheric Sciences of the American Association for the Advancement of Science (AAAS), and has chaired the Steering Committees for the IGBP/IAMAP International Global Atmospheric Chemistry Project, the U.S. National Research Council (NRC) Committee on Earth Sciences, and the U.S. Global Tropospheric Chemistry Program. He has been a member of the Steering Committees of the International Geosphere-Biosphere Program (IGBP), and the NASA Network for Detection of Atmospheric Composition Change, and a member of the IAMAP International Commission on Atmospheric Chemistry and Global Pollution, the NRC Space Science Board, the NRC Committee for the International Geosphere-Biosphere Program, the NASA Space Science and Applications Advisory Committee, and the NASA Earth System Sciences Committee. He has twice testified to the United States Congress on climate change science and its implications for policy. He is a Fellow of the American Geophysical Union (AGU), a recipient of AGU's Macelwane Medal, and a Fellow of the AAAS. He has published more than 250 peer-reviewed scientific papers, co-authored *Planets and their Atmospheres: Origin and Evolution* (Academic Press), and edited or co-edited *Global Atmospheric-Biospheric Chemistry* (Plenum), *Atmospheric Chemistry in a Changing World* (Springer), and *Inverse Methods in Global Biogeochemical Cycles* (AGU). Education: Sc.D., 1971, MIT; M.S., 1968, B.S., 1967, University of Auckland, New Zealand.) [https://globalchange.mit.edu/sites/default/files/MITJPSPGC\_Rpt118.pdf. Accessed 1 June 2022](https://globalchange.mit.edu/sites/default/files/MITJPSPGC_Rpt118.pdf.%20Accessed%201%20June%202022). //GHS CR

The ability of the lower atmosphere (troposphere) to remove most air pollutants depends on complex chemistry driven by the relatively small amount of the sun’s ultraviolet light that penetrates through the upper atmospheric (stratospheric) ozone layer (see: Ehhalt, 1999; Prinn, 2003). This chemistry is also driven by emissions of NOx, CO, CH4 and VOCs and leads to the production of O3 and OH. Figure 1 reviews, with much simplification, the chemical reactions involved (Prinn, 1994). The importance of this chemistry to climate change occurs because it involves both climate-forcing greenhouse gases (H2O, CH4, O3) and air pollutants (CO, NO, NO2). It also involves aerosols (H2SO4, HNO3, BC) that influence climate (through reflecting or absorbing sunlight), productivity of ecosystems (through their exposure to O3, and to H2SO4 and HNO3 in acid rain), and human health (through inhalation). Also important are free radicals and atoms in two forms: very reactive species like O(1 D) and OH, and less reactive ones like HO2, O(3 P), NO and NO2. 3 UV N2O Lightning CFCs O( 1D) Hydrosphere Biosphere & Human Activity HNO3 Greenhouse Gases Primary Pollutants Absorbing Aerosols (BC) Reactive Free Radical/Atom Less Reactive Radicals Reflective Aerosols O3 H2SO4 BC Stratosphere Figure 1. Summary of the chemistry in the troposphere important in the linkage between urban air pollution and climate (after Prinn, 1994, 2003). VOCs (not shown) are similar to CH4 in their reactions with OH, but they form acids, aldehydes and ketones in addition to CO. Referring to Figure 1, when OH reacts with CH4 the CH4 is converted mostly to CO in steps that consume OH and also produce HO2. The OH in turn converts CO to CO2, NO2 to HNO3, and SO2 to H2SO4. The primary OH production pathway occurs when H2O reacts with the O(1 D) atoms that come from dissociation of O3 by ultraviolet (UV) light. Within about a second of its formation, on average, OH reacts with other gases, either by donating its O atom (e.g., to CO to form CO2 and H) or by removing H (e.g., from CH4 to form CH3 and H2O). The H and CH3 formed in these ways attach rapidly to O2 to form hydroperoxy (HO2) or methylperoxy (CH3O2) free radicals which are relatively unreactive. If there is no way to rapidly recycle HO2 back to OH, then levels of OH are kept relatively low. The addition of NOx emissions into the mix significantly changes the chemistry. Specifically, a second pathway is created in which NO reacts with HO2 to form NO2 and to reform OH. Ultraviolet light then decomposes NO2 to produce O atoms (which attach to O2 to form O3) and reform NO. Hence NOx (the sum of NO and NO2) is a catalyst which is not consumed in these reactions. The production rate of OH by this secondary path in polluted air is about five times faster than the above primary pathway involving O(1 D) and H2O (Ehhalt, 1999). The reaction of NO with HO2 does not act as a sink for HOx (the sum of OH and HO2) but instead determines the ratio of OH to HO2. Calculations for 4 polluted air suggest that HO2 concentrations are about 40 times greater than OH (Ehhalt, 1999). This is due mainly to the much greater reactivity of OH compared to HO2. If emissions of air pollutants that react with OH, such as CO, VOCs, CH4, and SO2, are increasing, then keeping all else constant, OH levels should decrease. This would increase the lifetime and hence concentrations of CH4. However, increasing NOx emissions should increase tropospheric O3 (and hence the primary source of OH), as well as increase the recycling rate of HO2 to OH (the second source of OH). This OH increase should lower CH4 concentrations. Thus changing the level of OH causes greenhouse gas, and thus climate, changes. Climate change will also influence OH. Higher ocean temperatures should increase H2O in the lower troposphere and thus increase OH production through its primary pathway. Higher atmospheric temperatures also increase the rate of reaction of OH with CH4, decreasing the concentrations of both. Greater cloud cover will reflect more solar ultraviolet light, thus decreasing OH, and vice versa. Added to these interactions involving gases, are those involving aerosols. For example, increasing SO2 emissions and/or OH concentrations should lead to greater concentrations of sulfate aerosols which are a cooling influence. Accounting for all of these interactions, and other related ones (see e.g., Prinn, 2003), requires that a detailed interactive atmospheric chemistry and climate model be used to assess the effects of air pollution reductions on climate.

