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On the Moral Challenge of the Climate Crisis

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1.

When the planes were grounded by the virus, the fires in Siberia were only getting started. Temperatures in the Arctic would soon break a hundred degrees Fahrenheit. Earth frozen since the beginning of history began smoldering over a colossal area. Within weeks, millions of acres of forest and tundra had been burned up by the flames. Even so, the fires were but a single link in a chain of unparalleled events. The following year, warm water was found beneath the massive Thwaites glacier in Antarctica. Like the active methane leaks that have now been documented on the seabed, this discovery is bound to alter when we will be told to expect even more rapid melting. We know this because it has happened so regularly and so often. With every decade, the poles have been warming faster than the outlying predictions of the previous period. Where once we thought it would take a century, we are now told that the Arctic may be ice-free as early as the 2040s. Less ice will lead to yet more ice-destroying rain, evaporation produced by the sea absorbing more of the sun’s rays. In turn, more wind will stir the seas and the methane deposits trapped beneath, while rains that reach the land will accelerate the thawing of the frozen ground. As the northern climate warms, the annual fires will reach still more of the boreal forests, releasing enormous quantities of carbon stored in vegetation, peat and hummus. Predictably, there will be more melting, more rain and flooding, more drought and fire, and still more warming. All the while, the climate will not care if the people are distracted by the growing jingoism or the latent fascism or the failure to respond rationally to a virus. On the contrary, with every hurricane, drought and crop failure, nature will present humanity with yet more occasions for division and further obstacles to solidarity.

Until recently, most thinking people were as good as sleeping on this issue. To be sure, most had at some point heard of its existence, and many even saw through the denialist propaganda of their bought-and-paid-for politicians. Yet for decades, even privileged people in wealthy countries persistently ranked the climate crisis near the bottom of their so-called policy priorities. It is a ray of hope in a time of darkness that majorities of voters are slowly beginning to revise what they profess to be their sovereign preference on this matter. Nevertheless, I believe that even well-meaning people continue to be deluded by the scale of the challenge that we face. In a word, it’s not the case that all we need is the political will to pass a Green New Deal. Aside from distorting the politics that produced the climate crisis in the first place, this familiar invocation ignores both the technological challenge and the moral difficulty of conceiving a suitably rapid energy transition. Overcoming these blind spots is essential to understanding the strategic predicament of everyone who wishes to avert the suffering and the cruelty now looming in our future.

When I first started thinking about this subject, I thought the philosophical dimensions were interesting but quite irrelevant practically speaking. Like others, I was content to know that the world just needed to cut its greenhouse gas emissions. As I learned more about the problem, I gradually lost my unexamined confidence. In fact, I went from thinking that we already know what we morally ought to do about the climate crisis to realizing that we don't even have an adequate approach to this question, let alone a fully defensible answer. One reason why it's hard to see this is that the consequences of past inaction are closer and more dire than many people think, even while the challenge of avoiding worse consequences is now greater than most of us suppose. There is certainly a large number of low-hanging fruit still left to be picked, stoves to be replaced, and houses insulated. But the changes that will make most of us better off, if only the politics allow, are not where any of the difficult moral problems lie.

The problems surface only once we're honest about the remaining carbon budget and the difficulty of a global energy transition. Even ignoring for a moment the prison of our capitalist politics, the world is very far away from being able to decarbonize all existing human energy consumption. Hence total consumption would need to drop for humanity to stop adding greenhouse gases to the atmosphere in the near-term. Meanwhile the clock is ticking on feedback mechanisms and other catastrophic outcomes. This means that we cannot think responsibly about the climate crisis without evaluating both per capita energy use and global population size. Yet these subjects are immensely difficult and certainly make a mockery of the conventional policy approaches. They also raise hard questions concerning how much we owe to future generations and what we owe to other animals.

In this paper, I will present an approach that I think is the only satisfactory of dealing jointly with the first three problems: i) evaluating restrictions on carbon-intensive present-day consumption ii) as requirements of intergenerational justice iii) without succumbing to the problems of population ethics. On this approach, duties of intergenerational justice are owed first and foremost by the adult powerholders in the present generation to the younger people who are already alive and will replace them someday. The core imperative of intergenerational justice on this view is to put in place all those restrictions on existing rights and freedoms that, unless they are put in place, will require even more serious sacrifices having to be made later by today's younger people, lest they fall afoul of the very same imperative in the future. In turn, the essence of intergenerational *in*justice is a form of 'kicking the can down the road': *failing* to put in place restrictions on existing rights and freedoms that are necessary to prevent even more serious sacrifices having to be made later for the purpose of enacting justice and securing every living person's rights to be free from avoidable famine, drought, resource wars, and so on.

I shall argue that this is exactly what today's most powerful people are unconscionably doing now, and it is exactly how you and I were wronged by the people who were in charge 30, 40, 50 years ago. They failed to make changes to energy systems that, though they would have been costly and socially disruptive, would have been much less burdensome to undertake in the time that was then still available to prevent catastrophic climate change. Instead, they chose to indulge much less urgent interests in consumption and accumulation and left us in a much more dire situation. In turn, today's powerholders are doing the very same thing to the children born around the world yesterday. They are indulging various less important interests in accumulation and consumption rather than reducing emissions and accelerating the global energy transition, ensuring that even

more burdensome steps will later be morally required—of these children, for this purpose—else the world eventually collapse from catastrophic climate change.

I will suggest (because I have come to think) that this approach is the only satisfactory way of reasoning about the intergenerational dimension of climate change. Even so, setting out a way of reasoning does not itself answer urgent practical questions. Moreover, there are dimensions of the climate crisis that are absolutely central to the question of what our governments presently ought to do but regarding which, after many attempts to think them through, I still hardly know where to begin. In the final part of this paper, I will bare my (un-lonely) ignorance about two such issues before focusing in more detail on a third. The first issue is the question of what it would be for our generation to address the climate crisis in a way that respects the claims, not merely of human beings, but of all the other wild and domesticated animals. The second question is how to make fateful social decisions regarding the pace of the global energy transition under conditions of profound uncertainty about the consequences of these actions. The final issue is how you and I ought to reason about our moral obligations when we admit to ourselves that the powerful will, predictably, not do any of these things, and that other people will respond to the fallout with yet more wrongdoing in their turn.

The seas will warm, the storms will come, the insurance markets will fail; and yet the people who fly private jets will more or less be made whole. And then one year, the staple crops will wither simultaneously in many highly populated places around the world. That's when the reactionary impulse against the growing migrant flows will really start to take hold. Think about what just a few million foreigners on the shores of Europe and the US southern border has done to the politics of these countries. Children in cages; openly fascist parties; EU-funded goons beating unarmed migrants. If the recent past is any indication, the response to hundreds of millions of Asian, African and Latin American migrants will be even more toxic. How should such sober expectations affect how you and I, here and now, understand our intellectual and political obligations? Needless to say, this final dimension of the climate crisis—the non-ideal theory of climate ethics—contains all of the most urgent practical questions. What's more, these questions do not in any way avoid the challenges of so-called ideal theory; on the contrary, they inherit those philosophical problems while adding new ones. Thanks to these compounding difficulties, I no longer think that it's already perfectly clear what we, together and individually, should do. Instead, I have come to think that climate change is perhaps the hardest moral problem that humanity has ever faced, to the extent that this phrase (a problem that 'humanity has faced') even makes sense in a still-unplanned, uncoordinated and divided world.

