SURVEY ARTICLE

Ethics and Global Climate Change*

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Very few moral philosophers have written on climate change.[1] This is puzzling, for several reasons. First, many politicians and policy makers claim that climate change is not only the most serious environmental problem currently facing the world, but also one of the most important international problems per se.[2] Second, many of those working in other disciplines describe climate change as fundamentally an ethical issue.[3]

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1. Prominent exceptions include John Broome (Broome 1992), Dale Jamieson (including Jamieson 1990, 1991, 1992, 1996, 1998, 2001, forthcoming), Henry Shue (Shue 1992, 1993, 1994, 1995*a*, 1995*b*, 1996, 1999*a*, 1999*b*, in press), and an early anthology (Coward and Hurka 1993). Recently a few others have joined the fray. Gardiner (2004*b*), Singer (2002), and Traxler (2002) all write specifically about climate change; and Francis (2003), Gardiner (2001), and Green (2002) discuss issues in global ethics more generally but take climate change as their lead example. (Moellendorf 2002 contains a short but substantive discussion.) There are also brief overviews in two recent collections (Hood 2003; Shue 2001). There is rather more work by nonphilosophers. Grubb (1995) is something of a classic. Also worth reading are Athanasiou and Baer 2002; Baer 2002; Harris 2000*a*, 2001, Holden 1996, 2002; Intergovernmental Panel on Climate Change (IPCC) 1995; Lomborg 2001; Paterson 1996, 2001; Pinguelli-Rosa and Munasinghe 2002; and Victor 2001. Brown 2002 provides a very readable introduction, aimed at a general audience.

2. Such claims are made by both liberals (such as former U.S. President Bill Clinton and Britain's former Environment Minister, Michael Meacher) and conservatives (U.S. Senator Chuck Hagel and the Bush administration's first EPA director, Christine Todd Whitman). See Johansen 2002, pp. 2, 93; and Lomborg 2001, p. 258.

3. For example, the most authoritative report on the subject begins by saying: "Natural, technical, and social sciences can provide essential information and evidence needed for decisions on what constitutes 'dangerous anthropogenic interference with the climate

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Third, the problem is theoretically challenging, both in itself and in virtue of the wider issues it raises.[4] Indeed, some have even gone so far as to suggest that successfully addressing climate change will require a fundamental paradigm shift in ethics (Jamieson 1992, p. 292).

Arguably, then, there is a strong presumption that moral philosophers should be taking climate change seriously. So, why the neglect? In my view, the most plausible explanation is that study of climate change is necessarily interdisciplinary, crossing boundaries between (at least) science, economics, law, and international relations.

This fact not only creates an obstacle to philosophical work (since amassing the relevant information is both time-consuming and intellectually demanding) but also makes it tempting to assume that climate change is essentially an issue for others to resolve. Both factors contribute to the current malaise—and not just within philosophy, but in the wider community too.

My aims in this survey, then, will be twofold. First, I will try to overcome the interdisciplinary obstacle to some extent, by making the climate change issue more accessible to both philosophers and nonphilosophers alike. Second, by drawing attention to the ethical dimensions of the climate change problem, I will make the case that the temptation to defer to experts in other disciplines should be resisted. Climate change is fundamentally an ethical issue. As such, it should be of serious concern to both moral philosophers and humanity at large.

The interdisciplinary nature of the climate change problem once prompted John Broome to imply that a truly comprehensive survey of the relevant literature would be impossible (Broome 1992, p. viii). I shall not attempt the impossible. Instead, I shall present an overview of the most major and recent work relevant to philosophical discussion. Inevitably, this overview will be to some extent selective and opinionated. Still, I hope that it will help to reduce the interdisciplinary obstacles to philosophical work on climate change, by giving both philosophers and the public more generally some sense of what has been said so far and what might be at stake. In my view, the ethics of global climate change is still very much in its infancy. Hopefully, this small contribution will encourage its development.

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system.' At the same time, *such decisions are value judgments* determined through sociopolitical processes, taking into account considerations such as development, equity, and sustainability, as well as uncertainties and risk" (IPCC 2001*c*, p. 2, emphasis added). See also Grubb 1995, p. 473.

4. For example, I argue (Gardiner 2001) that climate change is an instance of a severe and underappreciated intergenerational problem.

I. TERMINOLOGY

> While global warming has catastrophic communications attached to it, climate change sounds a more controllable and less emotional challenge. (Frank Luntz)[5]

Potential confusion about the climate change problem begins even with the terms used to describe it: from 'greenhouse effect' to 'global warming' to the more recently favored 'climate change'.[6] To begin with, many people spoke of 'the greenhouse effect'. This refers to the basic physical mechanism behind projected changes in the climate system.[7] Some atmospheric gases (called 'greenhouse gases' [GHG]) have asymmetric interactions with radiation of different frequencies: just like glass in a conventional greenhouse, they allow shortwave incoming solar radiation through but reflect some of the Earth's outgoing long-wave radiation back to the surface. This creates "a partial blanketing effect," which causes the temperature at the surface to be higher than would otherwise be the case (Houghton 1997, pp. 11–12). Humans are increasing the atmospheric concentrations of these gases through industrialization. This would, other things being equal, be expected to result in an overall warming effect.

The basic greenhouse mechanism is both well understood and uncontroversial. Still, the term 'greenhouse effect' remains unsatisfactory to describe the problem at hand. There are two reasons. First, there is a purely natural greenhouse effect, without which the earth would be much colder than it is now.[8] Hence, it is not accurate to say

5. From a memo penned by strategist Frank Luntz recommending that Republicans adopt the new terminology. Cited by Lee 2003.

6. Sometimes skeptics suggest that the terminological change is suspicious. Recently, however, most have embraced it. See previous note.

7. It is perhaps worth pointing out that the global warming problem is distinct from the problem of stratospheric ozone depletion. Ozone depletion is principally caused by man-made chlorofluorocarbons (CFCs) and has as its main effect the ozone "hole" in the Southern hemisphere, which increases the intensity of radiation dangerous to human health through incidence of skin cancer. These compounds are currently regulated by the Montreal Protocol, apparently with some success. Since some of them are also potent greenhouse gases, their regulation is to be welcomed from the point of view of global warming. However, their main replacements, hydrochloro-fluorocarbons (HCFCs) and hydrofluorocarbons (HFCs) are also greenhouse gases, though they are less potent and less long-lived than CFCs. There is an agreement to phase out HCFCs by 2030, but the concentration of such compounds remains a concern from the point of view of global warming. (See Houghton 1997, pp. 35–38. Houghton's book provides an excellent overview of the science. Also worth reading is Alley 2000.)

8. Houghton calculates that the average temperature at the Earth's surface without the natural greenhouse effect would be −6°C. With the natural effect, it is about 15°C (Houghton 1997, pp. 11–12).

that "the greenhouse effect" as such is a problem; in fact, the reverse is true: without some greenhouse effect, the Earth would be much less hospitable for life as we know it. The real problem is the enhanced, human-induced, greenhouse effect. Second, it is not the greenhouse effect in isolation which causes the climate problem. Whether an increase in the concentration of greenhouse gases does in fact cause the warming we would otherwise expect depends on how the immediate effects of an increase in low frequency radiation play out in the overall climate system. But that system is complex, and its details are not very well understood.