mini-satellites, or forcing the junk to burn up in the atmosphere.

**Solving warming is not all-or-nothing – every additional fraction of a degree is irreversible and costs millions of lives—prefer IPCC assessments that are the gold standard for warming consensus**

David Wallace-Wells 19 [National Fellow at New America. He is deputy editor of New York Magazine, where he also writes frequently about climate and the near future of science and technology, including his widely read and debated 2017 cover story on worst-case scenarios for global warming], *The Uninhabitable Earth: A Story of the Future* (Kindle Edition: Allen Lane, 2019), pg. 8-30, beckert

* Every degree key – each bit 🡪 hundreds of millions of lives
* IPCC🡪best ev b/c conservative estimate + still really big impact
* Now key – not reversible, feedback loops 🡪 speeds up later

There is almost no chance we will avoid that scenario. The Kyoto Protocol achieved, practically, nothing; in the twenty years since, despite all of our climate advocacy and legislation and progress on green energy, we have produced more emissions than in the twenty years before. In 2016, the Paris accords established two degrees as a global goal, and, to read our newspapers, that level of warming remains something like the scariest scenario it is responsible to consider; just a few years later, with no single industrial nation on track to meet its Paris commitments, two degrees looks more like a **best-case outcome**, at present hard to credit, with an entire bell curve of more horrific possibilities extending beyond it and yet shrouded, delicately, from public view.28 For those telling stories about climate, such horrific possibilities—and the fact that we had squandered our chance of landing anywhere on the better half of that curve—had become somehow unseemly to consider. The reasons are almost too many to count, and so half-formed they might better be called impulses. We chose not to discuss a world warmed beyond two degrees out of decency, perhaps; or simple fear; or fear of fearmongering; or technocratic faith, which is really market faith; or deference to partisan debates or even partisan priorities; or skepticism about the environmental Left of the kind I’d always had; or disinterest in the fates of distant ecosystems like I’d also always had. We felt confusion about the science and its many technical terms and hard-to-parse numbers, or at least an intuition that others would be easily confused about the science and its many technical terms and hard-to-parse numbers. We suffered from slowness apprehending the speed of change, or semi-conspiratorial confidence in the responsibility of global elites and their institutions, or obeisance toward those elites and their institutions, whatever we thought of them. Perhaps we felt unable to really trust scarier projections because we’d only just heard about warming, we thought, and things couldn’t possibly have gotten that much worse just since the first Inconvenient Truth; or because we liked driving our cars and eating our beef and living as we did in every other way and didn’t want to think too hard about that; or because we felt so “postindustrial” we couldn’t believe we were still drawing material breaths from fossil fuel furnaces. Perhaps it was because we were so sociopathically good at collating bad news into a sickening evolving sense of what constituted “normal,” or because we looked outside and things seemed still okay. Because we were bored with writing, or reading, the same story again and again, because climate was so global and therefore nontribal it suggested only the corniest politics, because we didn’t yet appreciate how fully it would ravage our lives, and because, selfishly, we didn’t mind destroying the planet for others living elsewhere on it or those not yet born who would inherit it from us, outraged. Because we had too much faith in the teleological shape of history and the arrow of human progress to countenance the idea that the arc of history would bend toward anything but environmental justice, too. Because when we were being really honest with ourselves we already thought of the world as a zero-sum resource competition and believed that whatever happened we were probably going to continue to be the victors, relatively speaking anyway, advantages of class being what they are and our own luck in the natalist lottery being what it was. Perhaps we were too panicked about our own jobs and industries to fret about the future of jobs and industry; or perhaps we were also really afraid of robots or were too busy looking at our new phones; or perhaps, however easy we found the apocalypse reflex in our culture and the path of panic in our politics, we truly had a good-news bias when it came to the big picture; or, really, who knows why—there are so many aspects to the climate kaleidoscope that transforms our intuitions about environmental devastation into an uncanny complacency that it can be hard to pull the whole picture of climate distortion into focus. But we simply wouldn’t, or couldn’t, or anyway didn’t look squarely in the face ﻿of the science. This is not a book about the science of warming; it is about what warming means to the way we live on this planet. But what does that science say? It is complicated research, because it is built on two layers of uncertainty: what humans will do, mostly in terms of emitting greenhouse gases, and how the climate will respond, both through straightforward heating and a variety of more complicated, and sometimes contradictory, feedback loops. But even shaded by those uncertainty bars it is also very clear research, in fact terrifyingly clear. The United Nations’ Intergovernmental Panel on Climate Change (IPCC) offers the **gold-standard** assessments of the state of the planet and the likely trajectory for climate change—gold-standard, in part, because **it is conservative**, integrating only new research that passes the threshold of inarguability. A new report is expected in 2022, but the most recent one says that if we take action on emissions soon, instituting immediately all of the commitments made in the Paris accords but nowhere yet actually implemented, we are likely to get about **3.2 degrees of warming**, or about three times as much warming as the planet has seen since the beginning of industrialization—bringing the unthinkable collapse of the planet’s ice sheets not just into the realm of the real but into the present.29, 30 That would eventually flood not just Miami and Dhaka but Shanghai and Hong Kong and a hundred other cities around the world.31 The tipping point for that collapse is said to be around two degrees; according to several recent studies, even a rapid cessation of carbon emissions could bring us that amount of warming by the end of the century.32 The assaults of climate change do not end at 2100 just