2.

To appreciate the difficulty, it helps to begin by reflecting on a familiar kind of hard-nosed skepticism. On this view, thinking about the ethical dimensions of the climate crisis is at best irrelevant and at worst a dangerous distraction. The putative reason is that states don't care about ethical considerations when they set their policies; they care only about advancing their self-interest. This general proposition is said to be borne out by the shape of the existing energy transition. Europe, the continent that has made the most progress towards decarbonization, is also the continent that is least rich in oil and gas deposits. The United States began to leave coal behind only when fracking technology unleashed its awesome natural gas reserves; not coincidentally, it

has since become the world's single largest producer of both natural gas and oil. China is rapidly developing its western coal reserves so that it can reduce its dependence on oil from overseas, not least because such dependence makes the regime vulnerable to a future naval blockade over the issue of Taiwan. Russia, as the third largest oil producer, is entirely unconcerned about climate change and is planning drilling projects in the Arctic even as it melts. Canadian politicians talk politely about the future of our children while developing the second largest and by far the dirtiest oil deposit in the world. And most other fossil fuel producing countries are similarly dressed-up climate wolves. So, the thought goes, it is better not to talk about ethics if one wants to see meaningful global greenhouse gas reductions. Instead, one should speak to the self-interest of states and ask three simple questions. Who stands to benefit most from a robust climate treaty? Who stands to benefit less? And how can the less vulnerable countries be bought off?

Taking their own advice, the economists Eric Posner and David Weisbach report that “an optimal climate treaty could well require side-payments to rich countries like the United States and rising countries like China, and indeed possibly from very poor countries which are extremely vulnerable to climate change—such as Bangladesh.”¹ They call this the “realist” approach to international negotiations. I begin with this approach because, aside from being quietly influential in policy discussions, it is also instructively naïve about the nature of the climate crisis. Most importantly, the proposal assumes that it is in the narrow economic self-interest of the vulnerable countries to take rapid action to stave off the worst effects of climate change. But that is a mistake, based on a failure to appreciate two things: the very temporally extended consequences of the growing planetary energy imbalance, and just how difficult it will be to avoid irreversible tipping points in the near-term whose worst effects will come only in the distant future.

There are many such tipping points in the climate system and each has the potential for devastating consequences.² They include accelerated melting of the Greenland and Antarctic icesheets, accelerated melting of the polar sea ice, accelerated warming from the thawing of the permafrost, accelerated warming from the growing fires in the boreal forests, the collapse of the Amazon and the loss of a planetary carbon sink, warmer southern oceans from the collapse of the Atlantic overturning circulation system, the collapse of marine food webs upon the death of the remaining coral reefs, the tipping of the Pacific Ocean into a permanent El Niño state, hotter conditions in the Northern Hemisphere leading to yet more fires in the boreal forests and yet more melting of the polar ice and yet more methane release from soil decomposition. Moreover, some of these climate system shifts may be well be breached in the near future. Most alarmingly, the Amazon may be near the point of an irreversible collapse into savannah,³ and the Atlantic overturning circulation (which drives many of the world's weather-affecting ocean currents) could pass the point of no return as early as 2025.⁴

However, none of these things mean that it is in the narrow self-interest of the vulnerable countries to take the steps that would be necessary to stave off the worst effects of climate change. That's because the worst effects of climate change—all of the world's coastal cities being swallowed by the oceans, the massive expansion of deserts outward from the equatorial latitudes, heat waves everywhere that are not survivable by mammals—will take many centuries to unfold, long after everyone alive today is dead. Meanwhile, the near-term challenge of avoiding temperatures at which tipping elements may be breached is hard to overstate. Consider for instance what it would take to stop the world from warming more than 1.5 or 2 degrees.⁵

As of January 2023, the carbon budget for a 50% chance of not exceeding 1.5 degrees is only 250 gigatons of CO₂, or just over 6 years of current global emissions. For a somewhat higher 66% chance of limiting warming to 1.5 degrees, the carbon budget shrinks to less than 4 years of current annual emissions. This means that, at this point, the only way to avoid dangerously higher temperatures is for annual emissions to go into a sudden freefall. What would be required for this purpose would be instantly ceasing the use of virtually all fossil fuels: all marine diesel used for transoceanic shipping; all existing jet fuel; all of the gasoline and heating oil; all of the coal that drives the world's steel plants and cements kilns; all of the natural gas that is used to make the world's fertilizer. Even then, the global temperature would still likely rise by more than 1.5 degrees above the pre-industrial level as the sulfur pollution from existing coal plants fell to the ground and removed a major atmospheric albedo cooling effect.⁶ The recent warming of the Atlantic ocean stemming from reductions in marine diesel sulfur content is a prelude to the spike in global temperatures that the world can expect to see on the loss of the global sulfur albedo.⁷

Now consider the challenge of avoiding more than 2 degrees of warming. As of 2023, another 950 gigatons of CO₂ can be emitted to leave the planet with a 66% chance of avoiding more than 2 degrees of warming by the year 2100. This carbon budget amounts to less than 24 years of current annual emissions. However, if the world's emissions continue at the present rate for just another 10 years, then the slope of emissions reductions required to stay within 2 degrees of warming will be just as steep as the freefall required for a chance of staying under 1.5 degrees today. While this observation may be striking, it is just a consequence of the most important truth of global warming. The global temperature will keep rising—to an ever-higher plateau above 2 degrees—until humanity wholly transforms its land-use practices and altogether stops the use of fossil fuels. Merely “reducing” planet-warming emissions is not going to be enough. The global temperature will continue rising as long as humanity is adding anything whatsoever to the atmospheric stock of greenhouse gases. And yet the world's emissions are still growing rather than holding steady, let alone falling. The uptrend was briefly interrupted when Covid shut down the global economy in 2020. But then emissions rebounded strongly in 2021 and hit another all-time high last year. In short, the prospect of avoiding temperatures that could trigger catastrophic tipping elements in the climate system is steadily slipping out of view.

Why does humanity find itself in such an unforgiving situation? Part of the answer is very clearly the elites' naked greed and intransigence. I will say more about this in a moment. But to stop there would be to miss the other moral problems. These problems surface when we notice that many existing energy-intensive activities cannot presently be decarbonized,⁸ and that, in any case, renewables are not presently being used to replace fossil fuels: at a global level, renewables are merely adding to the total amount of energy consumed.⁹ These two facts together explain the uncomfortable parameters of the Kaya identity. Humanity's total annual emissions are a function of the energy intensity of producing a unit of GDP, the carbon emissions per unit of energy consumed, the number of people consuming energy, and the average annual energy consumption per person. Yet while there have been very significant gains in the first two components of this equation since 1950, these gains in efficiency have been completely swamped by growth in energy consumption per person and growth in global population size.¹⁰

In short, a continually growing global economy is presently barreling towards 2 degrees of warming and more *without* the ability to rapidly decarbonize long-haul aviation, transoceanic shipping, cement and steel production, most industrial heat processes, the mass production of

fertilizer, and so on. In perhaps another ten or fifteen years' time, unless all of these processes suddenly stop, the eventual rise in temperature may trigger irreversible tipping elements in the climate system whose effects could be catastrophic for human beings and countless other species in the long-run. The reason why we find ourselves in this unforgiving situation is not merely because the elites have been so intransigent, but also because total human energy consumption is growing faster than it has been or even could be decarbonized at present. We therefore cannot think responsibly about the climate crisis without evaluating both energy consumption per capita and global population size. And yet these tasks continue to be systematically avoided in mainstream policy discussions.