For a while, then, the term 'global warming' was favored. This term captures the point that it is the effects of increased levels of greenhouse gases which are of concern. However, it also has its limitations. In particular, it highlights a specific effect, higher temperatures, and thus suggests a one-dimensional problem. But while it is true that rising temperature has been a locus for concern about increasing human emissions of greenhouse gases, it is not true that temperature as such defines either the core problem or even (arguably) its most important aspects. Consider, for example, the following. First, a higher global temperature does not in itself constitute the most important impact of climate change. Indeed, considered in isolation, there might be no particular reason to prefer the world as it is now to one several degrees warmer.[9] However, second, this thought is liable to be misleading. For presumably if one is imagining a warmer world and thinking that it may be appealing, one is envisioning the planet as it might be in a stable, equilibrium state at the higher level, where humans, animals, and plants have harmoniously adapted to higher temperatures. But the problem posed by current human behavior is not of this kind. The primary concern of many scientists is that an enhanced greenhouse effect puts extra energy into the earth's climate system and so creates an imbalance. Hence, most of the concern about present climate change has been brought about because it seems that change is occurring at an unprecedented rate, that any equilibrium position is likely to be thousands, perhaps tens or hundreds of thousands, of years off, and that existing species are unlikely to be able to adapt quickly and easily under such conditions. Third, though it is at present unlikely, it is still possible that temperature might go down as a result of the increase in atmospheric greenhouse gas con-

9. Hence, skeptics sometimes correctly point out that the Earth has been much warmer in previous periods of its history. They might also note, however, that we were not around during those times, that the climate has been extremely stable during the rise of civilization, and that we have never been subject to climate changes as swift, or of such a magnitude, as those projected by the IPCC.

centrations. But this does not cast any doubt on the serious nature of the problem. This is partly because a rapid and unprecedented lowering of temperature would have similar kinds of adverse effects on human and nonhuman life and health as a rapid warming, and partly because the effects most likely to cause cooling (such as a shutdown of the thermohaline circulation [THC] which supports the Gulf Stream current to Northern Europe [discussed in the next section]) may well be catastrophic even in relation to the other projected effects of global warming.

For all these reasons, current discussion tends to be carried out under the heading 'climate change'. This term captures the fact that it is interference in the climate system itself which is the crucial issue, not what the particular effects of that interference turn out to be. The fundamental problem is that it is now possible for humans to alter the underlying dynamics of the planet's climate and so the basic life-support system both for themselves and all other forms of life on Earth. Whether the alteration of these dynamics is most conveniently tracked in terms of increasing, declining, or even stable temperatures is of subsidiary interest in comparison to the actual changes in the climate itself and their consequences for human, and nonhuman, life.[10]

II. CLIMATE SCIENCE

> Almost no one would deny that in principle our actions and policies should be informed by our best scientific judgments, and it is hard to deny that our best scientific judgments about climate change are expressed in the IPCC reports. (Jamieson 1998, p. 116)[11]

> Recent scientific evidence shows that major and widespread climate changes have occurred with startling speed. . . . Climate models typically underestimate the size, speed, and extent of those changes. . . . Climate surprises are to be expected. (U.S. National Research Council 2002, p. 1)

What do we know about climate change? In 1988, the Intergovernmental Panel on Climate Change (IPCC) was jointly established by the World Meteorological Association and the United Nations Environment Pro-

10. It is perhaps worth noting that 'climate change' is not yet the perfect term. For one thing, it may turn out that there are other ways in which humans can profoundly alter global climate than through greenhouse gases; for another, much of our concern with climate change would remain even if it turned out to have a natural source.

11. For a dissenting view, based on a Kuhnian view of public science, see Michaels and Balling 2000, chap. 11.

gram to provide member governments with state of the art assessments of "the science, the impacts, and the economics of—and the options for mitigating and/or adapting to—climate change" (IPCC 2001*c*, p. vii).[12] The IPCC has, accordingly, submitted three comprehensive reports, in 1990, 1995, and 2001.[13] The results have remained fairly consistent across all three reports, though the level of confidence in those results has increased.[14] The main findings of the most recent are as follows.

The IPCC begins with an account of patterns of climate change observed so far. On temperature, they report: "The global average surface temperature has increased over the 20th century by about 0.6°C"; "Globally, it is very likely[15] that the 1990s was the warmest decade and 1998 the warmest year in the instrumental record, since 1861"; and "The increase in temperature in the 20th century is likely to have been the largest of any century during the past 1,000 years" (IPCC 2001*c*, p. 152). For other phenomena, they say that snow cover and ice extent have decreased, global average sea level has risen, and ocean heat content has increased. They also cite evidence for increases in the amount of precipitation in some regions; the frequency of heavy precipitation

12. It should be noted that IPCC processes are politicized in several ways. For one thing, the scientific membership is decided by participant governments, who nominate their representatives. For another, the most important part of each report (the Summary for Policymakers [SPM]) is approved by member governments on a line-by-line, consensus basis (though this is not true of the scientific reports themselves). The latter procedure in particular is vigorously attacked both by skeptics (see, e.g., Lomborg 2001, p. 319, who complains that the IPCC toughened the language of the 2001 SPM for political reasons) and nonskeptics (many of whom believe that the consensus necessary for the SPMs substantially weakens the claims that would be justified based on the fuller scientific reports). Since they were the subject of intense negotiation, I have repeated the precise wording of the IPCC statements here, rather than paraphrasing.

13. The first two reports are divided into three component volumes, which address the scientific basis for projections about climate change, adaptation, and mitigation. The 2001 report also includes a synthesis report. The reports are all available from Cambridge University Press. The full 2001 report is also available online at the IPCC web site, http://www.ipcc.ch. Guides to the 1990 and 1995 reports were prepared by John Houghton, the lead author, and published in book form in 1993 and 1997 by Cambridge University Press. See Houghton 1997.

14. The U.S. National Academy of Science (2001) reviewed the issue in 2001, at the request of the Bush administration, and found itself in general agreement with the IPCC. See U.S. National Academy of Science 2001.

15. The IPCC's scientific report defines likelihoods in terms of probabilities. Its definitions are as follows: virtually certain (greater than 99 percent chance that a result is true); very likely (90–99 percent chance); likely (66–90 percent chance); medium likelihood (33–66 percent chance); unlikely (10–33 percent chance); very unlikely (1–10 percent chance); and exceptionally unlikely (less than 1 percent chance). See IPCC 2001*c*, p. 152, n. 7.

events; cloud cover in some latitudes; and the frequency, persistence, and intensity of El Nino phenomenon.[16]

The IPCC also surveys the literature on relevant human activities. They conclude that since preindustrial times (1750 is the usual benchmark), humans have altered "the atmosphere in ways that are expected to affect the climate" by markedly increasing the concentrations of greenhouse gases (IPCC 2001*c*, p. 154). The main culprit is carbon dioxide,[17] for which "the concentration has increased by 31% since 1750"; "the present CO_2 concentration has not been exceeded during the past 420,000 years and likely not during the past 20 million years"; and "the current rate of increase is unprecedented during at least the past 20,000 years . . . at about 1.5 ppm [parts per million] (0.4%) per year" (IPCC 2001*c*, p. 155). The main anthropogenic sources of CO_2 are the burning of fossil fuels (about 75 percent) and changes in land-use patterns (principally, deforestation). Of secondary importance is methane, where the present atmospheric concentration "has increased by . . . 151% since 1750; and has not been exceeded during the past 420,000 years," and "slightly more than half of current . . . emissions are anthropogenic (e.g., use of fossil fuels, cattle, rice agriculture and landfills)" (IPCC 2001*c*, pp. 156–57). Molecule for molecule, methane is a more potent greenhouse gas than carbon dioxide. Still, because CO_2 lasts much longer in the atmosphere (about 5–200 years, as opposed to methane's 12 years),[18] it is the more important anthropogenic greenhouse gas.[19]

The IPCC also tries to predict future climate. To do so, it uses computer models to simulate a variety of different possible future scenarios, incorporating different assumptions about economic growth, world population, and technological change. The basic results are as follows. First, carbon dioxide emissions due to the burning of fossil fuels are "virtually certain to be the dominant influence on the trends in atmospheric CO_2 concentration during the 21st century," and by 2100,

16. Some phenomena that are sometimes cited as a source of concern are reported not to show a change as yet. These include tropical storm intensity and frequency, the frequency of tornados, thunder, and hail, and the extent of Antarctic sea ice (IPCC 2001*c*, p. 154).

