Deadly Delays, Saving Opportunities

Creating a More Dangerous World?

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Will there really be a "morning"?
Is there such a thing as "Day"?
Could I see it from the mountains
If I were as tall as they?
—EMILY DICKINSON

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We now know that anthropogenic emissions of greenhouse gases (GHGs) are interfering with the planet's climate system in ways that are likely to lead to dangerous threats to human life (not to mention nonhuman life)[1] and that are likely to compromise the fundamental well-being of people who live at a later time.[2] We have not understood this for very long—for most of my life, for example, we were basically clueless about climate. Our recently acquired knowledge means that decisions about climate policy are no longer properly understood as decisions entirely about *preferences of ours* but also crucially about the *vulnerabilities of others*—not about the question "How much would we like to spend to slow climate change?" but about "How little are we in decency permitted to spend in light of the difficulties and the risks of difficulties to which we are likely otherwise to expose people, people already living and people yet to live?" For we now realize that the carbon-centered energy regime under which we live is modifying the human habitat, creating a more dangerous world for the living and for posterity. Our technologically primitive energy regime based on setting fire to fossil fuels is storing up, in the planet's radically altering atmosphere, sources of added threat for people who are vulnerable to us and cannot protect themselves against the consequences of our decisions for the circumstances in which they will have to live—most notably, whichever people inherit the worn-and-torn planet we vacate.[3]

Large Disasters, Considerable Likelihoods

As we academics love to note, matters are, of course, complicated. Let's look at a few of the complications, concentrating on some concerning risk.[4] Mostly, we are talking about risks because, although we know strikingly much more about the planetary climate system than we did a generation ago, much is still unknown and unpredictable. I will offer three comments about risk. The third comment is the crucial

one and makes a strong claim about a specific type of risk, with three distinctive features. After illustrating the three features with the effects of a possible bird-flu epidemic, I then argue somewhat more fully that the three features are also jointly characteristic of the effects of climate change, with strong implications for how we should regard our recently discovered complicity in producing climate change and thereby worsening the circumstances to which whoever succeeds us will need to adapt. Then I will consider the specific implications for what it is most essential and urgent to do.

The first point to be made about risk and climate change, however, is that not everything is uncertain, for two reasons. One is simply that some threatening changes in the climate are already occurring, as practically every informed person acknowledges. I would not have the scientific knowledge to sort through very many specifics, but clearly, for example, patterns of rainfall and storm intensity have already changed somewhat, resulting in both flooding and drought.[5] The other reason is that unless virtually all human understanding about the climate were completely misguided, other changes are practically certain to occur; for example, sea level will surely rise significantly.[6] If nothing else, the volume of the water would increase from the rise in temperature that has already straightforwardly been measured. And other factors are converging on sea-level rise, such as amazingly rapid melting of Arctic and Greenland ice that both directly increases the amount of water in the ocean, when the melting ice was previously on land (i.e., was an ice sheet, not an ice shelf),[7] and indirectly warms the planet by reducing albedo through elimination of the reflectivity of the snow. Some island nations in the South Pacific are already well into the process of being submerged by rising sea levels. Nothing in my argument to follow turns on how much is already in fact happening, since I will mostly be discussing risk of future events, but it is simply factually misleading to talk as if climate change is all risk only and nothing untoward is happening yet.

Now, what about the risks, which virtually anyone will acknowledge are fortunately still most of the problem? The second point to note about risk is that it is highly significant morally whether one is choosing a risk for oneself or imposing it, conditionally or unconditionally, on others. A certain level of risk may be a reasonable one for me to choose for myself but not a reasonable one for me to impose on others. Therefore, even if the level of risk from climate change imposed on future generations were the same as the risk for us—of course, it is not remotely the same—it might still be unreasonable for us to impose it on them, even if it were not unreasonable for us to choose it for ourselves. I am free to choose to mountain-climb, but I could not reasonably propose that an experience of mountain-climbing be a requirement for graduation from university, because mountain-climbing is too dangerous to require of others generally. That we are imposing risks that others will inherit at birth is extremely important.

Risk is most often explained as the product of magnitude and probability. The magnitude is a measure of the seriousness of the loss risked, and the probability is a measure of the likelihood of that loss occurring. Some corporate and government opponents of vigorous action to slow climate change, especially coal and oil interests, have made much of alleged "uncertainty." In many cases they have purposely distorted the science and wildly exaggerated the extent of our current ignorance; Steve Vanderheiden has aptly characterized this intentional smoke blowing as "manufactured uncertainty."[8] The tobacco companies always claimed that the connections between smoking and bad health were uncertain; the coal and oil companies claim the connections between carbon combustion and bad climate are uncertain. Neither connection is uncertain. But what I want to show here is that there is a crucial kind of cases in which a considerable degree of uncertainty does not matter even if we are appropriately uncertain without having been tricked by industry and government propaganda.

I will defend the suggestion—this is the third, and chief, point about risk—that there are cases in which one can reasonably, and indeed ought to, ignore entirely questions of probability beyond a certain minimal level of

likelihood. These are cases with three features: (1) *massive loss*: the magnitude of the possible losses is massive; (2) *threshold likelihood*: the likelihood of the losses is significant, even if no precise probability can be specified, because (a) the mechanism by which the losses would occur is well understood, and (b) the conditions for the functioning of the mechanism are accumulating; and (3) *non-excessive costs*: the costs of prevention are not excessive (a) in light of the magnitude of the possible losses and (b) even considering the other important demands on our resources.[9] Where these three features are all present, one ought to try urgently to make the outcome progressively more unlikely until the marginal costs of further efforts become excessive, irrespective of the outcome's precise prior probability, which may not be known in any case. We know that our actions now are opening the doors to some terrible outcomes; we ought to reclose as many of these doors as we can. The suggestion, then, is that these three features jointly constitute a sufficient set for prompt and robust action to be required.[10] When all three conditions are present, action ought to be taken urgently and vigorously. Doing nothing but calling for further research is morally irresponsible, I will now argue. Obviously, further research is also good provided that it is not a substitute for effective action.

Basically, the argument is that because the magnitude of particular losses is so serious, the only acceptable probability is as close as possible to zero, provided this reduction in likelihood can be achieved at a cost that is not inordinate. Some losses would be utterly intolerable, especially "losses" involving massive deprivations of necessities to which all people, regardless of individual identity, have rights simply as human beings. This applies to (a) some cases in which the probability is known and small but still significant and (b) some cases in which the probability cannot be calculated but can be known to be significant (because the relevant mechanism is understood and the conditions for its functioning are appearing). Only the latter would be a case of uncertainty in the technical sense, that is, an event with no calculable probability. Obviously, several aspects of this argument each need separate discussion.

I begin with a preliminary reminder about uncertainty. That something is uncertain in the technical sense, that is, has no calculable probability, in no way suggests that its objective probability, if known, would be small.[11] There is a grand illusion here: if we cannot see what the probability is, it must be small. Perhaps we assume a visual metaphor: we cannot see the probability because it is too small to see, so it must be really tiny. This inference is totally groundless. If all we know is that the probability cannot be calculated, then we do not know anything about what it is; if we do not know anything about what it is, then we do not know whether it is small or large.