3.

Nearly two decades ago, Stephen Pacala and Robert Socolow proposed the stabilization wedge approach to mitigation.¹¹ They outlined fifteen technological changes that, if put in place, would each reduce annual emissions by one billion tons of carbon in 50 years. To give a sense of the scale of the technological changes involved, one of these wedges called for building 700 new nuclear plants, twice the number that have ever been built. A second wedge called for reforesting an area equivalent to twice the arable land of the United States. A third wedge called for installing two million 1-megawatt windmills on an area larger than the United Kingdom. Despite the scale of these projects, the authors noted that on the current emissions trajectory, the world would need to implement eight such wedges simultaneously—not in order to *cut* annual global emissions—but just to keep them from *doubling*.

As Philip Cafaro has noted in his illuminating reflections on this topic, none of the proposed stabilization wedges makes a serious effort to limit total human consumption growth.¹² For example, meat-eating contributes approximately two and a half billion tons of carbon per annum to global emissions.¹³ In fact, there are so many animals now raised for human consumption that if you were to put them all on a scale, the caged animals would outweigh all of the wild mammals and birds left in the world by a ratio of 10 to 1.¹⁴ Meanwhile, the UN projects that between 2000 and 2050, the worldwide production of animals for human consumption will double, from 60 billion to 120 billion animals produced per annum. This growth will inevitably greatly increase agricultural greenhouse gas emissions. Yet if the world were merely to hold fixed the number of animals produced for human consumption at the current level, this would reduce projected emissions by the equivalent of two and a half of the stabilization wedges that I just mentioned.¹⁵ Indeed, even preventing just half of the expected growth in animal consumption by 2050 would reduce projected carbon emissions by the equivalent of tripling the global number of nuclear power plants.

A similar analysis applies to other extremely emissions-intensive activities, such as aviation. Global air passenger traffic is currently doubling roughly every 15 years.¹⁶ Preventing half of the projected increase to 2050 would likely reduce emissions by two billion tons of carbon per year or two of the wedges I mentioned, whereas holding flights at the current level would likely cut four billion tons annually or four stabilization wedges.¹⁷ Finally, consider the human population, which has doubled from four billion to eight billion people in the fifty years since 1973, and is projected to reach ten billion people by some time in the 2060s. With every additional 500 million people on the planet, global greenhouse gas emissions are expected to grow by at least one billion

tons of carbon per annum. Thus, if the human population were to stabilize at the current level of eight billion by 2050, that would reduce projected global emissions by likely four billion tons of carbon annually. However, if global population were to follow the UN's "high growth scenario" and reach twelve billion people by the 2060s, then reforesting an area three times the size of Australia would still not be enough to outweigh the growth in carbon emissions.¹⁸

In short, human consumption growth and global population size will both make an enormous difference to how much carbon is emitted and therefore whether catastrophic climate tipping points are triggered. Yet limits on these variables are rarely seriously discussed by climate policymakers and researchers. Philip Cafaro, who has done more than most to draw attention to this problem, has asked philosophers to weigh in on the question of why these topics continue to be systematically avoided. I would now like to take the opportunity to offer my response.

As I see it, there are two principal reasons why many experts neglect to discuss limits on total consumption growth. The first reason is that most existing analyses of consumption growth come from economic models, and economists have been incredibly cavalier about the risks of climate change. Consider for instance that in the standard DICE model, it is strictly impossible to crash the global economy even with six or more degrees of global warming.¹⁹ At six degrees of warming, the daily temperature in New York would be deadly to mammals for likely two months of the year; most existing insect species would be extinct; and with enough time for the melting to take place, crocodiles would once again be living in what is now the Arctic.²⁰ Yet in the DICE model it is impossible for changes even of this magnitude to crash the sum of human welfare. That is because, among other things, GDP is taken as a suitable proxy for welfare and it's assumed that nothing that happens outside can affect GDP in our predominantly indoors service-sector economy. Here is a statement of this mainstream idea from the Intergovernmental Panel on Climate Change: "Economic activities such as agriculture, forestry, fisheries, and mining are exposed to the weather and thus vulnerable to climate change. Other economic activities, such as manufacturing and services, largely take place in controlled environments and are not really exposed to climate change."²¹

I mention this Nobel-prize winning idea only to set it aside. The other reason why analysts tend not to discuss constraints on total consumption growth is because the standard optimal policy framework is sum-total utilitarian.²² This is clear from the *maximands* of the integrated assessment models used to evaluate alternative consumption and emissions pathways. These models tell us to maximize an additive intergenerational social welfare function that takes as inputs estimates of all present and future preferences over consumption. Yet there is no way for such an approach to provide morally sound guidance concerning what should be done about human consumption growth. On the contrary, the approach produces morally abhorrent results and the practitioners have long understood this fact.

To see this, consider first the question of optimal population size.²³ One might think that with the sorts of impacts that I have outlined, a utilitarian approach to climate policy would recommend attempting to stabilize or even gradually reduce the size of the global population. In fact, a sum-total utilitarian approach makes the opposite recommendation: it tells us to adopt policies that will grow the population. The reason for this recommendation, called the Repugnant Conclusion by philosophers of population ethics, is the fact that sum-total utilitarianism fundamentally cares only about the sum of welfare and not about the fate of anyone in particular. Accordingly, it will direct us to take steps to grow the population, to many tens of billions of people,

all of whom consequently have lives that are barely worth living, just as long as the total amount of welfare summed across persons is larger (in much the way that a million bottles of wine, each containing a single drop, will hold more wine in sum than a single full bottle).

This problem is just a special instance of a more general problem with the utilitarian approach to climate policy. Another instance arises when we try to use the approach to tell us how much present-day consumption we should be prepared to sacrifice for the sake of future generations. Here is the second issue in a nutshell. For every resource that we can either consume now or withhold from consumption and invest for the future, the objective of maximizing an additive intergenerational social welfare function will demand that we *deny* ourselves the use of this resource and invest it for the future, just as long as this would produce positive net returns to aggregate welfare summed across an indefinite series of future generations.²⁴ Applied to emissions reductions, this approach will therefore tell us to literally starve the present generation if, say, a drastically lower population would allow the biosphere to recover from such ongoing processes as the sixth extinction and thereby enable even higher consumption paths in the more distant future. In other words, as long as drastic cuts in present-day consumption are technically feasible and would maximize total welfare summed across many generations, an intergenerational utilitarian social objective will require the present generation to undertake the severest possible cuts in human energy and land-use, irrespective of the potentially unbearable sacrifices thereby implied for people living in the present.