17. Water vapor is the main atmospheric greenhouse gas, but humans have been doing little to increase its concentration. However, the IPCC does report that one expected consequence of global warming would be an increase in water vapor concentration as a positive feedback.

18. For this reason, David Victor argues that methane emissions do not raise the same issues of intergenerational justice as CO_2 emissions. For most of the warming effects of the former will be visited in the short- to medium-term on the present and next generation (Victor 2001).

19. Other, but less significant, contributing factors include nitrous oxide, halocarbons, aerosols, and natural factors (including variations in solar output) (IPCC 2001*c*, p. 157).

that concentration should be 90–250 percent above preindustrial levels (of 280 parts per million), at 540–970 parts per million (IPCC 2001*c*, pp. 158–59). Second, if this occurs, the full range of model scenarios predict that surface temperature will increase by 1.4–5.8°C over the century. The IPCC states that this is not only a much larger projected rate of warming than that observed during the twentieth century but one "very likely . . . without precedent during at least the last 10,000 years."[20] Third, models indicate that "stabilisation of atmospheric CO_2 concentrations at 450, 650 or 1,000 ppm would require global anthropogenic CO_2 emissions to drop below 1990 levels, within a few decades, about a century, or about two centuries, respectively, and continue to decrease steadily thereafter. Eventually CO_2 emissions would need to decline to *a very small fraction* of current emissions" (IPCC 2001*c*, p. 160; emphasis added).

Alarming as the IPCC predictions are, we should also pay attention to the fact that they might be overly optimistic. For some authors argue that the current climate models typically underestimate the potential for nonlinear threshold effects (U.S. National Research Council 2002; Gagosian 2003). One well-known threat of this sort is the potential collapse of the West Antarctic Ice Sheet (WAIS), which would eventually raise global sea levels by 4–6 meters. But the recent literature registers even greater concern about a lesser-known issue: the possibility of a weakening or shutdown of the deep circulation system which drives the world's ocean currents. This system, known as "the Ocean Conveyor," distributes "vast quantities of heat around our planet, and thus plays a fundamental role in governing Earth's climate . . . [and] in the distribution of life-sustaining water" (Gagosian 2003, p. 4).

The Ocean Conveyor has been called the climate's "Achilles Heel" (Broecker 1997), because it appears to be a major threshold phenomenon. There are two grounds for concern. First, there is strong evidence that in the past the conveyor has slowed, and slowed very quickly, with significant climatic consequences. One such event, 12,700 years ago, saw a drop in temperatures in the North Atlantic region of around 5 degrees Celsius in a single decade. This apparently caused icebergs to spread as far south as the coast of Portugal and has been linked to widespread

20. Furthermore, the temperature rise is not evenly spread. Models suggest that it is "very likely" that the land will warm more quickly, and more so in the Northern Hemisphere. In fact, northern North America and Asia are projected to exceed the global average "by more than 40 percent." Based on these temperature results, over the course of the twenty-first century the IPCC predicts increases in global average water vapor concentration and precipitation, mean sea level, maximum and minimum temperatures, the number of hot days, and the risk of drought; and decreases in the day-night temperature range and (in the Northern Hemisphere) in snow cover and sea ice (IPCC 2001*c*, pp. 161–63).

global drought. Second, the operation of the conveyor is governed by factors that can be affected by climate change. In particular, the world's currents are driven by the sinking of a large volume of salty water in the North Atlantic region. But this process can be disrupted by an influx of fresh water, which both dilutes the salty water and can also create a lid over it, restricting heat flow to the atmosphere.[21]

The possibility of dramatic climate shifts of this sort complicates the picture of a global warming world in several ways. First, it suggests that gradual warming at the global level could cause, and coexist with, dramatic cooling in some regions. (Among other things, this has serious ramifications for our ability to plan for future changes.) Second, it envisages that the major losers from climate change may not be the usual suspects, the less developed countries (LDCs). For it is the rich countries bordering the North Atlantic that are particularly vulnerable to Conveyor shifts. Climate models predict that "the North Atlantic region would cool 3 to 5 degrees Celsius if conveyor circulation were totally disrupted," producing winters "twice as cold as the worst winters on record in the eastern United States in the past century" for a period of up to a century (Gagosian 2003, p. 7).[22]

The IPCC does not emphasize the problem of the Ocean Conveyor. For one thing, though it acknowledges that most models predict a weakening of the conveyor during the twenty-first century, it emphasizes that such changes are projected to be offset by the more general warming; for another, it suggests that a complete shutdown is unlikely during the twenty-first century (though increasingly likely thereafter) (IPCC 2001*c*, p. 16). Hence, the IPCC's attitude is relatively complacent. Still, it is not clear what justifies such complacency. On the one hand, even if the threshold will not be reached for 100 years, this is still a matter of serious concern for future generations, since once the underlying processes which will breach it are in motion, it will be difficult, if not impossible, to reverse them. On the other hand, the current models of thermohaline circulation are not very robust, primarily because scientists simply do not know where the threshold is. And some models do predict complete shutdown within a range which overlaps with IPCC projections for the twenty-first century (IPCC 2001*c*, p. 440).[23]

21. Such changes seem already to be afoot. Gagosian cites recent evidence that over the last fifty years the North Atlantic has freshened considerably, and the flow of salty water into the Atlantic has slowed (Dickson et al. 2002; Hansen et al. 2001).

22. Gagosian adds: "A persistent string of severe winters, lasting decades to a century, can cause glaciers to advance, rivers to freeze, and sea ice to grow and spread. It can render prime agricultural lands unfarmable" (Gagosian 2003, p. 10).

23. Other respectable scientific groups take the possibility much more seriously. See, e.g., the U.S. National Research Council 2002, chap. 3, which suggests that the behavior of the THC becomes considerably less predictable as the threshold is approached.

III. SCIENTIFIC UNCERTAINTY

> Scientists aren't any time soon going to give politicians some magic answer. Policy makers for a long, long time are going to have to deal with a situation where it's not clear what the costs and benefits are, where lots of people disagree about them, and they can't wait until everything is resolved. (Robert J. Lampert)[24]

> Should the public come to believe that the scientific issues are settled, their views about global warming will change accordingly. Therefore, you need to continue to make the lack of scientific certainty a primary issue. (Frank Luntz, in Lee 2003)

> It is sometimes argued that the uncertainty of the scientist's predictions is a reason for not acting at present, and that we should wait until some further research has been concluded. This argument is poor economics. (Broome 1992, p. 17)

Politically, the most common objection raised to action on climate change is that of scientific uncertainty.[25] In this section, I will explain why most writers on the subject believe this objection to be a red herring.

The first thing to note is that, at least in economics, uncertainty is a technical term, to be distinguished from risk. In the technical sense, a risk involves a known, or reliably estimable, probability, whereas an uncertainty arises when such probabilities are not available. So to say that there is scientific uncertainty surrounding global warming is to claim that we do not know, and cannot reliably estimate, the probability that climate change will occur, nor its extent if it does occur.