However, we might have independent evidence that a likelihood is either small or large, without being able to calculate the probability. Cases of type (b) just mentioned above are such cases in which we cannot calculate a probability but know on other grounds that the likelihood is significant. The point now is that the simple fact that the probability is uncertain does not entail that it is small. Thinking so would be like thinking that if you are not sure where a city is located, the city must be small. We may simply be totally overlooking an entire dimension of a problem that will turn out to be huge. Things can be invisible for reasons other than being small. Some probabilities unknown at one time turn out later to be very large. Often the universe has major surprises for us, some very unpleasant.

Next we turn to cases illustrating the three features that I think require us to push the probability as close as we can to zero, whatever exactly it is now, given that it is significant. One example of the kind of case I have in mind is the reasons for the measures now being taken to prevent a possible bird-flu pandemic.[12] In a bird-flu pandemic, (1) the losses would be massive; (2) the likelihood of occurrence is significant even if it cannot be calculated because the mechanism of occurrence is well understood and conditions for its functioning have appeared; and (3) the costs of prevention, while far from negligible, are (extremely) moderate in light of (a) the possible losses

and (b) even the other legitimate demands on resources.

First, the losses could be massive. Tens of millions of people died from the 1918 flu epidemic that helped to end World War I.[13] Now that we have enhanced globalization, including rapid movements of large numbers of people for great distances, it is entirely possible that deaths from a flu pandemic would be in the hundreds of millions of people—a modern, global plague.

And second, we understand the mechanisms by which this would happen and can see conditions favorable for the working of the mechanism arising. This second one is the "antiparanoia" requirement, designed to narrow the range of possibilities on which we need to act. By requiring a clear mechanism we avoid reacting similarly to every imaginable threat. If all the oxygen on earth burst into flame, that, too, would be a disaster, but we do not know of any way that could happen. The specification of a clear mechanism is the central contributor to our conviction that the probability is significant in spite of our not being able to calculate it.

Human flu is highly contagious, and the active bird flu has already rapidly mutated several times. Nothing naturally prevents a mutation into a form directly transmissible from human to human—it is the precise probability of this occurring that is unknown. Once the mutated flu was passing directly among humans, it would move quickly if no directly applicable vaccine had been prepared in sufficient quantity in advance of the outbreak of the pandemic. Vaccine has a production time of months using current technology; this is the problem of lead time, which is monumentally important in the case of climate change. It would take a very long time, depending on how many labs were manufacturing vaccine, to produce, say, 1 billion doses, which would still leave five out of six humans unprotected, providing only enough vaccine for a population the size of either China or India.

Meanwhile, the virus might mutate again, making the vaccine already produced until that time ineffective. So actually, the best argument for doing nothing to prevent a pandemic would be the fatalistic argument that it was impossible to stay ahead of the virus. But it is not known to be impossible—that, too, is uncertain—so I think we should try, as to some degree we are, because, third, preparing facilities for the manufacture of vaccine in large quantities, while expensive, is not prohibitively so.[14] It would be difficult to imagine a better investment of public funds than subsidizing this manufacturing capacity.

What I want to emphasize is that no precise probability of the pandemic plays any role in the argument whatsoever, primarily because the magnitude of the possible loss is so great—tens of millions or hundreds of millions of human lives. Another probability that would matter would be a virtual certainty that attempts at prevention would fail, making the funds spent on expanded production of vaccine a waste; even so, unless the costs were astronomical—on the order of a perpetual boondoggle such as the dysfunctional U.S. ballistic-missile defenses, for example—would it even begin to seem unreasonable to try. Extra manufacturing capacity for flu vaccine would cost only a tiny fraction of what is currently being wasted on misguided military systems.

Obviously, what I am next going to suggest is that a number of phenomena that could result from climate change, especially climate change allowed to build up even more momentum before anything serious is done to slow it, are like the possible flu pandemic in having the three key features: (1) the possible losses are massive; (2) while the precise probability of these losses occurring is unknown, their likelihood is significant because the mechanism by which they would occur is well understood and conditions for its functioning are falling into place, and (3) the costs of preventing these losses are not excessive—at least for now—in light of the magnitude of the possible losses, even taking into account the other important current demands on resources.

The three features must apply to each potential loss that is given weight in deciding what to do, and, of course, that each feature applies is an empirical claim that must be established with detailed scientific argument. My only hope here is to formulate a reasonable

set of criteria; I lack the knowledge to make all of the various cases that the criteria are in fact satisfied. So I will merely briefly indicate the kind of empirical cases that need to be spelled out. We can count on the rapidly developing science to spell them out.

How might massive losses arise from climate change? For example, among ecosystems, agricultural systems are especially touchy.[15] Crops for humans need to be edible, which basically means they need to be just right. It cannot be too hot or too cold, too wet or too dry. If they are underripe, they cannot be eaten; if they are overripe, they cannot be eaten. If the rain comes too soon, they parch later; if the rain comes too late, they have already shriveled or will rot. Farmers already gamble on the weather. Climate change is long-term weather change. Gambling on climate change is raising the odds greatly against the already-wagering farmers, who keep us alive, when they are lucky.[16]

Generally speaking, if the weather changes faster than the crops can adapt, there is trouble, that is, shortage of food. Severe shortage in one place tends to mean higher prices in other places, if those whose own agriculture failed have enough money to import food. The famine can be exported, but it cannot be made to evaporate. As Amartya Sen demonstrated in *Poverty and Famines*, those with high incomes bid up the price of food, and those with low incomes starve.[17] So in the case of climate change, too, (1) the potential human losses could be massive. This is for many reasons, but a lethal one is disruption of food supplies, causing volatile food prices. Others include the need for massive relocations of population from low-lying shores inundated by rising sea levels.

(2) The mechanisms leading from burning fossil fuel, above all, to the climate changes are increasingly well understood.[18] Those connecting the climatic changes in turn to human misery were already well understood, since necessities as elemental as food and shelter are directly assaulted by the physical phenomena constituting climate change, such as more intense storms and atypical weather.

(3) The costs of prevention are moderate, although far from insignificant.[19] First come the "no regrets" measures that eliminate current costly energy waste and thereby improve living standards and reduce dependence on Middle Eastern dictatorships such as Saudi Arabia which are lightning rods for terrorism and entice heedless Western politicians into needless wars and bloated military budgets. Much of what we need to give up next after the economically and politically profitable, no-regrets reductions are frivolous preferences, life-shortening luxuries, and pointless indulgences. What we must give up after those depends on how long we continue to make the problem worse by continuing to derive our energy from fossil fuel before we begin to make it better by switching to alternative sources.[20] Plainly, delay will not make the necessary transition less painful—it will only shift it off us and onto others.

The Creation of a More Dangerous World

So far we have only a quick overview of the case of climate change, and now we need to look at selected aspects a little more thoroughly. The nature of what I have so far been vaguely referring to as "massive losses" can be specified more precisely. I will examine four aspects of danger, acknowledging three and setting aside the fourth.