because most modeling, by convention, sunsets at that point. This is why some studying global warming call the hundred years to follow the “century of hell.”33 Climate change is fast, much faster than it seems we have the capacity to recognize and acknowledge; but it is also long, almost longer than we can truly imagine. In reading about warming, you will often come across analogies from the planetary record: the last time the planet was this much warmer, the logic runs, sea levels were here. These conditions are not coincidences. The sea level was there largely because the planet was that much warmer, and the geologic record is the best model we have for understanding the very complicated climate system and gauging just how much damage will come from turning up the temperature by two or four or six degrees. Which is why it is especially concerning that recent research into the deep history of the planet suggests that our current climate models may be **underestimating** the amount of warming we are due for in 2100 by as much as half.34 In other words, temperatures could rise, ultimately, by as much as double what the IPCC predicts. Hit our Paris emissions targets and we may still get four degrees of warming, meaning a green Sahara and the planet’s tropical forests transformed into fire-dominated savanna.35 The authors of one recent paper suggested the warming could be more dramatic still—slashing our emissions could still bring us to four or five degrees Celsius, a scenario they said would pose severe risks to the habitability of the entire planet. “Hothouse Earth,” they called it.36 Because these numbers are so small, we tend to trivialize the differences between them—one, two, four, five. Human experience and memory offer no good analogy for how we should think of those thresholds, but, as with world wars or recurrences of cancer, you don’t want to see even one. At two degrees, the ice sheets will begin their collapse, 400 million more people will suffer from water scarcity, major cities in the equatorial band of the planet will become unlivable, and even in the northern latitudes heat waves will kill thousands each summer.37, 38 There would be thirty-two times as many extreme heat waves in India, and each would last five times as long, exposing **ninety-three times more people**.39 This is our **best-case scenario**. At three degrees, southern Europe would be in **permanent drought**, and the average drought in Central America would last nineteen months longer and in the Caribbean twenty-one months longer. In northern Africa, the figure is sixty months longer—five years. The areas burned each year by wildfires would double in the Mediterranean and sextuple, or more, in the United States. At four degrees, there would be eight million more cases of dengue fever each year in Latin America alone and close to annual global food crises.41 There could be 9 percent more heat-related deaths.40 Damages from river flooding would grow thirtyfold in Bangladesh, twentyfold in India, and as much as sixtyfold in the United Kingdom. In certain places, six climate-driven natural disasters could strike **simultaneously**, and, globally, damages could pass $600 trillion—more than twice the wealth as exists in the world today. Conflict and warfare could **double**. Even if we pull the planet up short of two degrees by 2100, we will be left with an atmosphere that contains 500 parts per million of carbon—perhaps more. The last time that was the case, sixteen million years ago, the planet was not two degrees warmer; it was somewhere between five and eight, giving the planet about 130 feet of sea-level rise, enough to draw a new American coastline as far west as I-95.42 Some of these processes take thousands of years to unfold, but they are also irreversible, and therefore effectively permanent. You might hope to simply reverse climate change; you can’t. It will outrun all of us. This is part of what makes climate change what the theorist Timothy Morton calls a “hyperobject”—a conceptual fact so large and complex that, like the internet, it can never be properly comprehended.43 There are many features of climate change—its size, its scope, its brutality—that, alone, satisfy this definition; together they might elevate it into a higher and more incomprehensible conceptual ﻿category yet. But time is perhaps the most mind-bending feature, the worst outcomes arriving so long from now that we reflexively discount their reality. Yet those outcomes promise to mock us and our own sense of the real in return. The ecological dramas we have unleashed through our land use and by burning fossil fuels—slowly for about a century and very rapidly for only a few decades—will play out over many millennia, in fact over a longer span of time than humans have even been around, performed in part by creatures and in environments we do not yet even know, ushered onto the world stage by the force of warming. And so, in a convenient cognitive bargain, we have chosen to consider climate change only as it will present itself this century. By 2100, the United Nations says, we are due for about 4.5 degrees of warming, following the path we are on today.44 That is, farther from the Paris track than the Paris track is from the two-degree threshold of catastrophe, which it more than doubles. As Naomi Oreskes has noted, there are far too many uncertainties in our models to take their predictions as gospel.45 Just running those models many times, as Gernot Wagner and Martin Weitzman do in their book Climate Shock, yields an 11 percent chance we overshoot six degrees.46 Recent work by the Nobel laureate William Nordhaus suggests that better-than-anticipated economic growth means better than one-in-three odds that our emissions will exceed the U.47N.’s worst-case “business as usual” scenario. In other words, a temperature rise of five degrees or possibly more. The upper end of the probability curve put forward by the U.N. to estimate the end-of-the-century, business-as-usual scenario—the worst-case outcome of a worst-case emissions path—puts us at eight degrees. At that temperature, humans at the equator and in the tropics would not be able to move around outside without dying.48 In that world, eight degrees warmer, direct heat effects would be the least of it: the oceans would eventually swell two hundred feet higher, flooding what are now two-thirds of the world’s major cities; hardly any land on the planet would be capable of efficiently producing any of the food we now eat; forests would be roiled by rolling storms of fire, and coasts would be punished by more and more intense hurricanes; the suffocating hood of tropical disease would reach northward to enclose parts of what we now call the Arctic; probably about a third of the planet would be made unlivable by direct heat; and what are today literally unprecedented and intolerable