This distinction is useful, because the first problem with the objection from scientific uncertainty is that the IPCC does not seem to view global warming as uncertain in the technical sense. As we have seen, the 2001 Scientific Assessment explicitly assigns probabilities to its main climate predictions, making the situation one of risk, rather than uncertainty. Furthermore, these probabilities are of considerable magnitude. (For example, the IPCC says that it is "very likely" that in the twenty-first century there will be "higher maximum temperatures and more hot days over nearly all land areas" [IPCC 2001*c*, p. 162], by which they mean a probability of 90–99 percent [IPCC 2001*c*, p. 152, n. 7].) Given that many of the effects assigned high probabilities are associated with significant costs, they would seem to justify some kinds of action.

24. Lampert, senior scientist and expert in risk analysis at the RAND Corporation, quoted in Revkin 2001*b*.

25. See, e.g., former White House Spokesman Ari Fleischer, as quoted by Traxler 2002, p. 105.

But perhaps the idea is that the IPCC's probability statements are not reliable, so that we should ignore them,[26] treat the situation as genuinely uncertain, and hence refuse to act. Still, there is a difficulty. For, to an important extent, some kind of uncertainty "is an inherent part of the problem" (Broome 1992, p. 18). Arguably, if we knew exactly what was going to happen, to whom, and whose emissions would cause it, the problem might be more easily addressed;[27] at the very least, it would have a very different shape. Hence, to refuse to act because of uncertainty is either to refuse to accept the global warming problem as it is (insisting that it be turned into a more respectable form of problem before one will address it) or else to endorse the principle that to "do nothing" is the appropriate response to uncertainty. The former is a head-in-the-sand approach and clearly unacceptable, but the latter is also dubious and does not fit our usual practice.

The third, and perhaps most crucial, point to make about the problem of uncertainty is that it is important not to overplay it. For one thing, many decisions we have to make in life, including many important decisions, are also subject to considerable uncertainties.[28] For another, all uncertainties are not created equal. On the one hand, the reason I am unable to assign probabilities may be that I know absolutely nothing about the situation,[29] or else that I have only one past instance to go on. But I may also be uncertain in circumstances where I have considerable information.[30]

26. There is some case for this. It is not clear how the IPCC generates its "probability" estimates (Reilly et al. 2001).

27. For example, using ozone depletion and deforestation as his case studies, Rado Dimitrov argues that the crucial variable in resolving global environmental problems is knowledge of their cross-border consequences, rather than of their extent and causes, since this "facilitates utility calculations and the formation of interests" (Dimitrov 2003, p. 123).

28. For example, suppose I am weighing a job offer in a distant city. Suppose also that one major consideration in my decision is what kind of life my eighteen-month-old son will have. The information I have about this is riddled with uncertainty. I know that my current location offers many advantages as a place for children to grow up (e.g., the schools are good, the society values children, there are lots of wholesome activities available) but some considerable disadvantages (e.g., great distances from other family members, a high youth suicide rate). But I have no idea how these various factors might affect my son (particularly since I can only guess at this stage what his personality might turn out to be). So, I am in a situation of uncertainty.

29. For example, suppose that the position is on the other side of the world in New Zealand. Suppose also that I have never been to New Zealand, nor know anyone who has. I might be completely bereft of information on which to make a decision. (These days, of course, I have the internet, the local library, and Amazon.com. But pity the situation of the early settlers.)

30. For example, suppose I'm considering the job offer again, but now I'm thinking about whether my fifteen-year-old daughter will like the move. This time I do have considerable information about her personality, preferences, goals, and aspirations. But this

Now it seems clear that uncertainty in the first kind of case is worse than uncertainty in the second, and potentially more paralyzing. Furthermore, and this is the crucial point, it seems reasonably clear that scientific uncertainty about global warming is of the second kind. As Donald Brown argues: "A lot of climate change science has never been in question, . . . many of the elements of global warming are not seriously challenged even by the scientific skeptics, and . . . the issues of scientific certainty most discussed by climate skeptics usually deal with the magnitude and timing of climate change, not with whether global warming is a real threat" (Brown 2002, p. 102).[31] To see this, let us briefly examine a number of sources of uncertainty about global warming.

The first concerns the direct empirical evidence for anthropogenic warming itself. This has two main aspects. First, systematic global temperature records, based on measurements of air temperature on land and surface-water temperature measurements at sea, exist only from 1860,[32] and satellite-based measurements are available only from 1979. The direct evidence for recent warming comes from the former. But skeptics suggest that the satellite measurements do not match the surface readings and do not provide evidence for warming.[33] Second, there is no well-defined baseline from which to measure change.[34] While it is true that the last couple of decades have been the warmest in human history, it is also true that the long-term climate record displays significant short-term variability and that, even accounting for this, climate

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does not mean there is not considerable uncertainty about how good the move would be for her. Suppose, e.g., that I know that the most important thing from her point of view is having very close friends. I also know that she is good at making friends, but I don't know whether a suitable friend will present herself.

31. According to Brown, these facts have been obscured in the American mind by aggressive propaganda campaigns by some business interests, and the media's tendency to run "for and against" articles (and so overrepresent the views of skeptics).

32. There are also notable issues within this data set, especially in comparing different instruments used, and in a possible locational bias in favor of urban areas, which have quite likely warmed during the period due to industrialization.

33. In 2000, a U.S. National Research Council group (which included some skeptics) unanimously concluded that the discrepancy did not cast doubt on evidence that the Earth was warming up (MacIlwain 2000). More recently, evidence has emerged that the satellite data are difficult to interpret because of observational uncertainty, and it is claimed that this evidence "strengthens the case for a pronounced human influence on climate" (Santer et al. 2003, p. 1284). The IPCC produces data suggesting a reasonable match in trends between surface and satellite readings, once corrections are made for the Mount Pinatubo volcano eruption and for El Nino events (Houghton 1997, p. 48, citing Nicholls et al. 1996; see also IPCC 2001*b*, p. 121).

34. There is, of course, an important presumption here. Dale Jamieson points out that the very idea of climate change presupposes a paradigm of stability versus change, and this brings with it a need to distinguish signal from noise (see Jamieson 1991, pp. 319–21).

seems to have been remarkably stable since the end of the last Ice Age 10,000 years ago, as compared with the preceding 100,000 years.[35] Hence, global temperatures have fluctuated considerably over the long-term record, and it is clear that these fluctuations have been naturally caused.[36]

The skeptics are right, then, when they assert that the observational temperature record is a weak data set and that the long-term history of the climate is such that even if the data were more robust, we would be rash to conclude that humans are causing it solely on this basis.[37] Still, it would be a mistake to infer too much from the truth of these claims. For it would be equally rash to dismiss the possibility of warming on these grounds. For, even though it might be true that the empirical evidence is consistent with there being no anthropogenic warming, it is also true that it provides just the kind of record we would expect if there were a real global warming problem.

This paradox is caused by the fact that our epistemological position with respect to climate change is intrinsically very difficult: it may simply be impossible to confirm climate change empirically from this position. This is because our basic situation may be a bit like that of a coach who is asked whether the current performance of a fifteen-year-old athlete shows that she will reach the highest level of her sport. Suppose the coach has the best evidence that she can have. It will still only be evidence for a fifteen-year-old. It will be at most consistent with reaching the highest level. It cannot be taken as a certain prediction. But that does not mean it is no prediction at all, or worthless. It is simply the best prediction she is currently in a position to make.