Even the practitioners of this approach find these conclusions unacceptable. To avoid them, the conventional optimal policy framework has come to make use of two ad hoc devices. The first is the device of discounting the welfare of future generations in order to make room for more present-day consumption. The second is the tactic of ignoring global population size by treating it as exogenous to the analysis. For obvious reasons, these tactics make the conventional approach useless for evaluating total human consumption growth. Yet both tactics are widely used and indeed felt to be absolutely necessary. Otherwise, it is feared, the present generation will literally have to “starve itself to benefit future generations,” while optimal climate policy will call for growing rather than stabilizing the future human population.²⁵

These fears rest on a mistake, however. The conclusions that climate economists seek to avoid follow only if we, the present generation, have a duty to maximize the sum of preference satisfaction across all of time. Yet this assumption misdescribes our duties of intergenerational justice in two important ways. First, we do not owe it to future people to help them get more of whatever they happen to want. The desires of future people for robotic maids and vacations in space are less urgent than the needs of poor people today for clean water, electricity and basic sanitation facilities. Conversely, irreversible losses in the future of arable land and other life-sustaining resources cannot be offset by the ability of today’s wealthy consumers to continue their frequent air travel to distant locales. By treating present and future “preferences” for these diverse goods as if they were all on a moral par, and telling us to maximize the extent of preference satisfaction across all of time, the utilitarian approach to climate policy misrepresents what we owe to our contemporaries as well as to others more distant in time.

Second, we do not owe it to future people to bring more and more of them into existence as a means of maximizing the sum of welfare. In fact, we do not owe it to any of our countless, merely possible offspring to bring any of them into existence at all. Instead, what is true is that we *will* owe various things to everyone who ever comes to exist, if and when they come to exist—

things ranging from police protection, the rule of law, and a system of functional educational institutions, to all of the other rights and entitlements that all living persons should be understood to have as a matter of social and international justice. The real problem of intergenerational justice, then, is not how we can avoid starving the living or ballooning the population in the name of creating the maximum amount of welfare in the future. These problems are artifacts of a consequentialist utilitarian approach that is entirely misguided in a case like climate change. Instead, the real problem of intergenerational justice is how to understand our present-day duty to preserve rights-respecting institutions for the indefinite future, and in particular how to conceive this duty so that it will be appropriately demanding. I will now describe how I think this challenge is best understood and how I think it can be solved.

4.

In my view, the most significant philosophical obstacle to defensible moral reasoning concerning the requirements of intergenerational justice in the climate change context comes not from the Repugnant Conclusion but from the Non-Identity Problem. This is because, even if our failure to cut global emissions quickly will have truly catastrophic consequences in the future, the Non-Identity Problem makes it difficult to see why the present generation will be wronging anyone by continuing with business as usual. The difficulty arises from three observations, not always clearly appreciated.

First, if what I have said in this paper is even remotely true, it will be immensely costly to cut global greenhouse emissions to net zero before they threaten to trigger irreversible climate tipping points. After all, there are billions of people around the world who still lack electricity, adequate nutrition, access to medicine and basic sanitation facilities, not to mention all of the other things that you and I take for granted. And yet at present, the global economy cannot operate even at current levels of output without using enormous quantities of fossil fuels for many decades. Alternatives to many combustion processes, petrochemicals, steel, concrete and other carbon-intensive materials have yet to be invented, and their mass production is likely to take decades even in the best of circumstances. Accordingly, if the world is to avoid temperatures that threaten catastrophic long-run dangers, then at least a temporary halt in the staggering rate of total human consumption growth appears to be necessary in the short-term. Yet for this purpose, our governments would need a very good justification.

Two further observations make this justification elusive on a non-consequentialist, person-regarding view of intergenerational justice. The first is that by continuing with business as usual, we will not actually be undermining the possibility of just institutions in the future. For even when the environment has been despoiled in, say, a couple of hundred years, it will continue to be possible for institutions to fairly ration the remaining resources and treat all living people in what will then be the morally required way.²⁶ It's just that, because the environment will have been ruined, maintaining just institutions in the future will at best afford everyone a much lower quality of life than some of us are able to enjoy today.

At the same time, it does not appear that we will be wronging anyone by lowering the standard of living attainable in the future to a very low level. For the present generation is in fact benefited by not having to make large sacrifices for the sake of the distant future; and even if it were to make such sacrifices, this would not actually *help* the people who will see the world's

coastal cities swallowed by the oceans several centuries from now. On the contrary, these particular people would end up never being born at all. After all, rapidly reducing global greenhouse emissions would have countless effects on what people today are able to do and be, and consequently also on whom they ever meet, and with whom they decide to have kids. But just you would never have been born had your mother never met your father and instead had children with some other individual, so, too, the persons who will live if we continue with business as usual will not be one and the same as the persons who will be born if the world makes rapid and extensive changes to its land-use practices, all of its transportation systems, and all of its energy infrastructure. Like ripples in a pool, the behavioral changes that will then inevitably follow will alter not only who meets whom and has children with them in the present generation, but also whose children will go on to have children of their own. Thus, if emissions are rapidly reduced today to avoid triggering catastrophic climate tipping points, this will not actually help the people who, several centuries from now, would otherwise live through the loss of the world's cities from dozens of feet of sea level rise. Instead, because of the countless behavioral changes that will then inevitably follow, these particular people will end up never being born at all.

In short, from the perspective of a non-consequentialist and person-regarding view of intergenerational justice, it's not clear why the present generation has a duty to rapidly reduce its consumption growth *even if* this is necessary to avoid triggering climate tipping points that will eventually prove catastrophic. For it appears that the people who will live through such catastrophes will not be benefited if we do, whereas the duty not to undermine the possibility of just institutions does not seem to rule out continuing with business as usual either. So from a non-utilitarian and person-regarding point of view, how should we reason about intergenerational justice so that the implications for what the present generation is morally required to do will be both illuminating and suitably demanding?

In thinking about this question, I have come to the conclusion that we should understand our duties of intergenerational justice as owed first and foremost to our younger contemporaries. In other words, I do not think that we should try to dissolve the fact of non-identity, much less to ignore it. It is simply true that, no matter what we do, our climate policies will affect who and how many people will come after us. If we continue on our current course, then many children will one day be born in makeshift environmental refugee camps, to parents who tragically met there for the first time in part because of our inaction. Yet as long as the lives of these children will still have been worth living, they would not be helped by our changing the course of world history; instead, they would end up never existing. The task for moral theory as I now see it is, not to deny this simple truth, but to make it strictly *irrelevant* to the content of appropriately demanding present-day environmental duties. Moreover, I believe that three ideas will prove sufficient for this purpose.

First, it's false that climate disasters attributable to today's emissions will befall *only* people who will be born in the future. On the contrary, some children who are already alive will one day be gravely harmed by the emissions that the global economy will put out tomorrow. We have no way of knowing who these particular children are. But even if the lag between emissions and destructive environmental consequences is decades long, we can be certain that some such children are already alive and that they will eventually be gravely harmed. Second, we need to recognize that as a matter of justice, all living persons have claims of varying degrees of moral importance, not just a single claim to "preference satisfaction"; and that institutions must be erected that continuously give every living person's diverse claims the appropriate weight as soon as and

for as long as they live. But these two ideas together already show that, by failing to cut much of the world's present-day luxury consumption, the older generation in charge today in all of the world's countries is wronging some of the children born around the world yesterday. For it will create a situation in which, later in life, not all of these children will be able to escape conflict, famine, and drought, for no reason more important than the present-day consumption of luxury experiences and goods. Letting this happen *now* is incompatible with the duty to ensure, as far as we can, that just institutions are in place and at all times give the appropriate weight to every living person's diverse moral claims—some urgent and some much less so.