droughts and heat waves would be the quotidian condition of whatever human life was able to endure.49, 50, 51, 52 We will, almost certainly, avoid eight degrees of warming; in fact, several recent papers have suggested the climate is actually less sensitive to emissions than we’d thought, and that even the upper bound of a business-as-usual path would bring us to about five degrees, with a likely destination around four.53 But five degrees is nearly as unthinkable as eight, and four degrees not much better: the world in a permanent food deficit, the Alps as arid as the Atlas Mountains.54 Between that scenario and the world we live in now lies only the open question of human response. Some amount of further warming is already baked in, thanks to the protracted processes by which the planet adapts to greenhouse gas. But all of those paths projected from the present—to two degrees, to three, to four, five, or even eight—will be carved overwhelmingly by what we choose to do now. There is nothing stopping us from four degrees other than our own will to change course, which we have yet to display. Because the planet is as big as it is, and as ecologically diverse; because humans have proven themselves an adaptable species, and will likely continue to adapt to outmaneuver a lethal threat; and because the devastating effects of warming will soon become too extreme to ignore, or deny, if they haven’t already; because of all that, it is unlikely that climate change will render the planet truly uninhabitable. But if we do nothing about carbon emissions, if the next thirty years of industrial activity trace the same arc upward as the last thirty years have, whole regions will become unlivable by any standard we have today as soon as the end of this century. ﻿A few years ago, E. O. Wilson proposed a term, “Half-Earth,” to help us think through how we might adapt to the pressures of a changing climate, letting nature run its rehabilitative course on half the planet and sequestering humanity in the remaining, habitable half of the world.55 The fraction may be smaller than that, possibly considerably, and not by choice; the subtitle of his book was Our Planet’s Fight for Life. On longer timescales, the even-bleaker outcome is possible, too—the livable planet darkening as it approaches a human dusk. It would take a spectacular coincidence of bad choices and bad luck to make that kind of zero earth possible within our lifetime. But the fact that we have brought that nightmare eventuality into play at all is perhaps the overwhelming cultural and historical fact of the modern era—what historians of the future will likely study about us, and what we’d have hoped the generations before ours would have had the foresight to focus on, too. Whatever we do to stop warming, and however aggressively we act to protect ourselves from its ravages, we will have pulled the devastation of human life on Earth into view—close enough that we can see clearly what it would look like and know, with some degree of precision, how it will punish our children and grandchildren. Close enough, in fact, that we are already beginning to feel its effects ourselves, when we do not turn away. ﻿It is almost hard to believe just how much has happened and how quickly. In the late summer of 2017, three major hurricanes arose in the Atlantic at once, proceeding at first along the same route as though they were battalions of an army on the march.56 Hurricane Harvey, when it struck Houston, delivered such epic rainfall it was described in some areas as a “500,000-year event”—meaning that we should expect that amount of rain to hit that area once every five hundred millennia.57 Sophisticated consumers of environmental news have already learned how meaningless climate change has rendered such terms, which were meant to describe storms that had a 1-in-500,000 chance of striking in any given year. But the figures do help in this way: to remind us just how far global warming has already taken us from any natural-disaster benchmark our grandparents would have recognized. To dwell on the more common 500-year figure just for a moment, it would mean a storm that struck once during the entire history of the Roman Empire. Five hundred years ago, there were no English settlements across the Atlantic, so we are talking about a storm that should hit just once as Europeans arrived and established colonies, as colonists fought a revolution and Americans a civil war and two world wars, as their descendants established an empire of cotton on the backs of slaves, freed them, and then brutalized their descendants, industrialized and postindustrialized, triumphed in the Cold War, ushered in the “end of history,” and witnessed, just a decade later, its dramatic return. One storm in all that time, is what the meteorological record has taught us to expect. Just one. Harvey was the third such flood to hit Houston since 2015.58 And the storm struck, in places, with an intensity that was supposed to be a thousand times rarer still. That same season, an Atlantic hurricane hit Ireland, 45 million were flooded from their homes in South Asia, and unprecedented wildfires tilled much of California into ash.59, 60 And then there was the new category of quotidian nightmare, climate change inventing the once-unimaginable category of obscure natural disasters—crises so large they would once have been inscribed in folklore for centuries today passing across our horizons ignored, overlooked, or forgotten. In 2016, a “thousand-year flood” drowned small-town Ellicott City, Maryland, to take but one example almost at random; it was followed, two years later, in the same small town, by another.61 One week that summer of 2018, dozens of places all over the world were hit with record heat waves, from Denver to Burlington to Ottawa; from Glasgow to Shannon to Belfast; from Tbilisi, in Georgia, and Yerevan, in Armenia, to whole swaths of southern Russia.62 The previous month, the daytime temperature of one city in Oman reached above 121 degrees Fahrenheit, and did not drop below 108 all night, and in Quebec, Canada, fifty-four died from the heat.63 That same week, one hundred major wildfires burned in the American West, including one in California that grew 4,000 acres in one day, and another, in Colorado, that produced a volcano-like 300-foot eruption of flames, swallowing an entire subdivision and inventing a new term, “fire tsunami,” along the way.64, 65, 66 On the other side of the planet, biblical rains flooded Japan, where 1.2 million were evacuated from their homes.67 Later that summer, Typhoon Mangkhut forced the evacuation of 2.45 million from mainland China, the same week that Hurricane Florence struck the Carolinas, turning the port city of Wilmington briefly into an island and flooding large parts of the state with hog manure and coal ash.68, 69, 70 Along the way, the