Fortunately, for the climate change problem, the concern with the empirical record is not the end of the matter. For the temperature record is far from our only evidence for warming. Instead, we also have strong theoretical grounds for concern. First, the basic physical and chemical mechanisms which give rise to a potential global warming effect are well understood. In particular, there is no scientific controversy over the claims (*a*) that in itself a higher concentration of greenhouse gas molecules in the upper atmosphere would cause more heat to be

35. According to data largely from Arctic ice cores, in the last 10,000 years, the variation in average global temperatures was less than one degree Celsius; in the preceding 100,000 years, variations were sometimes experienced of up to five or six degrees Celsius in less than 100 years (Houghton 1997, chap. 4; United Nations Environment Program 1999, sheet 8).

36. A significant and poorly understood factor here is energy output from the sun (though fluctuations caused by variations in the earth's orbit are better known).

37. Interestingly, this does not imply that we should not have a policy to limit emissions. Since a prolonged natural warming would be just as disastrous for current patterns of human life on the planet as artificially induced warming, it could turn out that some abatement of projected anthropogenic emissions would be justified as a counteracting measure.

retained by the earth and less radiated out into the solar system, so that other things being equal, such an increase would cause global temperatures to rise; and (*b*) that human activities since the industrial revolution have significantly increased the atmospheric concentration of greenhouse gases. Hence, everyone agrees that the basic circumstances are such that a greenhouse effect is to be expected.[38]

Second, the scientific dispute, insofar as there is one, concerns the high level of complexity of the global climate system, given which there are the other mechanisms that might be in play to moderate such an effect. The contentious issue here is whether there might be negative feedbacks that either sharply reduce or negate the effects of higher levels of greenhouse gases, or even reduce the amount of them present in the atmosphere. However, current climate models suggest that most related factors will likely exhibit positive feedbacks (water vapor, snow, and ice),[39] while others have both positive and negative feedbacks whose net effect is unclear (e.g., clouds, ocean currents). Hence, there is genuine scientific uncertainty. But this does not by itself justify a skeptical position about action on climate change. For there may be no more reason to assume that we will be saved by unexpectedly large negative feedbacks than that the warming effect will be much worse than we would otherwise anticipate, due to unexpectedly large positive feedbacks.[40]

This is the basic scientific situation. However, three further aspects of uncertainty are worth mentioning. First, the conclusions about feedback are also open to doubt because considerable uncertainties remain about the performance of the models. In particular, they are not completely reliable against past data.[41] This is to be expected because the climate is a highly complex system which is not very well understood.[42]

38. Elsewhere I point out that the potential gains from carbon emissions are far from exhausted, given the low per capita rates in most parts of the world. Hence, even if global warming were not yet occurring, we would, other things being equal, expect it at some time in the future, as global emissions rise (Gardiner 2004*b*).

39. These may amplify the direct warming by a factor of two or three (United Nations Environment Program 1999, sheet 7).

40. In particular, there is no reason to assume that our planet's atmosphere is robustly stable in the face of different inputs. The atmosphere of Venus, e.g., has undergone a runaway greenhouse effect. (It is easy to forget that what we are dealing with fundamentally is a band of gases around the earth that is just a few miles wide.)

41. They tend to project warming against past data, especially over longer time periods. This is factored out in a linear way when the models are applied to the future, but of course the errors could be nonlinear.

42. David Frame has suggested to me that the problem has more to do with the models being tuned to fit the current and recent climate record and that the lingering errors may be due to the omission from the models of processes such as fully interactive biogeochemical and cryosphere cycles.

Still, it clouds the overall picture.[43] Second, as mentioned earlier, the current models tend to assume that atmospheric feedbacks scale linearly with surface warming, and they do not adequately account for possible threshold effects, such as the possible collapse of the West Antarctic Ice Sheet. Hence, they may underestimate the potential risks from global warming. Finally, there is a great deal of uncertainty about the distribution of climate change. Though global rises may seem small, they disguise considerable variation within years and across regions. Furthermore, though it is very difficult to predict which regions will suffer most, and in what ways, such evidence as there is suggests that, at least in the medium term, the impact will be heaviest in the tropical and subtropical regions (where most of the LDCs are), and lighter in the temperate regions (where most of the richer countries are).

In conclusion, there are substantial uncertainties surrounding both the direct empirical evidence for warming and our theoretical understanding of the overall climate system. But these uncertainties cut both ways. In particular, while it is certainly conceivable (though, at present, unlikely) that the climate change problem will turn out to be chimerical, it is also possible that global warming will turn out to be much worse than anyone has yet anticipated. More importantly, the really vital issue does not concern the presence of scientific uncertainty, but rather how we decide what to do under such circumstances. To this issue we now turn.

IV. ECONOMICS

> Economic analyses clearly show that it will be far more expensive to cut CO_2 emissions radically than to pay the costs of adaptation to the increased temperatures. (Lomborg 2001, p. 318)

> Cost-benefit analysis, when faced with uncertainties as big as these, would simply be self-deception. And in any case, it could not be a successful exercise, because the issue is too poorly understood, and too little accommodated in the current economic theory. (Broome 1992, p. 19)

As it turns out, many recent skeptics no longer cite scientific uncertainty as their reason for resisting action on climate change. Instead, they claim to accept the reality of human-induced climate change but argue

43. The IPCC is sometimes criticized for now positing a wider projection range in its latest report than before. This suggests expanding uncertainty. But it is worth noting that the IPCC range is not, as might be expected, a statistical measure, capturing error bars. Instead, it encompasses a cluster of model results. (Leading climate scientists such as Stephen Schneider have criticized the IPCC for being misleading here and so leaving themselves open to political manipulation.)

that there is a strong economic rationale for refusing to act.[44] Prevention, they insist, is more expensive than adaptation; hence, both present and future generations would be better off if we simply accepted that there will be climate change and tried to live with it. Furthermore, they assert, money that might be spent on prevention would be better spent helping the world's poor. I will consider the first of these arguments in this section and the second later on.

Several attempts have been made to model the economic implications of climate change.[45] Politically prominent among these is the DICE model proposed by the Yale economist William Nordhaus. The DICE model is an integrated assessment model. Integrated assessment (IA) models combine the essential elements of biophysical and economic systems in an attempt to understand the impact of climate and economic policies on one another. Typically, such models aim to find a climate policy which will maximize the social welfare function. And many give the surprising result that only limited abatement should occur in the next twenty to thirty years, since the costs of current reductions are too high in comparison to the benefits.[46] Hence, proponents of these models argue that, based on economic costs, the developed world (and the United States in particular) should pursue adaptation rather than abatement. This is the argument embraced by Lomborg, who cites Nordhaus's work as his inspiration.

1. The Cost Argument

A full response to Lomborg's proposal requires addressing both the argument about costs and the more general argument for an adaptation, rather than mitigation, strategy. Let us begin with the cost argument.

The first point to make is that, even if Nordhaus's calculations were reliable, the costs of climate change mitigation do not seem unmanageable. As Thomas Schelling puts it:

> The costs in reduced productivity are estimated at two percent of GNP forever. Two percent of GNP seems politically unmanageable in many countries. Still, if one plots the curve of US per capita GNP over the coming century with and without the two percent permanent loss, the difference is about the thickness of a line drawn with a number two pencil, and the doubled per capita income that would have been achieved by 2060 is reached in 2062. If someone could wave a wand and phase in, over a few years, a climate-

44. See, e.g., Lomborg 2001, p. 317 (though Lomborg does argue elsewhere in the chapter that the IPCC overstates both the temperature effect and the importance of the likely consequences).

45. The models and their results are summarized in Mabey et al. 1997, chap. 3.

46. Nordhaus claims that even the Kyoto controls are much too aggressive. For why this might be surprising, see the later discussion of the Kyoto Protocol.