These reflections are, I think, enough to show that requirements of intergenerational justice in respect of climate change can be coherently worked out over periods of time approximating a single human lifespan. The duty to ensure, as far as we can, that just institutions are continuously maintained for whoever exists, as soon as and as long as they exist, already imposes on us the appropriately demanding requirements over this particular time-horizon: the content of these requirements is given by our best theories of social and international justice. So, for instance, if our theories tell us that everyone's right to avoid unnecessary famine is more urgent or basic than anyone's claim to eat grass-fed beef or travel long distances by plane for vacation, then we already know what we are morally required to do as a matter of intergenerational justice: dramatically restrict emissions from animal agriculture, and dramatically restrict aviation emissions from tourism until a truly carbon-neutral alternative to jet fuel is invented. Otherwise, we will be wrongly indulging less important interests in luxury consumption at the expense of survival interests that are comparatively much more important.

However, the ideas that I have outlined can also be used to generate requirements of intergenerational justice across all of history: in particular, requirements on *each* generation in history to show appropriate environmental concern *at* each stage in history. Indeed, I believe that these ideas can even be used to reason about when and what form of constraints on population growth are morally appropriate, and to do so in a way that remains sound even when the number and identity of future people will be affected. What we need to do for this purpose is to recognize a third moral principle: unless there is an adequate justification, it wrongs people to create a situation in which it will no longer be possible to avoid either wronging or harming them in the future.

To articulate the reasoning warranted by this principle, I invite you to consider the following stripped-down example. Imagine a small-scale society consisting of a mother and a father and two children. The rules that the parents impose on everyone play the role of the society's basic political and economic structure. The land has been over-farmed for many generations. As a result, the family now lives at the edge of their means, in the following sense: if the parents were to have additional children, then it would no longer be possible for everyone to be adequately fed. The question is why it would be wrong for the parents to allow this happen, assuming that the additional child would still have a life that is worth living and doing otherwise would mean that the additional child would end up never existing. And the answer is that the parents would thereby wrong one another and their existing children.

Here is the reasoning that leads to this conclusion. 1. As a matter of justice, persons have claims to the protection of diverse goods and interests, and these claims have varying degrees of moral importance. Therefore, the rules of a society ought to avoid indulging claims to less important interests at the expense of interests that are in the circumstances even more important. Yet this is

precisely what the parents would be doing by failing to recognize a moderate restriction on their procreative freedoms—“moderate,” because they have already allowed themselves to have two children. By failing to recognize a moderate restriction on their procreative freedoms, the parents would create a situation in which an even more serious restriction—on a right that normally protects an even more urgent interest—would be needed to meet the diverse claims of everyone in existence. For then there would be five mouths to feed, each with identical claims on sustenance, and so even access to a bare minimum of *food* would now have to be strictly rationed, on pain of committing a grave injustice.

2. In permitting this situation to arise, the parents would be wronging everyone alive even *before* the arrival of their third child. This is because of what I have called the principle of disjunctive wrongs: in the absence of an adequate justification, it wrongs people to act in ways that will necessitate either wronging or harming them in the future. But that is exactly what would happen if the parents allowed themselves to have additional children in their already dire circumstances. The parents would need to harm everyone already alive by imposing a painful system of food rationing, or else wrong everyone by letting someone starve and thereby committing a grave injustice. In creating this situation, moreover, they would be acting without adequate justification, because they would privileging less important interests over interests that in the circumstances were even more important. Therefore, the parents would be acting wrongly—in particular, wronging their existing children—and it is strictly irrelevant that if they were to act *rightly*, the identity and size of the population would also be affected.

In short, there is a way of reasoning about the demands of intergenerational justice that is untouched by the non-identity issue. Moreover, this structure of reasoning can be extended indefinitely backwards and forwards in time. To see this, notice that the parents in our story will themselves have been wronged by *their* parents if, in order to fuel the grandparents’ runaway luxury consumption, the grandparents avoidably contributed to over-farming and thereby reduced the earth’s carrying capacity. That prior wrong will have had the identical structure: failing to put in place restrictions on less important, luxury consumption-related freedoms, and thereby creating a situation in which an even more serious restriction—on much more important, procreative freedom-related interests—would be needed to respect the diverse claims of everyone already in existence at the time that the grandparents were disastrously over-farming.

This, then, is what I have come to think is the right way to reason about requirements of intergenerational justice both in general and in the context of the climate crisis. The reasoning illustrated is able to establish an unending chain of person-regarding non-utilitarian intergenerational obligations that is indifferent to the identity of future generations. It is sometimes said that thinking about intergenerational ethics exclusively in terms of what we owe to our younger contemporaries ignores the independent claims of as-yet unborn future generations. But as I have just shown, that is a mistake. It is an essential part of the explanation for wrongdoing that I have given that future people *will* have moral claims on everyone as soon as they come into existence and that—unless decisive steps are taken in the present—even greater sacrifices will then be morally necessary to honor these rights, on pain of grave injustice.

Indeed, what the reasoning shows is that at *every* stage in history, people have strong justice-related reasons to put in place all those restrictions on existing rights and freedoms that, unless they are put in place, will eventually require even more serious sacrifices having to be made by their contemporaries—lest their contemporaries fall afoul of the very same moral imperative in

their relations with *their* future brethren. In turn, the essence of intergenerational *injustice* is a form of ‘kicking the can down the road’: *failing* to put in place restrictions on existing rights and freedoms that are necessary to prevent even more serious sacrifices having to be made later by one’s younger contemporaries for the purpose of enacting justice and securing every living person’s diverse moral claims to be free from avoidable famine, drought, resource wars, and so on.

As it turns out, this is exactly what today’s most powerful people are unconscionably doing now. And it is exactly how you and I were wronged by the people who were in charge several decades ago. They failed to make changes to energy systems that, though they would certainly have been costly and socially disruptive, would have been much less burdensome to undertake in the time that was then still available to prevent catastrophic climate change. Instead, they chose to indulge much less urgent interests in consumption and accumulation and left us in a much more dire situation. By kicking the can down the road, they thereby wronged the members of our generations. In turn, today’s powerholders are doing the very same thing to the children born around the world yesterday. They are indulging various less important interests in accumulation and consumption rather than reducing luxury emissions and accelerating the global energy transition, ensuring that even more burdensome steps will later be morally required—of these children, for this purpose—else the world eventually collapse from catastrophic climate change.

These are the sorts of general conclusions that are rendered sound by the form of non-utilitarian moral reasoning that I have set out. However, articulating a coherent approach to reasoning about a subject does not by itself answer urgent practical questions. In passing, I have suggested that governments have strong reasons of intergenerational justice to put in place at least temporary restrictions on industrial animal agriculture and luxury aviation emissions. Yet there are many other urgent energy and environmental issues about which I have said nothing, and many of these issues raise difficult questions concerning the relative importance of the interests at stake. To understand what precisely we morally ought to be do about the climate crisis and how quickly—which activities we should enable, and which activities we should restrict—there is no alternative in my view than to think through these issues one by one, using an approach that correctly identifies the central imperative of intergenerational injustice.

5.