winds of Florence produced dozens of tornadoes across the region.71 The previous month, in India, the state of Kerala was hit with its worst floods in almost a hundred years.72 That October, a hurricane in the Pacific wiped Hawaii’s East Island entirely off the map.73 And in November, which has traditionally marked the beginning of the rainy season in California, the state was hit instead with the deadliest fire in its history—the Camp Fire, which scorched several hundred square miles outside of Chico, killing dozens and leaving many more missing in a place called, proverbially, Paradise.74 The devastation was so complete, you could almost forget the Woolsey Fire, closer to Los Angeles, which burned at the same time and forced the sudden evacuation of 170,000. It is tempting to look at these strings of disasters and think, Climate change is here. And one response to seeing things long predicted actually come to pass is to feel that we have settled into a new era, with everything transformed. In fact, that is how California governor Jerry Brown described the state of things in the midst of the state’s wildfire disaster: “a new normal.”75 The truth is actually much scarier. That is, the end of normal; never normal again. We have already exited the state of environmental conditions that allowed the human animal to evolve in the first place, in an unsure and unplanned bet on just what that animal can endure. The climate system that raised us, and raised everything we now know as human culture and civilization, is now, like a parent, dead. And the climate system we have been observing for the last several years, the one that has battered the planet again and again, is not our bleak future in preview. It would be more precise to say that it is a product of our recent climate past, already passing behind us into a dustbin of environmental nostalgia. There is no longer any such thing as a “natural disaster,” but not only will things get worse; technically speaking, they have already gotten worse. Even if, miraculously, humans immediately ceased emitting carbon, we’d still be due for some additional warming from just the stuff we’ve put into the air already. And of course, with global emissions still increasing, we’re very far from zeroing out on carbon, and therefore very far from stalling climate change. The devastation we are now seeing all around us is a beyond-best-case scenario for the future of warming and all the climate disasters it will bring. ﻿What that means is that we have not, at all, arrived at a new equilibrium. It is more like we’ve taken one step out on the plank off a pirate ship. Perhaps because of the exhausting false debate about whether climate change is “real,” too many of us have developed a **misleading impression that its effects are binary**. But global warming is not “yes” or “no,” nor is it “today’s weather forever” or “doomsday tomorrow.” It is a function that **gets worse over time** as long as we continue to produce greenhouse gas. And so the experience of life in a climate transformed by human activity is not just a matter of stepping from one stable ecosystem into another, somewhat worse one, no matter how degraded or destructive the transformed climate is. The effects will grow and build as the planet continues to warm: from 1 degree to 1.5 to almost certainly 2 degrees and beyond. The last few years of climate disasters may look like about as much as the planet can take. In fact, we are only just entering our brave new world, one that collapses below us as soon as we set foot on it. Many of these new disasters arrived accompanied by debate about their cause—about how much of what they have done to us comes from what we have done to the planet. For those hoping to better understand precisely how a monstrous hurricane arises out of a placid ocean, these inquiries are worthwhile, but for all practical purposes the debate yields no real meaning or insight. A particular hurricane may owe 40 percent of its force to anthropogenic global warming, the evolving models might suggest, and a particular drought may be half again as bad as it might have been in the seventeenth century. But climate change is not a discrete clue we can find at the scene of a local crime—one hurricane, one heat wave, one famine, one war. Global warming isn’t a perpetrator; it’s a conspiracy. We all live within climate and within all the changes we have produced in it, which enclose us all and everything we do. If hurricanes of a certain force are now five times as likely as in the pre-Columbian Caribbean, it is parsimonious to the point of triviality to argue over whether this one or that one was “climate-caused.” All hurricanes now unfold in the weather systems we have wrecked on their behalf, which is why there are more of them, and why they are stronger. The same is true for wildfires: this one or that one may be “caused” by a cookout or a downed power line, but each is burning faster, bigger, and longer because of global warming, which gives no reprieve to fire season. Climate change isn’t something happening here or there but everywhere, and all at once. And unless we choose to halt it, it will never stop. Over the past few decades, the term “Anthropocene” has climbed out of academic discourse and into the popular imagination—a name given to the geologic era we live in now, and a way to signal that it is a new era, defined on the wall chart of deep history by human intervention. One problem with the term is that it implies a conquest of nature, even echoing the biblical “dominion.” But however sanguine you might be about the proposition that we have already ravaged the natural world, which we surely have, it is another thing entirely to consider the possibility that we have only provoked it, engineering first in ignorance and then in denial a climate system that will now go to war with us for many centuries, perhaps until it destroys us. That is what Wally Broecker, the avuncular oceanographer, means when he calls the planet an “angry beast.”76 You could also go with “war machine.” Each day we arm it more. The assaults will not be discrete—this is another climate delusion. Instead, they will produce a new kind of cascading violence, waterfalls and avalanches of devastation, the planet pummeled again and again, with increasing intensity and in ways that build on each other and undermine our ability to respond, uprooting much of the landscape we have taken for granted, for centuries, as the stable foundation on which we walk, build homes and highways, shepherd our children through schools and into adulthood under the promise of safety—and subverting the promise that the world we have engineered and built for ourselves, out of nature, will also protect us against it, rather than conspiring with disaster against its makers. Consider those California wildfires. In March 2018, Santa