Creating Danger

First, and most significant, failing to deal with climate change constitutes not only failing to protect future generations but inflicting adversity on them by making their circumstances more difficult and dangerous than they would have been without as much climate change, and more difficult and dangerous than circumstances are now for us.[21] If the current climate change were a naturally occurring problem, like some effects of human aging, and we did nothing to deal with it, we would leave future generations facing a problem that was only as severe when we bequeathed it as when we inherited it. We would have failed to provide protection—done nothing to make their lives

less dangerous. That would be blameworthy, but what we would be guilty of would be a "sin of omission": neglecting to provide protection for subsistence rights that was ours to give if we had chosen to bother.[22]

Failing to deal with our climate change is not like that, because the current climate change is not naturally occurring. Political choices about energy policy are causing climate change. At some points in the planet's history, climate change has occurred naturally, but the climate change happening now is, as the scientists say, anthropogenic: people are causing it, by bringing about the emission of increasing amounts of greenhouse gases such as the CO_2 from the burning of fossil fuels in car engines and electricity-generating plants. Human activities are undermining the environmental conditions to which human beings have successfully adapted, making the environmental conditions for future generations more threatening for them than the present conditions are for us. "Doing nothing" about climate change in the sense of simply continuing business as usual is—far from actually doing nothing—continuing to change the environmental conditions that future generations will face for the worse. To persist in the activities that make climate change worse, and thereby make living conditions for future generations worse, is not merely to decline to provide protection. It is to inflict danger, and to inflict it on people who are vulnerable to us and to whom we are invulnerable.[23] The relationship is entirely asymmetric: they are at our mercy, but we are out of their reach. Causation runs through time in only one direction. Lucky for us.

Endangering Additional Generations

Second, failing to deal with climate change constitutes inflicting danger on additional generations that could have been spared. It is not only that future generations that are already fated to be adversely affected by the GHGs that have already been injected into the atmosphere by previous generations since the spread of the industrial revolution will face more adverse conditions of life than if we had managed to get a grip on our fossil-fuel consumption. Yet later generations, the great-great-great-grandchildren rather than the grandchildren, that might have been spared this problem if it had been solved sooner, will suffer from it. Suppose that if our generation did whatever it ought to do to stop accelerating climate change, the effects of climate change would have become manageable by some Generation L. If we do not do what we ought, and everything else remains the same, then at the very least the next generation, Generation M, will suffer from climate change. So, besides making life more treacherous for every generation from A to L, we would have inflicted completely avoidable problems on Generation M (and doubtless others), which would have been free of these problems if we had restrained our environmentally damaging activities, assuming only that tackling the problem sooner means solving it sooner.

This assumption would not be straightforwardly true if, say, some technology needed to mature before it could be successfully applied to climate change and attempts to employ it sooner would be futile. If we had reason to believe this was the situation, however, we would have no basis for merely increasing fossil-fuel consumption as usual. First, we could, instead of attempting to use the immature technology before it was ready, be seriously investing in research on improving the technology or on alternative technologies, rather than simply indulging in our own high-emissions consumption. Our investment now might allow an intermediate generation still to implement the by-then-mature technology in time to save Generation M. Second, and more important, we do not need to develop any new technologies in order simply to cease wasteful and frivolous uses of fossil fuels and to defeat shortsighted politicians who block policies that would make the wasteful pay and that would create disincentives for excessive emissions. Time passes while the problem remains untackled, so additional generations will suffer. But this is not the worst.

Creating Additional Dangers

Third, failing to deal with climate change constitutes not simply continuing to make the

environment for human life more threatening but unnecessarily creating opportunities for it to become significantly more dangerous by feeding upon itself through positive feedbacks that would otherwise not have occurred—creating opportunities for the danger to escalate one or more levels. We have hardly scratched the surface of the seriousness of continued delay in facing the challenge of climate change. Climate change is dynamic. It involves many poorly understood feedbacks, negative as well as positive. It is conceivable that a continued worsening will trigger a negative feedback, such as an increase in the kinds of clouds that reflect sun waves back away from the earth, that will actually improve the situation for humans. Unknowns remain. But some of the best-understood and most likely feedbacks are positive, compounding the problem. For example, if emissions of CO_2 cause the Arctic tundra to thaw, as they appear well on the way to doing, the thawing tundra will release vast amounts of methane (CH_4), which is a far more powerful GHG per unit than CO_2 and will make climate change significantly more severe than it would have been if the tundra had not thawed.[24]

The opportunities we create for net positive feedbacks to occur may not be taken, or the positive feedback may somehow be more than canceled out by some now only more dimly foreseeable negative feedback. But it still seems wrong to create the opportunity for the positive feedback for no good reason. If I play Russian roulette with your head for my amusement as you doze and the hammer of the revolver falls on an empty chamber, I will have done you no physical harm. But I will have seriously wronged you by subjecting you to that unnecessary risk. We do no wrong when we unavoidably inflict risks on future generations, or even perhaps if we have compelling reasons for doing so where it would be avoidable. But we do wrong them if we subject them to opportunities for matters to worsen severely for no good reason except that we could not be bothered to change our comfortable habits and that the owners of the coal and oil reserves are greedy for maximum return. We can be justified in imposing a risk on others when the harm to ourselves from avoiding the risk to them would be severe—perhaps even if it would only be significant—but not when avoiding the imposition of the risk on them would cause us only mild inconvenience, or even serious but manageable difficulty, or leave us merely rich, not superrich.

The fourth aspect of danger is the most fearsome. For completeness, I need to mention it, but I will not rely on it in my argument.

Creating Desperate Dangers

Fourth, failing to deal with climate change constitutes not only unnecessarily creating opportunities for the planetary environment to become significantly worse for humans (and other living things) but unnecessarily creating opportunities for it to become catastrophically worse. It is not merely that (1) we make living conditions more dangerous for some generations that already will suffer from climate change and that (2) we make conditions dangerous for one or more generations that could have been secure from the threats of climate change and that (3) we create opportunities for the environment to degenerate severely. Worse still, (4) we could contribute to turning severe problems into literally insoluble problems. Or, of course, possibly not—this would, once again, be a question of the justifiability of avoidably imposing risks of adversity on defenseless others.

Unnecessarily imposing a risk of uncontrollable change—change that the people subject to it could neither steer nor stop—would be much like creating, for no good reason, a highly contagious fatal disease and leaving it behind without a cure for future generations to contend with.

Various mechanisms for runaway climate change are well understood and have in fact operated in the past. A runaway climate is certainly possible in the future because it has been actual in the past. A general category employed by scientists is abrupt climate change, which can be defined as "a large-scale change in the climate system that takes place over a few decades or less, persists (or is anticipated to persist) for at least a few decades, and causes

substantial disruptions in human and natural systems."[25] We know, for example, that rapid warming can lead to abrupt cooling, because it did in the Younger Dryas roughly 10,000 years ago and, as we know from astoundingly informative ice cores, several times far earlier.[26] So there is no doubt that something devastating to humans could happen if climate change crosses a threshold that we can cause it to cross or prevent it from crossing.

The 2007 report from Working Group I of the IPCC, however, is skeptical about abrupt climate change in the current century: "Abrupt climate changes, such as the collapse of the West Antarctic Ice Sheet, the rapid loss of the Greenland Ice Sheet or large-scale changes of ocean circulation systems, are not considered likely to occur in the 21st century, based on currently available model results. However, the occurrence of such changes becomes increasingly more likely as the perturbation of the climate system progresses."[27] While we should, I think, take little comfort from the fact that our own century might be safe from the most extreme possibilities, if the report is correct in its judgment, the possibility of desperate danger does not, then, fully satisfy my second condition, threshold likelihood. Although we understand various mechanisms that could lead to runaway climate change, we do not yet have strong reason to believe that the conditions in which those mechanisms operate are coming together—at least, not yet. So I return to the previous point: creating additional but non-catastrophic danger by creating opportunities for positive feedbacks to cause climate change to escalate one or more levels above where it is already destined to go.