Unfortunately, this will still not be enough. For there are dimensions that are absolutely central to the ethics of the climate crisis but that, in spite of many attempts to think them through, I hardly know where to begin and do not think I am alone. One such absolutely central issue is how to think about the impact of our actions on all of the other animals and the natural world. These impacts are so enormous that, like others, I often find myself paralyzed and recoil from learning more.²⁷ Already there are forest fires in the world that burn billions of fellow creatures in a single unstoppable inferno. In the summer of 2023, the ocean temperature breached 100 degrees Fahrenheit in a place tragically named Manatee Bay off the coast of southern Florida. Such temperatures represent invisible forest fires under the surface of the sea, decimating kelp forests that have sustained entire ancient ecosystems. As temperatures rise, destruction on an even larger scale will occur all around the world. At the same time, other less complex organisms will flourish in radically transformed environments. How should we incorporate such facts into our moral judgments? How much we should we be prepared to sacrifice in order to arrest global warming

even faster? For me, the temptation is to privilege the existing so-called higher animals in my reasoning, and to adopt an individual animal-regarding approach, modeled on the non-utilitarian person-regarding one above. Yet even though the same population ethics issues apply to animals with full force, here I have very little confidence that I have found anything like the right approach.²⁸

At the same time, I am convinced that the conventional policy framework represents an enormous moral crime against the other animals. This framework generally values animals only instrumentally for their “ecosystem services,” and more rarely because *people* feel distress at the thought of countless animals burning. When the conventional approach does give independent weight to animal suffering, it produces counter-intuitive conclusions in the climate change context. For example, it suggests paving over the jungles if the lives of the innumerable animals there are (plausibly) filled with suffering,²⁹ and that industrial agriculture should privilege greenhouse gas-intensive grass-fed beef because of the greater sum of pain felt by factory-farmed chickens.³⁰ Still, I hesitate to press such observations into criticisms because, as I have said, I have very little sense of the shape of a reasonable philosophical alternative.

My sense of being at sea in the ethics of the climate crisis is heightened by another dimension that is central to responsible moral reasoning in this context. This is the problem of how to make fateful social decisions under conditions of profound uncertainty about the consequence of these actions. In this paper, I have stressed that irreversible climate tipping points may well be triggered at nearby temperatures, and that even in the best of circumstances these nearby temperatures will be enormously costly to avoid. Yet although we know that certain tipping points could well be triggered even by the presently locked-in global temperature, for various tipping points there is no scientific basis for determining whether they are likely to be triggered in twenty years’ time, fifty years’ time, or in a century from now. In conventional integrated assessment modeling, this problem of deep or Knightian uncertainty is “solved” by *stipulating* probability distributions that represent all known catastrophic tipping points as unlikely tail events.³¹ In one way, this tactic for dealing with uncertainty is unsurprising: probability distributions are required to calculate what would maximize expected welfare. Still, there is no scientific basis for most of the implied empirical judgments. For instance, some of the worst effects of climate change will occur when countries like India, Pakistan and China go to war over migrants flows or dwindling water. Yet no self-respecting social scientist would agree to construct even rough probability distributions for such world-historical social tipping points. The result is that all existing calculations of the carbon price that would allegedly maximize expected global welfare are based on willful ignorance and unfounded stipulation.

This brings me to a final moral dimension of the climate crisis whose difficulty I believe is still not fully appreciated. The problem is how we, you and I, should reason about our moral obligations once we admit to ourselves that the powerful will predictably not obey any of the most important imperatives of climate ethics. Discussions of the climate crisis all-too-frequently ignore this problem by asking questions exclusively from the undivided perspective of “society”, or alternatively from the perspective of a morally well-motivated social planner. Yet both of these assumptions depart dramatically from reality. Just consider all of the new fossil fuel projects that are currently being licensed. The past few years have seen record worldwide coal demand; one hundred and ninety-five new coal plants are currently under construction.³² The United Kingdom has recently issued hundreds of new oil drilling blocks in the North Sea.³³ The United States has

engaged in record oil and gas exploration and now produces more than 12 million barrels of oil per day.³⁴ Germany is building several new liquified natural gas terminals; once the enormous liquification and transport energy costs are counted, these terminals will be responsible for far more emissions than simply digging up and burning German coal.³⁵ Meanwhile, India and China plan to complete dozens of new oil, coal, and gas projects by 2025.³⁶ Uganda has hundreds of new oil wells under construction by the Chinese.³⁷ In Namibia, billions of barrels of oil were recently discovered and are now under development.³⁸ In South Africa, trillions of cubic feet natural gas have been discovered and the fossil fuel companies are eagerly lining up to pump them.³⁹ In Canada, the tar sands of Alberta, which contain the dirtiest crude on earth,⁴⁰ currently produce 3 million barrels of oil a day, still far from the maximum theoretical yield. However, the capital projects that have been committed in the tar sands through 2025 should be enough to breach 2 degrees of global warming all by themselves.⁴¹

How are we to reason about climate ethics once we admit that these reckless actions will not stop? The first step is to understand that there will be auto-catalytic social effects. Past inaction on emissions will produce major social disruption from storms, droughts, heat waves and crop failures. In turn, these destructive consequences will provide the occasion for yet more wrongdoing by powerful people bent on exploiting all available fossil fuels. Effects of this kind are on the horizon everywhere we care to look. For example, a large number of US houses are now significantly mispriced because of increasingly uninsurable flood risk.⁴² When these losses are realized, the impact may well be another financial crisis. In other words, the housing market may yet present a second historic opportunity to socialize the losses to which finance capital has become exposed, while shifting the costs of rebuilding to an increasingly resentful working class living in coastal municipalities with a permanently lower tax base.

The next step in thinking clearly under such predictably non-ideal conditions is to recognize that auto-catalytic social effects can generate acute moral problems for the nearby actors. To see this, consider proposals to increase funding for research into solar geoengineering. In coming years, societies will increasingly face what can be thought as the air conditioner problem. As temperatures rise, hundreds of millions of additional people will need air conditioning merely to survive. Developing the electrical capacity for this purpose will then compete directly with the aim of accelerating the energy transition, since yet more energy infrastructure will need to be built out and decarbonized. In fact, this problem is merely an instance of a much bigger looming mitigation-adaptation tradeoff. As climate change damages countless buildings, washes out roads, and levels coastal cities, the energy, labor, and material costs of rebuilding all of this destroyed infrastructure will likewise come on top of all that will be needed to transform the global energy system.

In this context, solar geoengineering could in principle make the adaptation-mitigation tradeoff less severe, assuming that it does not turn out to be climatologically counterproductive. This is, of course, a very tall assumption. Solar geoengineering would do nothing to prevent increasingly dangerous ocean acidification from ongoing carbon emissions; it could well shift precipitation patterns that provide the water supply for hundreds of millions of people in politically unstable areas; and the sudden termination of a scaled-up geoengineering effort during an extended global conflict could be apocalyptic for the entire human species. However, to appreciate why the moral challenge is not limited to these issues, suppose that solar geoengineering would not have these climatologically counter-productive consequences. Then in principle its use could make the

adaptation-mitigation tradeoff less severe by reducing the amount of damaged infrastructure that would need to be rebuilt at high energy, labor and material cost.

But of course, these real savings could just as well be used to expand the production of fossil fuels, unsustainable consumption growth, and greenhouse gas-intensive land-use. In fact, the same goes for the various technologies of carbon capture. In the United States, there is already an extensive network of pipelines for transporting carbon dioxide removed from the air. The pipelines are used overwhelmingly not to sequester carbon but to enable enhanced oil recovery in fracked wells.