Barbara County issued mandatory evacuation orders for those living in Montecito, Goleta, Santa Barbara, Summerland, and Carpinteria—where the previous December’s fires had hit hardest. It was the fourth evacuation order precipitated by a climate event in the county in just three months, but only the first had been for fire.77 The others were for mudslides ushered into possibility by that fire, one of the toniest communities in the most glamorous state of the world’s preeminently powerful country upended by fear that their toy vineyards and hobby stables, their world-class beaches and lavishly funded public schools, would be inundated by rivers of mud, the community as thoroughly ravaged as the sprawling camps of temporary shacks housing Rohingya refugees from Myanmar in the monsoon region of Bangladesh.78 It was. More than a dozen died, including a toddler swept away by mud and carried miles down the mountainslope to the sea; schools closed and highways flooded, foreclosing the routes of emergency vehicles and making the community an inland island, as if behind a blockade, choked off by a mud noose.79 Some climate cascades will unfold at the global level—cascades so large their effects will seem, by the curious legerdemain of environmental change, imperceptible. A warming planet leads to melting Arctic ice, which means less sunlight reflected back to the sun and more absorbed by a planet warming faster still, which means an ocean less able to absorb atmospheric carbon and so a planet warming faster still. A warming planet will also melt Arctic permafrost, which contains 1.8 trillion tons of carbon, more than twice as much as is currently suspended in the earth’s atmosphere, and some of which, when it thaws and is released, may evaporate as methane, which is thirty-four times as powerful a greenhouse-gas warming blanket as carbon dioxide when judged on the timescale of a century; when﻿ judged on the timescale of two decades, it is eighty-six times as powerful.80, 81 A hotter planet is, on net, bad for plant life, which means what is called “forest dieback”—the decline and retreat of jungle basins as big as countries and woods that sprawl for so many miles they used to contain whole folklores—which means a dramatic stripping-back of the planet’s natural ability to absorb carbon and turn it into oxygen, which means still hotter temperatures, which means more dieback, and so on. Higher temperatures means more forest fires means fewer trees means less carbon absorption, means more carbon in the atmosphere, means a hotter planet still—and so on. A warmer planet means more water vapor in the atmosphere, and, water vapor being a greenhouse gas, this brings higher temperatures still—and so on. Warmer oceans can absorb less heat, which means more stays in the air, and contain less oxygen, which is doom for phytoplankton—which does for the ocean what plants do on land, eating carbon and producing oxygen—which leaves us with more carbon, which heats the planet further. And so on. These are the systems climate scientists call “feedbacks”; there are more.82 Some work in the other direction, moderating climate change. But many more point toward an acceleration of warming, should we trigger them. And just how these complicated, countervailing systems will interact—what effects will be exaggerated and what undermined by feedbacks—is unknown, which pulls a dark cloud of uncertainty over any effort to plan ahead for the climate future. We know what a best-case outcome for climate change looks like, however unrealistic, because it quite closely resembles the world as we live on it today. But we have not yet begun to contemplate those cascades that may bring us to the infernal range of the bell curve. Other cascades are regional, collapsing on human communities and buckling them where they fall. These can be literal cascades—human-triggered avalanches are on the rise, with 50,000 people killed by avalanches globally between 2004 and 2016.83 In Switzerland, climate change has unleashed a whole new kind, thanks to what are called “rain-on-snow” events, which also caused the overflow of the Oroville Dam in Northern California and the 2013 flood of Alberta, Canada, with damages approaching $5 billion.84 But there are other kinds of cascade, too. Climate-driven water shortages or crop failures push climate refugees into nearby regions already struggling with resource scarcity. Sea-level rise inundates cropland with more and more saltwater flooding, transforming agricultural areas into brackish sponges no longer able to adequately feed those living off them; flooding power plants, knocking regions offline just as electricity may be needed most; and crippling chemical and nuclear plants, which, malfunctioning, breathe out their toxic plumes. The rains that followed the Camp Fire flooded the tent cities hastily assembled for the first disaster’s refugees. In the case of the Santa Barbara mudslides, drought produced a state full of dry brush ripe for a spark; then a year of anomalously monsoonish rain produced only more growth, and wildfires tore through the landscape, leaving a mountainside without much plant life to hold in place the millions of tons of loose earth that make up the towering coastal range where the clouds tend to gather and the rain first falls. Some of those watching from afar wondered, incredulously, how a mudslide could kill so many. The answer is, the same way as hurricanes or tornadoes—by weaponizing the environment, whether “man-made” or “natural.” Wind disasters do not kill by wind, however brutal it gets, but by tugging trees out of earth and transforming them into clubs, making power lines into loose whips and electrified nooses, collapsing homes on cowering residents, and turning cars into tumbling boulders. And they kill slowly, too, by cutting off food delivery and medical supplies, making roads impassable even to first responders, knocking out phone lines and cell towers so that the ill and elderly must suffer, and hope to endure, in silence and without aid. Most of the world is not Santa Barbara, with its Mission-style impasto of infinite-seeming wealth, and in the coming decades many of the most punishing climate horrors will indeed hit those least able to respond and recover. This is what is often called the problem of environmental justice; a sharper, less gauzy phrase would be “climate caste system.” The problem is acute within countries, even wealthy ones, where the poorest are those who live in the marshes, the swamps, the floodplains, the inadequately irrigated places with the most vulnerable infrastructure—altogether an unwitting environmental apartheid. Just in Texas, 500,000 poor Latinos live in shantytowns called “colonias” with no drainage systems to deal with increased flooding.85 The cleavage is even sharper globally, where the poorest countries will suffer more in