And the possibility of such severe danger, even short of desperate danger, is more than enough to concern us. The ones who need to worry about severe climate change are the most vulnerable, including children yet to be born, who may reap the whirlwind if we sow the wind. Those who will suffer most, if anyone does, will be people with absolutely no past role in causing the problem and with no other kind of responsibility for it (and other species, most with no capacity for morally responsible action but full capacity for suffering and frustration). This would put the kind of wrong done by the avoidable precipitation of severe climate change, it seems to me, in the general moral category of the infliction of damage or the risk of damage on the innocent and the defenseless. This is far worse than simply neglecting to protect rights, as wrong as that is, and is more like recklessly dropping bombs without knowing or caring whom they might hit. Can someone seriously argue that we are not morally responsible for avoiding the wreaking of such havoc?

And—feature three, once more—the human costs of preventing climate change from becoming severe could be modest, if well managed and begun promptly.[28] Much of our current GHG emissions serve worthy, even essential or admirable, goals. But substantial portions of it results from thoughtlessness, laziness, and wastefulness; and much serves purposes that are opulent, frivolous, or pointless.[29] I do not want to sound like a puritan; perhaps we are all free to engage in a certain amount of frivolity and pointless joy—at least, if we do no serious harm to others. On the other hand, much commends a life of simplicity, although I will not press that point here.[30] The main point here is that frivolous and pointless GHG emissions, far from being harmless, may be storing up threatening problems for whoever lives in future generations. There is low-emissions frivolity and high-emissions frivolity. I take no position here on low-emissions frivolity. High-emissions frivolity is another matter: it can be a serious threat to many other living things.

The overall picture, then, is that for the sake of benefits to ourselves that are, even if not forbidden, utterly insignificant, we are inflicting on whoever comes after us an unknown but substantial risk of a significantly more dangerous world—a dangerous world that would be to no minor extent our own creation: collateral damage from the primitive energy regime now fueling our lifestyle, not intended but no longer unforeseen. Even collateral damage in war is required to be proportional to the achievement of something important through a necessary action. To what present necessity would severe adversity on the part of successive generations of humans who succeed us be proportional?

Proportionality and Relativity

Judgments about proportionality—especially proportionality between incommensurable values such as qualities of human life and quantities of financial costs—cannot be precise.[31] I want to emphasize, however, the presence of two relativities in, but the absence of a third from, the proposed set of three jointly sufficient conditions for prompt and robust action. As already mentioned, the third factor, nonexcessive financial cost, is obviously not independent of the first factor, magnitude of human losses. What would be an excessive cost for preventing relatively smaller human losses might not be excessive for preventing relatively larger human losses. I take this to be the plainest of common sense. We cannot quantify very usefully, I think, but we can rank: a cost that would be excessive for preventing one additional destructive Atlantic hurricane per year might not be excessive for preventing the flooding of scores of the world's major cities by rising sea levels. Reasonable expenditure is obviously relative to the seriousness of the losses prevented.

I am tempted to say that no cost would be excessive for avoiding severe climate change that could lead to distortions of agriculture and yield additional starvation by way of global food-price fluctuations.[32] Such undercutting of the food system would be a monumental human tragedy. But the fact is that, as rich as we humans are in 2010, our financial resources are finite, so costs must, second, also be assessed in light of other legitimate current demands on resources. Right now, on the order of 18 million people are dying each year of readily remediable chronic poverty for want of relatively small sums of money and related institutional changes.[33] One could not sanely claim that unlimited sums should be devoted to blocking the possibility of future severe climate change if that entailed that one would, in consequence, refuse to spend what it would take to eliminate current severe poverty. This specific dilemma, however, is totally false: the budget for climate change does not need to be deducted from the budget for chronic poverty. It could be deducted from the budget for misguided military adventures.[34] Nevertheless, the point remains: at some level, expenditures on even the avoidance of dangerous climate change could be excessive, compared not to folly but to legitimate alternative uses. So in principle, what count as proportionate expenditures on the mitigation of climate change designed to stabilize it at a less dangerous level must be conceded to be relative not only to the losses that could occur if the expenditure is not made on prevention of climate change but also to the losses that would occur if, as is now far from being the case, the climate expenditure had to be taken away from other genuinely urgent matters. Therefore, the third condition within the sufficient set needed to be stated in a way that makes reasonable costs relative to the extent of the human losses that are the subject of the first condition and relative to other real—as opposed to politically manufactured—emergencies.[35]

What the costs do not need to be relative to, however, is a possible additional consideration: the probability of the massive losses. The second of the three features required for the set sufficient for action, threshold likelihood, has been formulated in order to deal with likelihood by relying on a threshold, not relying directly on probability. This is where I recommend diverging fundamentally from the standard manner of dealing with risk, which normally multiples the magnitude of possible losses by the probability of the losses occurring. My single most crucial claim here is that we ought not to discount huge possible losses by their probability when the likelihood of their occurrence is above some threshold level.[36] We cannot spend vast sums to prevent every catastrophe that is simply conceivable or barely possible. The likelihood must rise above a minimum threshold, as I have repeatedly emphasized. In the case of climate change, I believe this threshold is passed when (a) a mechanism and (b) emerging conditions for its working have been established. This is surely not the only basis on which the threshold can be satisfied.[37] But the essential point is that once the threshold is passed, one takes vigorous action until—

third feature—the costs of doing so become excessive. In sum, reasonable costs of action are relative to how massive the possible losses are if the expenditures are not made and to how great the losses are if the expenditures are diverted from other important uses, but reasonable costs of action are not directly relative to the probability of those losses occurring when the possible losses are massive and their likelihood is above a minimal threshold. One does not discount by the probability; one checks to see whether there is a significant likelihood, based on solid evidence, that massive losses may occur. If so, one takes preventive action.