> mitigation program that depressed our GNP by two percent in perpetuity, no one would notice the difference. (Schelling 1997)

Even Lomborg agrees with this. For he not only cites the 2 percent figure with approval but adds, "there is no way that the cost [of stabilizing abatement measures] will send us to the poorhouse" (Lomborg 2001, p. 323).[47]

The second point is that Nordhaus's work is extremely controversial. For one thing, some claim that his model is simplistic, both in itself and, especially, relative to the climate models.[48] Indeed, one commentator goes so far as to say that "the model is extremely simple—so simple that I once, during a debate, dubbed it a toy model" (Gundermann 2002, p. 150). For another, others offer rival models which endorse the exact opposite to Nordhaus's conclusion: that action now (in the form of carbon taxes, etc.) would be more beneficial in the long term than waiting, even perhaps if global warming does not actually transpire (e.g., Costanza 1996; De Leo et al. 2001; Woodward and Bishop 1997).

Part of the reason that such disputes arise is because the models embody some very questionable assumptions.[49] Some are specific to Nordhaus (e.g., Gundermann 2002, p. 154). But others are the result of two more general kinds of difficulty.

The first is practical. There are severe informational problems involved in any reliable cost-benefit analysis for climate change. In particular, over the timescale relevant for climate change, "society is bound to be radically transformed in ways which are utterly unpredictable to us now," and these changes will themselves be affected by climate (Broome 1992, p. 10; see also Jamieson 1992, pp. 288–89).[50] Hence,

47. Peter Singer adds that, with global emissions trading, Lomborg's own figures suggest that Kyoto would be a net economic benefit (Singer 2002, p. 27). Lomborg's argument, of course, is that, even though this is true, the investment would be better placed elsewhere, in direct aid to poor countries (Lomborg 2001, p. 322).

48. It is worth noting that there is a serious paradox for at least some skeptics here. For some are both very skeptical and demanding on the standards they impose on predictive models from climatology but not at all cautious about the power of the economic models on which they choose to focus. But this should be surprising. For, without wishing in any way to be derogatory about contemporary macroeconomics, it has at least as dubious a status as a predictive science as climatology, if not worse. Hence, if one is going to be quite so critical of the IPCC consensus on climate change as some skeptics are, one should be even-handed in one's approach to the economic models (Gundermann 2002, p. 154).

49. For example, many models (including Nordhaus's) do not take into account indirect social and environmental costs and benefits not associated with production. But some claim that benefits of this sort might actually outweigh the direct costs of abatement (see, e.g., De Leo et al. 2001, pp. 478–79).

50. Jamieson is particularly concerned about climate effects. He says that the regional effects are varied and uncertain; predicting human behavior will be difficult since the impacts will affect a wide range of social, economic, and political activities; we have limited understanding of the global economy; and there will be complex feedbacks between different economic sectors.

Broome, for example, argues that fine-grained cost-benefit analyses are simply not possible for climate change.

The second kind of difficulty, of more interest to ethicists perhaps, is there are some basic philosophical problems inherent in the methods of conventional economic analysis. Here let me mention just two prominent examples.

One concerns the standard economic treatments of intergenerational issues. Economists typically employ a social discount rate (SDR) of 2–10 percent for future costs[51] (Lomborg uses 5 percent; Nordhaus 3–6 percent).[52] But this raises two serious concerns. The first is that, for the short- to medium-term effects of climate change (say, over ten to fifty years), model results can be extremely sensitive to the rate chosen. For example, Shultz and Kasting claim that the choice of SDR makes the rest of the climate change model largely irrelevant in Nordhaus's model, and variations in the SDR make a huge difference to model results more generally (Schultz and Kasting 1997, cited by Gundermann 2002, p. 147). The other concern is that, when the SDR is positive, all but the most catastrophic costs disappear after a number of decades, and even these become minimal over very long time periods.[53] This has serious consequences for the intergenerational ethics of climate change. As John Broome puts it: "It is people who are now children and people who are not yet born who will reap most of the benefits of any project that mitigates the effects of global warming. Most of the benefits of such a project will therefore be ignored by the consumer-price method of project evaluation. It follows that this method is quite useless for assessing such long-term projects. This is my main reason for rejecting it [for climate change]" (Broome 1992, p. 72).[54]

The second philosophical problem inherent in conventional eco-

51. Discounting is "a method used by economists to determine the dollar value today of costs and benefits in the future. Future monetary values are weighted by a value <1, or 'discounted'" (Toman 2001, p. 267). The SDR is the rate of discounting: "Typically, any benefit (or cost), B (or C), accruing in T years' time is recorded as having a 'present' value, PV of: $PV(B) = B_T/(1 + r)^T$" (Pearce 1993, p. 54).

52. For philosophical objections to the SDR, see Parfit (1985, app. F). A (partial) reply is to be found in Broome (1999). However, Broome explicitly denies that a positive SDR should be used for climate change (see Broome 1992, pp. 60, 72).

53. Alex Dubgaard makes the point with an example. Suppose that Denmark needs to be evacuated due to flooding. Current real estate value in Denmark is estimated at about USD$238 billion. If a discount rate of 5 percent is applied, then over 500 years, the same real estate would be worth just $6. Hence, "If they do not enlarge their property in the meantime, the loss of all real estate in Denmark would be compensated if, today, we make a saving equivalent to half a barbequed chicken with potato fritters." He calls such a conclusion obviously absurd (Dubgaard 2002, pp. 200–201).

54. This quotation refers specifically to the consumer-price method. But Broome also rejects other ways of generating a positive discount rate for future generations in the case of climate change (Broome 1992, chap. 3) and, indeed, specifically endorses a discount rate of zero in this context (Broome 1992, p. 108).

nomic analysis is that it cannot adequately capture all of the relevant costs and benefits. The obvious cases here are costs to nonhumans (such as animals, plants, species, and ecosystems) and noneconomic costs to humans, such as aesthetic costs (Sagoff 1998; Schmidtz 2001). But there is also concern that conventional economic analysis cannot adequately take into account costs with special features, such as irreversible and nonsubstitutable damages, that are especially associated with climate change (Shogren and Toman 2000; Costanza 1996).[55]

We can conclude, then, that there are strong reasons to be skeptical about Lomborg's cost argument in particular and about the reliability of fine-grained economic analyses of climate change more generally. Still, John Broome argues that two things can be said with some confidence: first, the specific effects of climate change "are very uncertain," where (as argued in the previous section) "this by itself has important consequences for the work that needs to be done," and, second, these effects "will certainly be long lived, almost certainly large, probably bad, and possibly disastrous" (Broome 1992, p. 12). To these claims we might add that at 2 percent of world production, the estimated costs of stabilizing emissions do not seem obviously prohibitive.

2. The Adaptation Argument

We can now turn to the more general argument that, instead of reducing emissions, we should pursue a policy of trying to adapt to the effects of climate change.[56] The first thing to note about this argument is that adaptation measures will clearly need to be part of any sensible climate policy, because we are already committed to some warming due to past emissions, and almost all of the proposed abatement strategies envisage that overall global emissions will continue to rise for at least the next few decades, committing us to even more.[57] Hence, the choice cannot be seen as being one between abatement and adaptation, since advocates of abatement generally support a combination of strategies. The real issue is rather whether adaptation should be our only strategy, so that abatement is ignored (Jamieson, forthcoming).

If this is the proposal, several points can be made about it. First,

55. Economists tend to operate under the assumption that all goods are readily substitutable for one another, so that in principle any one kind of good (such as clean air or blankets) can be substituted for any other kind (such as jewelry). But this seems dubious in general, and, in the case of environmental quality, to embody a significant value judgment that is not widely shared. Good starting points for discussion of such philosophical issues might be Adler and Posner 2001; and Chang 1997.