our hot new world. In fact, with one exception—Australia—countries with lower GDPs will warm the most.86 That is notwithstanding the fact that much of the global south has not, to this point, defiled the atmosphere of the planet all that much. This is one of the many historical ironies of climate change that would better be called cruelties, so merciless is the suffering they will inflict. But disproportionately as it will fall on the world’s least, the devastation of global warming cannot be easily quarantined in the developing world, as much as those in the Northern Hemisphere would probably, and not to our credit, prefer it. Climate disaster is too indiscriminate for that. In fact, the belief that climate could be plausibly governed, or managed, by any institution or human instrument presently at hand is another wide-eyed climate delusion. The planet survived many millennia without anything approaching a world government, in fact endured nearly the entire span of human civilization that way, organized into competitive tribes and fiefdoms and kingdoms and nation-states, and only began to build something resembling a cooperative blueprint, very piecemeal, after brutal world wars—in the ﻿form of the League of Nations and United Nations and European Union and even the market fabric of globalization, whatever its flaws still a vision of cross-national participation, imbued with the neoliberal ethos that life on Earth was a positive-sum game. If you had to invent a threat grand enough, and global enough, to plausibly conjure into being a system of true international cooperation, climate change would be it—the threat everywhere, and overwhelming, and total. And yet now, just as the need for that kind of cooperation is paramount, indeed necessary for anything like the world we know to survive, we are only unbuilding those alliances—recoiling into nationalistic corners and retreating from collective responsibility and from each other. That collapse of trust is a cascade, too. ﻿Just how completely the world below our feet will become unknown to us is not yet clear, and how we register its transformation remains an open question. One legacy of the environmentalist creed that long prized the natural world as an otherworldly retreat is that we see its degradation as a sequestered story, unfolding separately from our own modern lives—so separately that the degradation acquires the comfortable contours of parable, like pages from Aesop, aestheticized even when we know the losses as tragedy. Climate change could soon mean that, in the fall, trees may simply turn brown, and so we will look differently at entire schools of painting, which stretched for generations, devoted to best capturing the oranges and reds we can no longer see ourselves out the windows of our cars as we drive along our highways.87 The coffee plants of Latin America will no longer produce fruit; beach homes will be built on higher and higher stilts and still be drowned.88 In many cases, it is better to use the present tense. In just the last forty years, according to the World Wildlife Fund, more than half of the world’s vertebrate animals have died; in just the last twenty-five, one study of German nature preserves found, the flying insect population declined by three-quarters.89, 90 The delicate dance of flowers and their pollinators has been disrupted, as have the migration patterns of cod, which have fled up the Eastern Seaboard toward the Arctic, evading the communities of fishermen that fed on them for centuries; as have the hibernation patterns of black bears, many of which now stay awake all winter.91, 92, 93 Species individuated over millions of years of evolution but forced together by climate change have begun to mate with one another for the first time, producing a whole new class of hybrid species: the pizzly bear, the coy-wolf.94 The zoos are already natural history museums, the children’s books already out of date. Older fables, too, will be remade: the story of Atlantis, having endured and enchanted for several millennia, will compete with the real-time sagas of the Marshall Islands and Miami Beach, each sinking over time into snorkelers’ paradises; the strange fantasy of Santa and his polar workshop will grow eerier still in an Arctic of ice-free summers; and there is a terrible poignancy in contemplating how desertification of the entire Mediterranean Basin will change our reading of the Odyssey, or how it will discolor the shine of Greek islands for dust from the Sahara to permanently blanket their skies, or how it will recast the meaning of the Pyramids for the Nile to be dramatically drained.95, 96, 97 We will think of the border with Mexico differently, presumably, when the Rio Grande is a line traced through a dry riverbed—the Rio Sand, it’s already been called.98 The imperious West has spent five centuries looking down its nose at the plight of those living within the pale of tropical disease, and one wonders how that will change when mosquitoes carrying malaria and dengue are flying through the streets of Copenhagen and Chicago, too. But we have for so long understood stories about nature as allegories that we seem unable to recognize that the meaning of climate change is not sequestered in parable. It encompasses us; in a very real way it governs us—our crop yields, our pandemics, our migration patterns and civil wars, crime waves and domestic assaults, hurricanes and heat waves and rain bombs and megadroughts, the shape of our economic growth and everything that flows downstream from it, which today means nearly everything. Eight hundred million in South Asia alone, the World Bank says, would see their living conditions sharply diminish by 2050 on the current emissions track, and perhaps a climate slowdown will even reveal the bounty of what Andreas Malm calls fossil capitalism to be an illusion, sustained over just a few centuries by the arithmetic of adding the energy value of burned fossil fuels to what had been, before wood and coal and oil, an eternal Malthusian trap.99, 100 In which case, we would have to retire the intuition that history will inevitably extract material progress from the planet, at least in any reliable or global pattern, and come to terms, somehow, with just how pervasively that intuition ruled even our inner lives, often tyrannically. Adaptation to climate change is often viewed in terms of market trade-offs, but in the coming decades the trade will work in the opposite direction, with relative prosperity a benefit of more aggressive action. Every degree of warming, it’s been estimated, costs a temperate country like the United States about one percentage point of GDP, and according to one recent paper, at 1.5 degrees the world would be $20 trillion richer than at 2 degrees.101, 102 Turn the dial up another degree or two, and the costs balloon—the compound interest of environmental catastrophe. 