If it is certain that one person will die, one can say that the probability of a death is 1 and the magnitude of death is 1; on the usual way of calculating risk, $1 \times 1 = 1$. If 1,000,000 people might die, but the probability is known to be 0.000001, the usual calculation of risk is: $1{,}000{,}000 \times 0.000001 = 1$. Arithmetically, the two risks are equal. I have my doubts about whether we ought to respond to a one-in-a-million chance that 1 million people will die in the same manner that we respond to the certainty that one person will die; I am inclined to think that we should do much more in the case of the possible deaths of 1 million. This, however, is familiar and contentious territory. What I am claiming here is the following: (1) if we know that 1 million people might die, and we know that the likelihood is significant, then we should take action to prevent the million deaths until the costs of those actions are clearly excessive; and (2) one way we know that the likelihood is significant is when (a) we understand the mechanism by which the deaths are likely to occur and (b) we have begun to create the conditions that lead the mechanism to function.[38]

Much more needs to be worked out before we can judge with clarity how vigorous, expensive, and urgent our efforts ought to be to reduce our chances of making our own descendants miserable. For now, however, we are in absolutely no danger of overshooting and simply need to make a serious beginning. And we have seen that our responsibilities for the climate change we are producing are of a different, more demanding, kind from the responsibilities conventionally assumed, even by those who acknowledge our responsibility. Two aspects above all are clear: (1) we are called upon not only to provide security for the members of humanity who live later but also to refrain from causing them dangers; and (2) even if the worst does not eventuate, the lesser dangers we may cause are quite sufficient to ground responsibility for robust action now.[39]

The Most Essential Precaution

What specifically should we do? Here is where the science really matters. The single most important fact about climate change will be the historic peak level of atmospheric concentration of greenhouse gases, and what is crucial to where the concentration peaks is the percentage of the carbon now safely sequestered underground in the form of coal and oil that are extracted and injected into the atmosphere as CO_2. Of course, other GHGs matter as well. However, if we burn all of the fossil fuel under the surface of the earth, the atmospheric concentration of CO_2 will quadruple.[40] Business as usual is misleadingly packaged for PR purposes as the "preservation of diversity" in energy sources.[41]

Either the carbon under the planet's surface is injected into the air through burning or not. It can be kept out of the atmosphere either by being left where it is now under the ground or the sea or by being burned only after effective carbon-sequestration techniques are developed. The opposition of interests is sharp: what is good for those who want all of the carbon extracted and burned with or without effective sequestration is bad for the climate and for the other 99.999 percent of humanity. And waiting for the price to rise until fossil fuels become noncompetitive greatly risks—as far as I can see, guarantees—that too much carbon will already have been injected into the planet's layer of GHGs before the price rises high enough to cut demand. The friends of fossil fuel—the carbon peddlers—have joined the enemies of humanity.

That is a strong statement. The grounds for it are the underlying science, the physical dynamics of climate. Climate change is driven by the atmospheric concentration of GHGs; this is what determines how much radiation is trapped on the planet. The atmospheric concentration is driven by annual emissions in excess of those compatible with the climate humans evolved in adaptation to—call that the sustainable rate of GHG emissions. Every year that the annual rate of emissions is larger than the sustainable rate, the atmospheric concentration grows. That is the stinger: every year that we fail to bring carbon emissions (and other GHG emissions) down to a sustainable level, the atmospheric concentration expands and more heat is trapped inside it. The atmospheric concentration has been expanding now for a century and a half. In recent years, it has been ballooning faster almost every year: the rate of increase is increasing.[42] "It is *very likely* that the average rates of increases in CO_2, as well as in the combined radiative forcing from CO_2, CH_4 and N_2O concentration increases, have been at least five time faster over the period from 1960 to 1999 than over any other 40-year period during the past two millennia prior to the industrial era."[43]

Even if the rate of increase were not increasing, as it is, the underlying arithmetic would be inexorable. The relation between unsustainable annual emissions and the atmospheric concentration is roughly like the relation between annual budget deficits and the national debt, or like the relation between annual population growth and size of total population at stabilization. The longer it takes a country to go down to replacement levels of fertility—the more years of growth in population—the larger the population size when the country stops growing. The more years of budget deficits, the larger the national debt is when the budget is finally balanced. In the best circumstances imaginable, the more years of unsustainable emissions, the higher the atmospheric concentration of GHGs when the concentration stabilizes—if it ever does. If we do not stop until we have pumped all of the oil and dug all of the coal, we will have the largest possible level of carbon dioxide concentrated in the atmosphere. And as far as we can tell, the larger the atmospheric concentration, the greater the disruption of the climate to which humans were adapted. At a minimum, we create a risk of greater disruption.

Matters are worse in two respects. We face political inertia and physical inertia. One cannot change the energy regime overnight because the superrich who own and distribute the fossil fuels have powerful political friends and articulate intellectual defenders.[44] Politics guarantees that high carbon emissions will continue for some time. That is bad enough. But the physical problem of lead time, analogous to the cultivation period for flu vaccine, is almost unimaginably daunting. In general, the whole planetary mechanism of atmosphere, oceans, and surface-level weather has enormous inertia overall once it is moving in a particular direction.[45] This is not the kind of dynamic process that gets reversed in a hurry. But the worst news may be specifically about CO_2, the most important GHG:

> A[n atmospheric] lifetime for CO_2 cannot be defined.... The behaviour of CO_2 is completely different from the trace gases with well-defined lifetimes. Stabilisation of CO_2 emissions at current levels would result in a continuous increase of atmospheric CO_2 over the 21st century and beyond.... In fact, only in the case of essentially complete elimination of emissions can the atmospheric concentration of CO_2 ultimately be stabilised at a constant level.... More specifically, the rate of emission of CO_2 currently greatly exceeds its rate of removal, and the slow and incomplete removal implies that small to moderate reductions in its emissions would not result in the stabilisation of CO_2 concentrations, but rather would only reduce the rate of its growth in coming decades. A 10% reduction in CO_2 emissions would be expected to reduce the growth rate by 10%, while a 30% reduction in emissions would similarly reduce the growth rate of atmospheric CO_2 concentrations by 30%.[46]

I repeat the critical finding: "only in the case of essentially complete elimination of emissions

can the atmospheric concentration of CO_2 ultimately be stabilised at a constant level." It is, therefore, urgent to move aggressively now to cut CO_2 emissions sharply.

This science has strong implications for how we think about policy toward climate change. We need to ask, "What must we do now to keep the total atmospheric concentration below a dangerous level?" not "By how much would we like to reduce our emissions?" We need to focus on the target, which is lowering the risk of great danger, and reason back along the means-ends connections to what we must do now.

And the costs of lowering the risk of severe threat can be affordable if action begins soon enough. The longer we wait to start, the more it is likely to cost and the more abrupt the reductions in emissions would later have to be in order to keep the atmospheric concentration below a dangerous level.[47] How much we will need to tighten our belts depends on how rapid the transition to alternative energy is. Defenders of the carbon status quo say that to reduce emissions as much as scientists suggest would decimate the economy by depriving it of energy. But that is only if the economy continues to be dependent on fossil fuel. The economy can remain vibrant, while we avoid potential danger, as long as its energy source is not fossil fuel. The key is to move away from fossil fuel sooner, not later, before price rises force a switch. We need to get down to sustainable levels of annual GHG emissions, not when oil or—heaven help the future—coal "runs out" and not when its price rises too high, but as soon as possible, leaving as much carbon as possible in the ground, where it is harmless, or burning it only after we understand how to sequester the CO_2 for a very long time.[48]

We have been considering *imposing* risks on the vulnerable of the future. One natural objection would take the line: What do you mean, "imposing"? Will not future generations be able to make choices for themselves? Well, they will choose from the range of options we leave them.[49] Here are two vital factors they cannot choose because these will have been determined by earlier generations like us: (1) the size of the atmospheric concentration of GHGs already present (and unlikely to decline significantly during the succeeding century insofar as CO_2 is a factor) and (2) the dominant energy regime. If they inherit, say, an atmospheric concentration triple pre-industrial revolution levels and a still entrenched fossil-fuel regime like the one we labor under now—still digging that coal and pumping that oil—the people of the future are screwed. We would have been complicit in the imposition of a range of choice containing no good options in two ways: (1) we would have made the atmospheric concentration larger than it needed ever to become, and (2) we would have cooperated in the maintenance of an antiquated and corrosive fossil-fuel regime, and the high-casualty foreign policies serving it, that humans need to escape from.