56. This argument received political prominence at a meeting in Delhi in 2002, where it was promoted by the United States and India (Revkin 2002; Harding 2002).

57. This is why the IPCC and others speak of further emissions reductions as "mitigation," rather than prevention.

we should beware of making the case for adaptation a self-fulfilling prophesy. For example, it is true that the existing capital stock in the United States made it difficult for America to meet its original Kyoto target for 2008–12.[58] But it is also true that a significant amount of this capital was invested after the United States committed itself to stabilizing emissions at the Rio Earth Summit of 1992. Furthermore, matters will only get worse. The Bush administration's current energy plan calls for the building of 1,300 new power plants in the next twenty years, boosting supply (and thereby emissions) by more than 30 percent.

Second, the comparison between abatement and adaptation costs looks straightforward but is not. In particular, we have to bear in mind the different kinds of economic costs at stake in each case. On the one hand, suppose we allow global warming to continue unchecked. What will we be adapting to? Chances are, we will experience both a range of general gradual climatic changes and an increase in severe weather and climate events. On the other hand, if we go for abatement, we will also be adapting, but this time to increases in tax rates on (or decreases in permits for) carbon emissions.[59] But there is a world of difference between these kinds of adaptation: in the first case, we would be dealing with sudden, unpredictable, large-scale impacts which descend at random on particular individuals, communities, regions, and industries and visit them with pure, unrecoverable costs,[60] whereas, in the second, we would be addressing gradual, predictable, incremental impacts, phased in so as to make adaptation easier.[61]

58. Victor argues that, given an actual 12 percent rise in U.S. emissions from 1990 to 1999, and a projected further 10 percent rise to 2008, the Kyoto requirement of a 7 percent cut on 1990 levels amounts to a 30 percent cut overall from projected emissions. He adds, "Compliance with a sharp 30% cut would force the premature disposal of some of the 'capital stock' of energy equipment and retard significant parts of the US economy. Electricity power generation is especially vulnerable. About half of US electric power is supplied by coal, which is the most greenhouse gas intensive of all fossil fuels. *The time to implement easy changes has already passed.* About four-fifths of the US generating capacity that will electrify 2010 will already have been built by the end of the year 2000" (Victor 2001, pp. 3–4, emphasis added).

59. Of course, in reality, the contrast between the two scenarios is not so stark. Since we are already committed to some warming due to past emissions, it is not true that we can completely shield ourselves from the possibility of unpredictable impacts. But we can shield ourselves to some extent from unpredictable impacts from our future emissions.

60. One effect of this would be to introduce new and more widespread costs. For example, since the impacts are unpredictable, all prudent agents will insure against them, so that some will spend money on emergency services and flood walls that they do not need. This contrasts with an abatement strategy, where the direct costs are incurred only by those responsible for excessive emissions.

61. Not only do we avoid the unnecessary costs mentioned above, but costs in the second case can be distributed in a rational fashion over the sources of the problem and may even generate revenue (through taxation or the price of permits) which could be used to alleviate the effects of warming to which we are already committed or for other socially beneficial purposes.

Surely, adaptation in the second kind of case is, other things being equal, preferable to the first.[62]

Third, any reasonable abatement strategy would need to be phased in gradually, and it is well documented that many economically beneficial energy savings could be introduced immediately, using existing technologies.[63] These facts suggest that the adaptation argument is largely irrelevant to what to do now. For the first steps that need to be taken would be economically beneficial, not costly. Yet opponents of action on climate change do not want to do even this much.

V. RISK MANAGEMENT AND THE PRECAUTIONARY PRINCIPLE

> The risk assessment process . . . is as much policy and politics as it is science. A typical risk assessment relies on at least 50 different assumptions about exposure, dose-response, and relationships between animals and humans. The modeling of uncertainty also depends on assumptions. Two risk assessments conducted on the same problem can vary widely in results. (Raffensberger and Tickner 1999, p. 2)

Serious as they are, these largely technical worries about conventional economic analysis are not the only reasons to be wary of any economic solution to the climate change problem. For some writers suggest that exclusive reliance on economic analysis would be problematic even if all of the numbers were in, since the climate problem is ultimately one of values, not efficiency: as Dale Jamieson puts it, its "fundamental questions" concern "how we ought to live, what kinds of societies we want, and how we should relate to nature and other forms of life" (Jamieson 1992, p. 290).

But the problem may not be just that climate change raises issues of

62. There is something of a paradox here in the attitudes of some commentators, in that they appear to have great faith in the ability of the market to adapt in the first case, but not the second. It is not clear what could justify such a prejudice. (Commenting on some early works by Nordhaus and Beckerman, Broome says that they are "evidently assuming that human life is by now fairly independent of the natural world. . . . I find this assumption too complacent"; Broome 1992, p. 25, n. 31.)

63. There are many ways in which developed countries waste energy, and thereby carbon emissions, through inefficient practices. For example, the most fuel efficient cars and SUVs/trucks available in the United States are capable of 66 and 29 miles per gallon respectively on the open highway; the least efficient are capable of 14 and 16 miles per gallon (U.S. Environmental Protection Agency 2003). Furthermore, in recent years, manufacturers in the United States have actually stopped making the most fuel efficient cars, as such vehicles have been crowded out of the marketplace by sport-utility vehicles. Hence, average fuel efficiency has declined (Heavenrich and Hellman 2000). Less markedly, substantial energy savings could be made simply by switching to the most efficient currently available models of washing machines, hot water heaters, and the like.

value. It may also show that our existing values are insufficient to the task. Jamieson, for example, offers the following argument. First, he asserts that our present values evolved relatively recently, in "low-population-density and low-technology societies, with seemingly unlimited access to land and other resources." Then he claims that these values include as a central component an account of responsibility which "presupposes that harms and their causes are individual, that they can be readily identified, and that they are local in time and space." Third, he argues that problems such as climate change fit none of these criteria. Hence, he concludes, a new value system is needed (Jamieson 1992, pp. 291–92).[64]

How then should we proceed? Some authors advocate a rethinking of our basic moral practices. For example, Jamieson claims that we must switch our focus away from approaches (such as those of contemporary economics) which concentrate on "calculating probable outcomes" and instead foster and develop a set of "twenty-first century virtues," including "humility, courage, . . . moderation," "simplicity and conservatism" (Jamieson 1992, p. 294).

Other climate change theorists, however, are less radical. For example, Henry Shue employs the traditional notions of a "No Harm Principle" and rights to physical security (Shue 1999*a*, p. 43). He points out that even in the absence of certainty about the exact impacts of climate change, there is a real moral problem posed by subjecting future generations to the risk of severe harms. This implies a motive for action in spite of the scientific and economic uncertainties. Similarly, many policy makers appeal to the "precautionary principle,"[65] which is now popular in international law and politics[66] and receives one of its canonical statements in the 1992 United Nations Framework Convention on Climate Change (1992).[67] The exact formulation of the precautionary principle is controversial; but one standard version is the Wingspread

64. In a later article, Jamieson's position seems more modest. He suggests that there are two moral and legal paradigms associated with responsibility in the Western tradition: a causal paradigm and an "ability to benefit or prevent harm" paradigm. He then argues that the former founders with climate change; but the latter, which he associates with the utilitarian tradition, does not. See Jamieson 1998, pp. 116–17.

65. The literature on the precautionary principle is voluminous, though mostly written by nonphilosophers, and a thorough treatment of it would require a separate article. Some representative collections are O'Riordan, Cameron, and Jordan 2001; Raffensberger and Tickner 1999. Haller 2002 is a recent philosophical study of related issues, with some emphasis on climate change.