Accordingly, the danger facing anyone who stands to affect the development of technologies like solar geoengineering is the risk of creating a situation in which—thanks to these scientific efforts—various powerful actors are enabled to deepen the intergenerational injustice that is at the heart of the climate crisis. Instead of deploying the real savings that might be enabled by these technologies to accelerate the global energy transition, the economic elites who have time and again shown themselves to be indifferent to considerations of justice may well use these savings to develop yet more fossil fuels and unsustainable land-use—and thereby create a situation in which even more serious sacrifices will be necessary by our youngest contemporaries in order to forestall future catastrophic climate change.

This prospect raises an urgent practical question for anyone who finds himself in a similar position. How should wrongdoing that will be a predictable consequence of our actions affect how we understand our moral obligations? Is the injustice that others will commit entirely on them? Or does appropriate concern for justice demand that we change what we are doing, too? In thinking about the ethics of the climate crisis, it is difficult to overstate the practical significance of these questions. For the worst effects of climate change will come not from the storms or the fires or the simultaneous crop failures. The worst effects will come when the economic elites and other people respond morally wrongly to the burgeoning human fallout. In addition to the other philosophical challenges that I have noted, this fact makes understanding what you and I ought to do about the climate crisis among the hardest moral problems.

Notes

- ¹ Eric Posner and David Weisbach, *Climate Change Justice* (Princeton: Princeton University Press, 2010), p. 86.
- ² For a review of the scientific literature on tipping elements in the climate system, see Seaver Wang, Adrianna Foster, Elizabeth A. Lenz *et al.*, “Mechanisms and Impacts of Earth System Tipping Elements,” *Reviews of Geophysics* 61 (2023) <<https://doi.org/10.1029/2021RG000757>>.
- ³ Chris A. Boulton, Timothy M. Lenton, and Niklas Boers, “Pronounced Loss of Amazon Rainforest Resilience since the Early 2000s,” *Nature Climate Change* 12 (2022): 217-78 <<https://doi.org/10.1038/s41558-022-01287-8>>.
- ⁴ Peter Ditlevsen and Susanne Ditlevsen, “Warning of Forthcoming Collapse of the Atlantic Meridional Overturning Circulation,” *Nature Communications* 14 (2023) <<https://doi.org/10.1038/s41467-023-39810-w>>.
- ⁵ The updated carbon budget figures in the next two paragraphs are drawn from the important paper by Piers M. Forster, Christopher J. Smith, Tristram Walsh, *et al.*, “Indicators of Global Climate Change 2022: Annual Update of Large-Scale Indicators of the State of the Climate System and the Human Influence,” *Earth System Science Data*, 5 May 2023, Preprint. Unlike conventional IPCC estimates, the carbon budgets reported by these authors assume that carbon capture technology will not be deployed on a massive scale later this century to rapidly reduce the stock of atmospheric greenhouse gases by tens of billions of tons of carbon. I indicate why I think this assumption is appropriate in the final pages of this paper.
- ⁶ For discussion see James E. Hansen, Makiko Sato, Leon Simons *et al.*, “Global Warming in the Pipeline,” <<https://arxiv.org/abs/2212.04474>>.
- ⁷ Paul Voosen, “Ship Fuel Rules Have Altered Clouds and Warmed Waters: An Unforeseen Test of Reverse Geoengineering Unfolds Above the Oceans,” *Science* 381 (2023): 467-68.
- ⁸ Among others, these activities include flying more than 1000 miles (for example, from continent to continent), shipping heavy commodities across the oceans, most existing cement and steel production, the fuel sources for many industrial heat processes, and the energy-intensive production of fertilizer feedstock. In some cases, such as long-haul aviation, the fossil fuel alternatives have yet to be invented. In other cases, alternatives exist but their mass production will take many decades. Recall that barely 1% of the global vehicle fleet is electric, and already the demand for lithium and cobalt is stretching global mining capacity: see Chengjian Xu, Qiang Dai, Linda Gaines *et al.*, “Future Material Demand for Automotive Lithium-based Batteries,” *Communications Materials* 1 (2020). <<https://doi.org/10.1038/s43246-020-00095-x>>: “Given the magnitude of the battery material demand growth across all scenarios, global production capacity for Li, Co, and Ni will have to increase drastically. For Li and Co, demand could outgrow current production capacities even before 2025.”
- ⁹ See Hannah Ritchie, Max Roser and Pablo Rosado, “Energy,” *Our World in Data* (2022) <<https://ourworldindata.org/energy-production-consumption>>.
- ¹⁰ “GDP/capita and population growth were the main drivers of the increase in global emissions during the last three decades of the 20th century. ... At the global scale, declining carbon and energy intensities have been unable to offset income effects and population growth and, consequently, carbon emission have risen.” Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: Mitigation* (2007), Technical Summary, p. 107. For further discussion see Philip Cafaro, “Beyond Business as Usual: Alternative Wedges to Avoid Catastrophic Climate Change and Create Sustainable Societies,” in D. Arnold, ed., *The Ethics of Global Climate Change* (Cambridge University Press, 2011): 192-215.
- ¹¹ See Stephen Pacala and Robert Socolow, “Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technologies,” *Science* 305 (2004): 968-972.

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- ¹² See Cafaro, “Beyond Business as Usual.” In the next two paragraphs, I reproduce some of the analysis that Cafaro sets out on pp. 201-208.
- ¹³ United Nations Food and Agriculture Organization, *Livestock’s Long Shadow: Environmental Issues and Options* (Rome: 2006), p. 112, discussed in Cafaro, “Beyond Business as Usual,” at p. 202.
- ¹⁴ Yinon M. Bar-On, Rob Phillips, and Ron Milo, “The Biomass Distribution on Earth,” *Proceedings of the National Academy of Sciences* 115 (2018): 6506-6511.
- ¹⁵ Gidon Eshel and Pamela Martin, “Diet, Energy, and Global Warming,” *Earth Interactions* 10 (2006), Paper No. 9, discussed in Cafaro, “Beyond Business as Usual,” at p. 202.
- ¹⁶ Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2007: Mitigation*, p. 334.
- ¹⁷ Cafaro, “Beyond Business as Usual,” p. 203.
- ¹⁸ See Cafaro, “Beyond Business as Usual,” pp. 206-8 for his corresponding discussion. I have added the Australia figure, using Pacala’s and Socolow’s estimate that 300 million hectares of new tree plantations would keep 1 billion tons of carbon annually from entering and remaining in the atmosphere in 50 years. If global population were to grow from 8 billion to 12 billion people later this century as projected in the UN’s “high growth scenario”, and if the average new person were to emit the current 2 ton global per capita average, then the required offset would be 8 billion tons of carbon per annum, or 8 times the amount removed by 300 million hectares of mature trees using Pacala’s and Socolow’s estimates. However, there are fewer than 800 million hectares of land on the entire continent of Australia. Thus, offsetting the emissions of an additional 4 billion people by reforesting 2400 million hectares (again using Pacala’s and Socolow’s stabilization wedge estimates) would require an area more than three times the continent of Australia.
- ¹⁹ For discussion of the observations in this paragraph, see Steve Keen, “The Appallingly Bad Neoclassical Economics of Climate Change,” *Globalizations* (2020) <<https://doi.org/10.1080/14747731.2020.1807856>>, and Steve Keen, Timothy M. Lenton, Antoine Godin *et al.*, “Economists’ Erroneous Estimates of Damages from Climate Change,” *Proceedings of the Royal Society A* (2021) <<https://arxiv.org/abs/2108.07847>>.
- ²⁰ See C. Mora, B. Dousset, I.R. Caldwell *et al.*, “Global Risk of Deadly Heat,” *Nature Climate Change* 7 (2017), pp. 501–506, Figure 4 at p. 504; and R. Warren, J. Price, E. Graham, *et al.*, “The Projected Effect on Insects, Vertebrates, and Plants of Limiting Global Warming to 1.5 C rather than 2 C,” *Science* 360 (2018), 791–795, Figure 4 at p. 792; both cited in Keen, Lenton, Godin *et al.*, “Economists’ Erroneous Estimates of Damages from Climate Change,” pp. 6-7.
- ²¹ D.J. Arent, R.S.J. Tol, E. Faust *et al.*, “Key Economic Sectors and Services,” in C. B. Field, V. R. Barros, D. J. Dokken *et al.*, eds., *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge: Cambridge University Press, 2014), pp. 659–708 at p. 688. For discussion see Keen, “The Appallingly Bad Neoclassical Economics of Climate Change,” pp. 3-4.
- ²² See for example William D. Nordhaus, “Revisiting the Social Cost of Carbon,” *Proceedings of the National Academy of Sciences* 114 (2017): 1518–1523, which describes the influential Dynamic Integrated model of Climate and the Economy (DICE model).
- ²³ In the rest of this section and the next section, I draw on and extend formulations of ideas that I first presented in “How Quickly Should the World Reduce its Greenhouse Gas Emissions? Climate Change and the Structure of Intergenerational Justice,” in Mark Budolfson, Tristram McPherson, and David Plunkett, eds., *Climate Change and Philosophy* (Oxford: Oxford University Press, 2021), pp. 301-20.
- ²⁴ Or as Kenneth Arrow once put it, “strictly speaking, we cannot say that the first generation should sacrifice everything, if marginal utility approaches infinity as consumption approaches zero. But we can say that given any investment, short of the entire income, a still greater investment would be preferred.” Arrow, K. (1999). “Discounting, Morality, and Gaming,” in P. R. Portney and J. P. Weyant, eds., *Discounting and Intergenerational Equity* (New York: Resources for the Future, 1999), pp. 13–21 at p. 14.