We do not have a long time left to do the job, even now. If we cannot soon reverse the political inertia of favoritism toward fossil-fuel interests, the date of technological transition—that is, the date when the atmospheric concentration of GHGs ceases to increase—recedes into the future, and the level at which the atmospheric concentration finally stabilizes grows meanwhile like a planetary cancer, condemning more and more people to environmental danger and potentially undermining the ecological preconditions for sustainable human economies.[50]

If we in the present allow the continuing acceleration of a steady deterioration in the climate, the generation of today's students—or shockingly, even my own generation—could turn out to have had it as good as it gets. For the well-being and security of humans, history could be all downhill from here. Philosophers and economists used to think of the problem of intergenerational justice as the problem of the just-savings rate; the danger was that we might shortchange ourselves by saving or investing too much of our own resources for the sake of people in the future because each future generation would in any case—it was assumed—be better off than the previous one. So we needed to discount the value of benefits to people in the future. The specter of climate change means, by contrast, that we may be confronting the issue of the just-deterioration rate. How much worse off than the previous generation can we permit the next to be? And will we allow the deterioration to continue until critical thresholds for human

security are passed? Economic sustainability has ecological preconditions (unless one makes the assumption of literally infinite substitutability, which is not unusual among conventional economists but fantastic nevertheless if extended to the entire environment, including climate).

One way to characterize in moral terms the choice to run a genuine risk of massive loss for those who follow us is that it would be the voluntary and knowing infliction of a grievous wrong. We would have chosen to leave open the possibility of great distress, or even disaster, when, at relatively little cost to ourselves, we could have closed off that possibility. We could have protected people in the future against threats to their well-being; instead, we would have increased the threats and left them vulnerable to threats they likely cannot handle. Yet, however appropriate this first moral characterization, most people do not respond well to being threatened with a guilty label, and there is no need to try to lay a guilt trip on our own generation.

Opportunity for a Legacy of Security

A much more positive moral characterization of the situation we now face is equally appropriate: thanks to the remarkable ingenuity of the scientists of the present day, invaluable understanding of the dynamics of the planetary climate system has been gained that places us in the position to provide vital protection to people in the future who would very likely otherwise find it impossible to protect themselves. Apart from blind technological optimism, we have no grounds for expecting that humans in the next century would have the capacity to protect themselves if we do nothing toward that purpose. But we have the capacity to leave them a legacy of security instead of a legacy of danger.[51]

The spectacular opportunity opened to us by our new understanding of the climate—most important, the realization that we must not allow much more of the carbon under the soil and the sea to be injected into the atmosphere, and certainly not all of it—is that we can protect future generations by keeping as much as possible of the remaining fossil fuel right where it is now. Bottom line: Do not leave your descendants—and more important, the descendants of much poorer people, such as most people in Africa—in avoidable danger. Instead, provide them with security. Create an energy regime that will leave as much as possible of the remaining sequestered carbon out of circulation.

We can have all we need economically, and much of what we want but do not need, while promptly moving away from burning fossil fuels to alternative energy sources. No vital interests are at stake in the choice among energy sources for those of us who do not own coal and oil. But many vital interests are at stake for those in the future whose fates are vulnerable to our choices. We can leave them social institutions that will protect them—in particular, a cleaned-up energy regime that does not vomit GHGs into the sky. An energy regime not based on fossil fuels will make the worst effects of climate change that are now increasingly likely once again nearly impossible. Let us seize the opportunity to bequeath this magnificent gift of protection against vulnerability.

Acknowledgments

The gestation of this chapter has been long and painful, and I have been assisted in wrestling with various versions of it by responsive audiences at San Diego State University, University of Washington, Cornell University, University of Oslo, University of Oxford, New York University Law School, University of Edinburgh, and the University of Tennessee. In the last round, I have benefited especially from comments by Wilfred Beckerman and Nicole Hassoun.

Notes

1. "Between a quarter and a third of the world's wildlife has been lost since 1970, according to data compiled by the Zoological Society of

London." See "Wildlife Populations 'Plummeting,'" *BBC News*, May 16, 2008. Available at http://newsvote.bbc.co.uk/mpapps/pagetools/print/news.bbc.co.uk/2/hi/uk_news/7403989. For an attempt to calculate the purely economic value of the loss of biodiversity now to be expected, see Pavan Sukhdev, *The Economics of Ecosystems & Biodiversity (TEEB): An Interim Report* (European Communities, 2008). This is being described as the *Stern Review* (see note 20 below) for biodiversity and is available online at http://ec.europa.eu/environment/nature/biodiversity/economics/pdf/teeb_report.pdf. Also see http://ec.europa.eu/environment/nature/biodiversity/economics/index_en.htm.

2. In accepting Article 2 of the Framework Convention on Climate Change in 1992, world leaders committed themselves to achieve "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system." From <http://unfccc.int/essential_background/convention/background/items/1349.php. So far, they have failed to stabilize concentrations at all.

3. Many philosophers are preoccupied with what is known as the nonidentity problem, which was formulated by Thomas Schwartz in two contemporaneous pieces, "Obligations to Posterity," in *Obligations to Future Generations*, ed. R. I. Sikora and Brian Barry (Philadelphia: Temple University Press, 1978), pp. 3–13; and "Welfare Judgments and Future Generations," *Theory and Decision* 11 (1979): 181–194; and by Derek Parfit, *Reasons and Persons* (New York: Oxford University Press, 1984). As far as I can see, individual nonidentity has no implications at all for what we ought to do. At most, it has some implications for how we explain our moral judgments.

4. How to think about the imposition of risk is an exceedingly difficult question. One valuable collection is Paul Slovic, ed., *The Perception of Risk* (London and Sterling, Va.: Earthscan, 2000).

5. Andrew C. Revkin, "New Climate Report Foresees Big Changes," *New York Times*, May 28, 2008; and U.S. Climate Change Science Program, *Weather and Climate Extremes in a Changing Climate*, Final Report, Synthesis and Assessment Product 3.3 (June 2008). Available at <http://www.climatescience.gov/Library/sap/sap3-3/final-report/default.htm.

6. "There is strong evidence that global sea level gradually rose in the 20th century and is currently rising at an increased rate, after a period of little change between AD 0 and AD 1900. Sea level is projected to rise at an even greater rate in this century." Nathaniel L. Bindoff, Jürgen Willebrand, Vincenzo Artale, et al., "Observations: Oceanic Climate Change and Sea Level," in *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Susan Solomon, Dahe Qin, Martin Manning, et al. (Cambridge and New York: Cambridge University Press, 2007), pp. 408–414, at p. 409.

7. The chunk of Antarctic ice that collapsed in February–March 2008 was a piece of an already-floating ice shelf, the Wilkins ice shelf, and will not contribute to sea-level rise. See Associated Press, "Chunk of Antarctic Ice Collapses," *New York Times*, March 26, 2008.

8. See Steve Vanderheiden, *Atmospheric Justice: A Political Theory of Climate Change* (New York: Oxford University Press, 2008), pp. 192–202. He documents some of the intentional deceptions of U.S. citizens about the science for which the Bush-Cheney White House was notorious.