3.7 degrees of warming would produce $551 trillion in damages, research suggests; total worldwide wealth is today about $280 trillion.103, 104 Our current emissions trajectory takes us over 4 degrees by 2100; multiply that by that 1 percent of GDP and you have almost entirely wiped out the very possibility of economic growth, which has not topped 5 percent globally in over forty years.105 A fringe group of alarmed academics call this prospect “steady-state economics,” but it ultimately suggests a more ﻿complete retreat from economics as an orienting beacon, and from growth as the lingua franca through which modern life launders all of its aspirations.106 “Steady-state” also gives a name to the creeping panic that history may be less progressive, as we’ve come to believe really only over the last several centuries, than cyclical, as we were sure it was for the many millennia before. More than that: in the vision steady-state economics projects of a state-of-nature competitive scramble, everything from politics to trade and war seems brutally zero-sum. For centuries we have looked to nature as a mirror onto which to first project, then observe, ourselves. But what is the moral? There is nothing to learn from global warming, because we do not have the time, or the distance, to contemplate its lessons; we are after all not merely telling the story but living it. That is, trying to; the threat is immense. How immense? One 2018 paper sketches the math in horrifying detail. In the journal Nature Climate Change, a team led by Drew Shindell tried to quantify the suffering that would be avoided if warming was kept to 1.5 degrees, rather than 2 degrees—in other words, how much additional suffering would result from just that additional half-degree of warming. Their answer: 150 million more people would die **from air pollution alone** in a 2-degree warmer world than in a 1.1075-degree warmer one. Later that year, the IPCC raised the stakes further: in the gap between 1.1085 degrees and 2, it said, **hundreds of millions of lives were at stake**. Numbers that large can be hard to grasp, but 150 million is the equivalent of twenty-five Holocausts. It is three times the size of the death toll of the Great Leap Forward—the largest nonmilitary death toll humanity has ever produced. It is more than twice the greatest death toll of any kind, World War II. The numbers don’t begin to climb only when we hit 1.5 degrees, of course. As should not surprise you, they are already accumulating, at a rate of at least seven million deaths, from air pollution alone, each year—an annual Holocaust, pursued and prosecuted by what brand of nihilism? This is what is meant when climate change is called an “existential crisis”—a drama we are now haphazardly improvising between two hellish poles, in which our best-case outcome is death and suffering at the scale of twenty-five Holocausts, and the worst-case outcome puts us on the brink of extinction.109 Rhetoric often fails us on climate because the only factually appropriate language is of a kind we’ve been trained, by a buoyant culture of sunny-side-up optimism, to dismiss, categorically, as hyperbole. Here, the facts are hysterical, and the dimensions of the drama that will play out between those poles **incomprehensibly large**—large enough to enclose not just all of present-day humanity but all of our possible futures, as well. Global warming has improbably compressed into two generations the entire story of human civilization. First, the project of remaking the planet so that it is undeniably ours, a project whose exhaust, the poison of emissions, now casually works its way through millennia of ice so quickly you can see the melt with a naked eye, destroying the environmental conditions that have held stable and steadily governed for literally all of human history. That has been the work of a single generation. The second generation faces a very different task: the project of preserving our collective future, forestalling that devastation and engineering an alternate path. There is simply no analogy to draw on, outside of mythology and theology—and perhaps the Cold War prospect of mutually assured destruction. Few feel like gods in the face of warming, but that the totality of climate change should make us feel so passive—that is another of its delusions. In folklore and comic books and church pews and movie theaters, stories about the fate of the earth often perversely counsel passivity in their audiences, and perhaps it should not surprise us that the threat of climate change is no different. By the end of the Cold War, the prospect of nuclear winter had clouded every corner of our pop culture and psychology, a pervasive nightmare that the human experiment might be brought to an end by two jousting sets of proud, rivalrous tacticians, just a few sets of twitchy hands hovering over the planet’s self-destruct buttons. The threat of climate change is more dramatic still, and ultimately more democratic, with responsibility shared by each of us even as we shiver in fear of it; and yet we have processed that threat only in parts, typically not concretely or explicitly, displacing certain anxieties and inventing others, choosing to ignore the bleakest features of our possible future and letting our political fatalism and technological faith blur, as though we’d gone cross-eyed, into a remarkably familiar consumer fantasy: that someone else will fix the problem for us, at no cost. Those more panicked are often hardly less complacent, living instead through climate fatalism as though it were climate optimism. Over the last few years, as the planet’s own environmental rhythms have seemed to grow more fatalistic, skeptics have found themselves arguing not that climate change isn’t happening, since extreme weather has made that undeniable, but that its causes are unclear—suggesting that the changes we are seeing are the result of natural cycles rather than human activities and interventions. It is a very strange argument; if the planet is warming at a terrifying pace and on a horrifying scale, it should transparently concern us more, rather than less, that the warming is beyond our control, possibly even our comprehension. That we know global warming is our doing should be a comfort, not a cause for despair, however incomprehensively large and complicated we find the processes that have brought it into being; that we know we are, ourselves, responsible for all of its punishing effects ﻿should be empowering, and not just perversely. Global warming is, after all, a human invention. And the flip side of our real-time guilt is that we remain in command. No matter how out-of-control the climate system seems—with its roiling typhoons, unprecedented famines and heat waves, refugee crises and climate conflicts—we are all its authors. And still writing.