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- ²⁵ Posner and Weisbach, *Climate Change Justice*, p. 149.
- ²⁶ Conversely, if providing some good to everyone will no longer be possible, then institutions will no longer be required to do so: ought implies can, after all.
- ²⁷ For an arresting discussion, see Mark Lynas, *Our Final Warning: Six Degrees of Climate Emergency* (London: 4th Estate, 2020).
- ²⁸ For a penetrating discussion of some of the issues, see Clare Palmer, “Does Nature Matter? The Place of the Nonhuman in the Ethics of Climate Change,” in Denis Arnold, ed., *The Ethics of Global Climate Change* (Cambridge: Cambridge University Press, 2011), pp. 272-291.
- ²⁹ For a discussion of the utilitarian assumptions that can produce such recommendations, see Jeff Sebo, “Animals and Climate Change,” in Budolfson, McPherson, and Plunkett, eds., *Climate Change and Philosophy*, pp. 42-66, particularly pp. 55-60. But see also the opposite suggestion that if total well-being is what matters, “then we seem to be committed to the idea that a world with, say, 10 quintillion ‘happy insects’ (each of whom, we can stipulate, has a life containing one unit of well-being) is better than a world with, say, 10 billion happy, flourishing humans (each of whom, we can stipulate, has a life containing one million units of well-being). Why? Because the insect world would contain 10 quintillion (1e+19) units of well-being overall, whereas the human world contain only 10 quadrillion (1e+16) units of well-being overall” (p. 59).
- ³⁰ Kevin Kuruc and Jonathan McFadden, “Monetizing the Externalities of Animal Agriculture: Insights from an Inclusive Welfare Function,” *Social Choice and Welfare* (2023): “Animal agriculture encompasses global markets with large externalities from animal welfare and greenhouse gas emissions. We formally study these social costs by embedding an animal inclusive social welfare function into a climate-economy model that includes an agricultural sector. The total external costs are found to be large under the baseline parameterization. These results are driven by animal welfare costs, which themselves are due to an assumption that animal lives are worse than nonexistence. Though untestable—and perhaps controversial—we find support for this qualitative assumption and demonstrate that our results are robust to a wide range of its quantitative interpretations. Surprisingly, the environmental costs play a comparatively small role, even in sensitivity analyses that depart substantially from our baseline case. For the model to find that beef, a climate-intensive product, has a larger total externality than poultry, an animal-intensive product, we must simultaneously reduce the animal welfare externality to 1% of its baseline level and increase climate damages roughly 35-fold. Correspondingly, the model implies both that the animal agriculture sector is much larger than its optimal level and that considerations across products ought to be dominated by animal welfare, rather than climate, effects.”
- ³¹ For illuminating discussion of this problem, see Mathias Frisch, “Modeling Climate Policies: The Social Cost of Carbon and Uncertainties in Climate Predictions,” in Elisabeth Lloyd and Eric Winsberg, eds., *Climate Modeling: Philosophical and Conceptual Issues* (London: Palgrave Macmillan, 2018), 413-48.
- ³² Sudarshan Varadhan and Aaron Sheldrick, “COP 26 Aims to Banish Coal. Asia is Building Hundreds of Power Plants to Burn It,” *Reuters*, 31 October 2021, <reuters.com>.
- ³³ Roger Harrabin, “UK Seeks to Drill More Oil and Gas from North Sea,” *BBC News*, 24 March 2021, <bbc.com>.
- ³⁴ James Osborne, “U.S. Oil Production Passes 12 Million Barrels a Day,” *Houston Chronicle*, 8 July 2019, <houstonchronicle.com>.
- ³⁵ “Germany to Build its own LNG Terminals at ‘Tesla speed’ in Shift Away from Russian Gas,” *Climate Home News*, 28 April 2022, <climatechangenews.com>.
- ³⁶ Victor Tachev, “Oil and Gas – Current State and What Lies Ahead for the Industry,” *Energy Tracker Asia*, 22 June 2022, <energytracker.asia>.
- ³⁷ George Tubei, “Uganda is Planning to Sink as Much as \$20 billion in Drilling Over 500 Wells to Expand its Nascent Oil Industry,” *Pulse Live*, 24 January 2020, <pulselive.co.ke>.
- ³⁸ Charne Hollands, “Top International Oil Companies Exploring Namibia’s Hydrocarbons,” *Energy, Capital & Power*, 10 February 2022, <energycapitalpower.com>.

³⁹ “The Gas Discoveries off South Africa’s coast Could be ‘Game Changers’”, *Business Tech*, 11 February 2021 <businesstech.co.za>.

⁴⁰ Lorne Stockman, *Petroleum Coke: The Coal Hiding in the Tar Sands* (Washington: Oil Change International, 2013).

⁴¹ Adam Scott and Greg Muttitt, *Climate on the Line: Why New Tar Sands Pipelines are Incompatible with the Paris Goals* (Washington: Oil Change International, 2017).

⁴² Jesse D. Gourevitch, Carolyn Kousky, Yanjun (Penny) Liao *et. al.*, “Unpriced Climate Risk and the Potential Consequences of Overvaluation in US Housing Markets,” *Nature Climate Change* 13 (2023): 250-57.