9. Obviously, the third feature is not independent of the first but proportional to it. My three features fit generally within what Neil A. Manson has called "the three part structure of the precautionary principle," consisting of a damage condition, a knowledge condition, and a remedy; see his penetrating article "Formulating the Precautionary Principle," *Environmental Ethics* 24 (2002): 263–274. My suggestion is also, I think, a variant of what Stephen M. Gardiner very fruitfully isolates as a "core precautionary principle"; see "A Core Precautionary Principle," *Journal of Political Philosophy* 14 (2006): 33–60. Whether either Manson or Gardiner would accept my specific suggestion is, of course, another matter. I will for the most part ignore the more general philosophical issues that they perceptively consider, although I do not believe I run afoul of anything they have established.

10. The suggestion is thus parallel to the suggestion of a sufficient set of conditions for states to take responsibility for the effects of their actions on affected people outside the territory they govern in Henry Shue, "Eroding Sovereignty," in *The Morality of Nationalism*, ed. Robert McKim and Jeff McMahan (New York: Oxford University Press, 1997), pp. 353–354. In both cases, the idea is that one has responsibility to protect against what might otherwise be the effects of one's own actions the people who would be vulnerable and unable

to protect themselves, in the one case across space (including national boundaries) and in the other case across time.

11. I realize that not everyone accepts that there are objective probabilities.

12. I am not hinting at any connection between climate change and bird-flu; this is a comparison.

13. Gina Kolata, *Flu: The Story of the Great Influenza Pandemic of 1918 and the Search for the Virus that Caused It* (New York: Farrar, Straus and Giroux, 1999).

14. The conduct of the U.S. occupation of Iraq currently costs $16 billion per month (the annual budget of the United Nations). Is one more likely to be killed by a terrorist based in Iraq or by bird flu?

15. Stephen H. Schneider, Serguei Semenov, Anand Patwardhan, et al., "Assessing Key Vulnerabilities and the Risk from Climate Change," in *Climate Change 2007: Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Martin Parry, Osvaldo Canziani, Jean Palutikof, et al. (Cambridge: Cambridge University Press, 2007), pp. 779–810. And see generally Cynthia Rosenzweig and Daniel Hillel, *Climate Change and the Global Harvest: Potential Impacts of the Greenhouse Effect on Agriculture* (New York: Oxford University Press, 1998), and *Climate Variability and the Global Harvest: Impacts of El Nino and Other Oscillations on Agro-ecosystems* (New York: Oxford University Press, 2008).

16. See, for example, David Fogarty, "Warming Globe to Test Farmers' Adaptability," *International Herald Tribune*, May 5, 2008, p. 13.

17. Amartya K. Sen, *Poverty and Famines: An Essay on Entitlement and Deprivation* (New York: Oxford University Press, 1983).

18. Hervé Le Treut, Richard Somerville, Ulrich Cubasch, et al., "Historical Overview of Climate Change Science," in *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Susan Solomon, Dahe Qin, Martin Manning, et al. (Cambridge and New York: Cambridge University Press, 2007), pp. 93–127. Also see Andrew C. Revkin, "Strong Action Urged to Curb Warming," *New York Times*, June 11, 2008.

19. For evidence that large reductions in greenhouse-gas emissions by the United States are possible at low cost, see Jon Creyts, Anton Derkach, Scott Nyquist, et al., *Reducing U.S. Greenhouse Gas Emissions: How Much at What Cost?* U.S. Greenhouse Gas Abatement Mapping Initiative (Chicago: McKinsey, 2007).

20. For one argument that the costs of mitigation, or abatement, will only go up, and steeply, see Nicholas Stern, *The Economics of Climate Change: The Stern Review* (Cambridge: Cambridge University Press, 2007).

21. This is a different formulation of the general thesis I advanced in "Climate," in *A Companion to Environmental Philosophy*, ed. Dale Jamieson (Malden, Mass., and Oxford: Blackwell, 2001), pp. 449–459.

22. For one argument for subsistence rights, see Henry Shue, *Basic Rights: Subsistence, Affluence, and U.S. Foreign Policy*, 2d ed. (Princeton, N.J., and Oxford.: Princeton University Press, 1996).

23. See Henry Shue, "Responsibility to Future Generations and the Technological Transition," in *Perspectives on Climate Change: Science, Economics, Politics, Ethics*, ed. Walter Sinnott-Armstrong and Richard B. Howarth (Amsterdam: Elsevier, 2005), pp. 265–283.

24. See "Permafrost Threatened by Rapid Retreat of Arctic Sea Ice, NCAR/NSIDC Study Finds," *National Snow and Ice Data Center Media Advisory*, June 10, 2008.

25. John P. McGeehin, John Barron, David M. Anderson, and David Verardo, *Abrupt Climate Change* (Washington, D.C.: U.S. Climate Change Science Program, 2008), p. 1. Also see Hans Joachim Schnellnhuber et al., eds., *Avoiding Dangerous Climate Change* (Cambridge: Cambridge University Press, 2006).

26. See Richard B. Alley, *The Two-Mile Time Machine: Ice Cores, Abrupt Climate Change, and Our Future* (Princeton, N.J.: Princeton University Press, 2000); U.S. National Academy of Sciences, National Research Council, Committee on Abrupt Climate Change, *Abrupt Climate Change: Inevitable Surprises* (Washington, D.C.: National Academy Press, 2002), pp. v, 24–36; M. Vellinga and R. A. Wood, "Global Climatic Impacts of a Collapse of the Atlantic Thermohaline Circulation," *Climatic Change* 54.3 (2002): 251–267; and Eystein Jansen, Jonathan Overpeck, Keith R. Briffa, et al., "Palaeoclimate," in *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Susan Solomon, Dahe Qin, Martin Manning, et al. (Cambridge and New York: Cambridge University Press, 2007), pp. 433–497.

27. Gerald A. Meehl, Thomas F. Stocker, William D. Collins, et al., "Global Climate

Projections," in *Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, ed. Susan Solomon, Dahe Qin, Martin Manning, et al. (Cambridge and New York: Cambridge University Press, 2007), p. 818. They add: "Catastrophic scenarios suggesting the beginning of an ice age triggered by a shutdown of the MOC [meridional overturning circulation] are thus mere speculations" (p. 818). Compare Juliet Eilperin, "Debate on Climate Shifts to Issue of Irreparable Change: Some Experts on Global Warming Foresee 'Tipping Point' When It Is Too Late to Act," *Washington Post*, January 29, 2006, p. A1.

28. See Creyts, Derkach, Nyquist, et al., *Reducing U.S. Greenhouse Gas Emissions*.

29. A distinction between "survival emissions" and "luxury emissions" was advocated in Anil Agarwal and Sunita Narain, *Global Warming in an Unequal World: A Case of Environmental Colonialism* (New Delhi: Centre for Science and Environment, 1991), p. 5. I pursued their suggestion in Henry Shue, "Subsistence Emissions and Luxury Emissions," *Law & Policy* 15.1 (January 1993): 39–59 (chapter 11 in this volume). I did not think of these two kinds of emissions as exhaustive: many emissions are neither subsistence nor luxury. Steve Vanderheiden treats "survival emissions" and "luxury emissions" as exhaustive categories in *Atmospheric Justice*, pp. 67–73, 242–243.

30. For provocative reflections on the value of a simpler life, see Duane Elgin, *Voluntary Simplicity: Toward a Way of Life That Is Outwardly Simple, Inwardly Rich*, rev. ed. (New York: William Morrow, 1993); Wallace Kaufman, *Coming Out of the Woods: The Solitary Life of a Maverick Naturalist* (Cambridge, Mass.: Perseus, 2000); and David E. Shi, *The Simple Life: Plain Living and High Thinking in American Culture* (New York and Oxford: Oxford University Press, 1985).

31. One can adopt a common metric and then quantify, of course, as some economists do, but the choice of common metric is determined largely by convenience, and the assignments of relative value are highly arbitrary. How many dollars is a decline in the quality of nutrition in Myanmar in 2410 worth now?

32. Nicole Hassoun knows how tempted, and I am grateful to her for discussions of the issues underlying the three conditions.

33. See Thomas Pogge, "Severe Poverty as a Human Rights Violation," in *Freedom from Poverty as a Human Right*, ed. Thomas Pogge (Oxford: Oxford University Press, 2007), pp. 11–53.

34. As I write, the Bush-Cheney "war of choice"—the totally unnecessary, ill-considered, and egregiously counterproductive plunge into the invasion and occupation of Iraq—is costing, as already mentioned, $16 billion per month in operating costs. The elimination of such murderous folly would free up vast sums. One year of the budget for the Iraq occupation would take care of chronic poverty plus several years of vigorous action on climate change. For fuller consideration of some of the issues underlying the precipitate rush into war in Iraq, see Henry Shue and David Rodin, eds., *Preemption: Military Action and Moral Justification* (Oxford: Oxford University Press, 2007).

35. Bryan G. Norton makes this general point in defense of his preferred guide, the safe minimum standard (SMS): "save the resource, provided the costs of doing so are bearable"; see *Sustainability: A Philosophy of Adaptive Ecosystem Management* (Chicago: University of Chicago Press, 2005), p. 346. Similarly, he builds affordability into his statement of the precautionary principle: "take affordable steps to avoid catastrophe tomorrow" (p. 352). "Bearability" and "affordability" depend, for Norton, on which other extremely important matters also require resources.

36. Weapons of mass destruction (WMDs) in Iraq could have fit the same principle if, for example, competent UN inspectors had been finding substantial evidence of their existence. See Shue and Rodin, *Preemption*. It is clear, however, that this eagerly launched war had entirely different purposes and that the case based on WMDs was politically concocted as a pretext; see Mark Danner, *The Secret Way to War: The Downing Street Memo and the Iraq War's Buried History* (New York: New York Review Books, 2006). It is profoundly ironic, and deeply evil, that the Bush-Cheney administration, while suppressing incontrovertible evidence of climate change gathered by thousands of the world's best scientists—see Vanderheiden, *Atmospheric Justice*, chap. 6—was manufacturing phony evidence to justify a war that is consuming many times the resources needed to deal with the real problem they vigorously covered up. Bare politically motivated assertion was accepted as the justification for what has become the longest war in American history, while a powerful body of scientific support for action to mitigate climate change was simply denied. See Mark Mazzetti and Scott Shane, "Bush Overstated Evidence on Iraq, Senators Report," *New York Times*, June 6, 2008; and U.S. Senate, 110th Congress, 2nd Session, Select

Committee on Intelligence, "Report on Intelligence Activities Relating to Iraq" (June 2008). Even NASA's press releases were for years distorted by political appointees; see Andrew C. Revkin, "NASA Office Is Criticized on Climate Reports," *New York Times*, June 3, 2008.

37. I would think that one of the most productive avenues to explore is what other grounds might satisfy the second condition. The generic form of the second condition is that the likelihood of the losses specified in the first condition must be above some minimum threshold. The specific form this condition takes in the cases of bird flu and climate change is mechanism and emerging conditions for functioning of the mechanism. But the generic condition could well be instantiated by other specific forms of threshold.

38. One million deaths is, of course, simply an example. There are other kinds of "massive losses" besides deaths, such as calamitous declines in standards of living or the undermining of civilization. If no one died but everyone had to live like cavemen, that would be a massive loss.

39. A splendid survey and analysis of the literature on the moral case is Stephen M. Gardiner, "Ethics and Global Climate Change," *Ethics* 114.3 (April 2004): 555–600 (chapter 1 in this volume). I tried to establish that each of three independently persuasive arguments all led in this same general direction in Henry Shue, "Global Environment and International Inequality," *International Affairs* 75.3 (1999): 531–545, reprinted in *Environmental Ethics: What Really Matters, What Really Works*, ed. David Schmidtz and Elizabeth Willott (New York: Oxford University Press, 2001), and as chapter 5 in this volume.

40. James F. Kasting, "The Carbon Cycle, Climate, and the Long-Term Effects of Fossil Fuel Burning," *Consequences: The Nature & Implications of Environmental Change*, vol. 4, no. 1 (1998). Available at http://www.gcrio.org/CONSEQUENCES/vol4no1/carbcycle.html.

41. TV ads in 2008 successfully opposed effective action on climate change in the U.S. Senate and were sponsored by the coal and oil lobbies. ExxonMobil ads, for example, say, "We're going to need them all," meaning, "Do not cut back on oil."

42. See David Adam, "World Carbon Dioxide Levels Highest for 650,000 Years, Says US Report," *Guardian*, May 13, 2008; and U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Earth System Research Laboratory, Global Monitoring Division, "Trends in Atmospheric Carbon Dioxide—Mauna Loa." Available at http://www.esrl.noaa.gov/gmd/ccgg/trends/.

43. Jansen, Overpeck, Briffa, et al., "Palaeoclimate," p. 436. Emphasis in original; "very likely" is used technically in that volume to mean a greater than 90 percent probability; see p. 23.

44. For the general picture, see Daniel Yergin, *The Prize: The Epic Quest for Oil, Money, & Power* (New York: Simon & Schuster, 1992); and Michael T. Klare, *Resource Wars: The New Landscape of Global Conflict* (New York: Henry Holt, 2001).

45. See Meehl, Stocker, Collins, et al., "Global Climate Projections," pp. 747–843.

46. Ibid., pp. 824–825.

47. Nicholas Stern, "The Economics of Climate Change," *American Economic Review* 98.2 (May 2008): 1–37 (chapter 2 in this volume).

48. It is not clear that there is any such thing as "running out," in any case. If coal becomes expensive enough, it may simply join its prettier cousin the diamond as a luxury good.

49. See the analysis of this as the "domination of posterity" in John Nolt, "Greenhouse Gas Emission and the Domination of Posterity," in *The Ethics of Global Climate Change*, ed. Denis Arnold (New York: Cambridge University Press, forthcoming).

50. For the initial development of the conception of the technological transition, see Shue, "Responsibility to Future Generations."

51. For an account of how the clean development mechanism of the Kyoto Protocol is failing to deal with the danger, see Henry Shue, "A Legacy of Danger: The *Kyoto Protocol* and Future Generations," in *Globalisation and Equality*, ed. Keith Horton and Haig Patapan (London and New York: Routledge, 2004), pp. 164–178.