66. Versions appear in the Third North Sea Conference (1990), and the Ozone Layer Protocol (1987); they are also endorsed by major institutions, such as the UN Environment Program (1989), the European Union in its environment policy (1994), and the U.S. President's Council on Sustainable Development (1996). See Raffensberger 1999.

67. Some take the precautionary principle to be equivalent to a "do no harm" principle and to have roots in the Hippocratic Oath (see, e.g., Ozonoff 1999, p. 100).

Statement, which reads: "When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically" (Wingspread Statement 1998).

Both no harm principles and the precautionary principle, are, however, controversial. No harm principles are often criticized for being either obscure or else overly conservative when taken literally; and the precautionary principle generates similar objections: its critics say that it is vacuous, extreme, and irrational.[68] Still, I would argue that, at least in the case of the precautionary principle, many of these initial objections can be overcome (Gardiner 2004*a*). In particular, a core use of the precautionary principle can be captured by restricting its application to those situations which satisfy John Rawls's criteria for the application of a maximin principle: the parties lack, or have good reason to doubt, relevant probability information; they care little for potential gains; and they face unacceptable outcomes (Rawls 1999, p. 134). And this core use escapes the initial, standard objections.[69]

More importantly for current purposes, I would also claim that a reasonable case can be made that climate change satisfies the conditions for the core precautionary principle (Gardiner 2004*a*). First, many of the predicted outcomes from climate change seem severe, and some are catastrophic. Hence, there are grounds for saying there are unacceptable outcomes. Second, as we have seen, for gradual change, either the probabilities of significant damage from climate change are high or else we do not know the probabilities; and for abrupt change the probabilities are unknown. Finally, given widespread endorsement of the view that stabilizing emissions would impose a cost of "only" 2 percent of world production, one might claim that we care little about the potential gains—at least relative to the possibly catastrophic costs.

There is reason to believe, then, that the endorsement by many policy makers of some form of precautionary or no harm approach is reasonable for climate change. But exactly which "precautionary measures" should be taken? One obvious first step is that those changes in present energy consumption which would have short-term, as well as long-term, economic benefits should be made immediately. In addition,

68. In a recent piece in the *New York Times*, a self-described "former Reagan administration trade hawk" asserted: "Without any scientific grounds, but on the basis of the so-called precautionary principle—that is, if we can't prove absolutely that it is harmless, let's ban it—the [European] Union has prevented genetically modified food from the United States from entering its markets" (Prestowitz 2003). For more measured, philosophical criticisms, see Soule 2000; and Manson 2002.

69. I would also argue that it renders many objections made to the principle in practical contexts misguided: instead of calling into doubt the reasonableness of the precautionary principle itself, critics are often arguing that the conditions for its application are not met.

we should begin acting on low-cost emissions-saving measures as soon as possible. Beyond that, it is difficult to say exactly how we should strike a balance between the needs of the present and those of the future. Clearly, this is an area where further thought is urgently needed.

Still, it is perhaps worthwhile closing this section with one, speculative, opinion about how we should direct our efforts. By focusing on the possibility of extreme events, and considering the available science, Brian O'Neill and Michael Oppenheimer suggest in a recent article in *Science* that "taking a precautionary approach because of the very large uncertainties, a limit of 2 C above 1990 global average temperature is justified to protect [the West Antarctic Ice Sheet]. To avert shutdown of the [Thermohaline circulation], we define a limit of 3 C warming over 100 years" (O'Neill and Oppenheimer 2002). It is not clear how robust these assertions are. Still, they suggest a reasonable starting point for discussion. For, on the assumption that these outcomes are unacceptable, and given the IPCC projections of a warming of between 1.4 and 5.8°C over the century, both claims appear to justify significant immediate action on greenhouse gas stabilization.[70]

VI. RESPONSIBILITY FOR THE PAST

> I'll tell you one thing I'm not going to do is I'm not going to let the United States carry the burden for cleaning up the world's air, like the Kyoto Treaty would have done. China and India were exempted from that treaty. I think we need to be more even-handed. (George W. Bush, quoted by Singer 2002, p. 30)[71]

> Even in an emergency one pawns the jewellery before selling the blankets. . . . Whatever justice may positively require, it does not permit that poor nations be told to sell their blankets [compromise their development strategies] in order that the rich nations keep their jewellery [continue their unsustainable lifestyles]. (Shue 1992, p. 397; quoted by Grubb 1995, p. 478)

> To demand that [the developing countries] act first is patently unfair and would not even warrant serious debate were it not the position of a superpower. (Harris 2003)

Suppose, then, that action on climate change is morally required. Whose responsibility is it? The core ethical issue concerning global warming is that of how to allocate the costs and benefits of greenhouse gas emissions

70. O'Neill and Oppenheimer 2002 suggest stabilization at 450 parts per million of carbon dioxide, which would require a peak in global emissions between 2010 and 2020.

71. From the second televised presidential debate of 2000.

and abatement.[72] On this issue, there is a surprising convergence of philosophical writers on the subject: they are virtually unanimous in their conclusion that the developed countries should take the lead role in bearing the costs of climate change, while the less developed countries should be allowed to increase emissions for the foreseeable future.[73]

Still, agreement on the fact of responsibility masks some notable differences about its justification, form, and extent; so it is worth assessing the competing accounts in more detail. The first issue to be considered is that of "backward-looking considerations."[74] The facts are that developed countries are responsible for a very large percentage of historical emissions, whereas the costs likely to be imposed by those emissions are expected to be disproportionately visited on the poorer countries (IPCC 1995, p. 94).[75] This suggests two approaches. First, one might invoke historical principles of justice that require that one "clean up one's own mess." This suggests that the industrialized countries should bear the costs imposed by their past emissions.[76] Second, one

72. Shue usefully distinguishes four issues of distributive fairness here: how to allocate the costs of preventing avoidable change; how to allocate the costs of coping with change that will not be avoided; the background allocation of wealth that would allow fair bargaining about such issues; and the allocation of the gases themselves, both in the long run and during any period of transition to it (Shue 1993, p. 40).

73. Some try to account for the convergence. For example, Peter Singer claims that it arises because the facts of climate change are such that all the major traditional lines of thought about justice in ethical theory point to the same conclusion (Singer 2002); Henry Shue argues that three "commonsense principles of fairness, none of them dependent upon controversial theories of justice" all support the position (Shue 1999*b*, p. 531); and Wesley and Peterson believe that the United States should accept heavier burdens because they are justified by "at least four of Ross's *prima facie* duties" (see Wesley and Peterson 1999, p. 191).

74. The term is from Traxler. Singer calls them "historical." Shue objects to that label, preferring to use a fault-based and no-fault distinction. (He argues that no-fault principles are not necessarily ahistorical: an ability to pay principle might emerge from a historical analysis; Shue 1993, p. 52.)

75. Singer cites Hayes and Smith 1993, chap. 2, table 2.4, which says that, even from 1950 to 1986, the United States, with about 5 percent of world population, was responsible for 30 percent of cumulative emissions, while India, with 17 percent of world population, was responsible for less than 2 percent. (Another study suggests that the developed world is responsible for 85.9 percent of the increase in atmospheric concentration of carbon dioxide since 1800; see Grubler and Fujii 1991, cited by Neumayer 2000, p. 190; and IPCC 1995, p. 94.) Furthermore, Singer says that "at present rates of emissions . . . including . . . changes in land use . . . contributions of the developing nations to the atmospheric stock of GHG will not equal the built-up contributions of developed nations until about 2038. If we adjust . . . for population—per person contributions. . .—the answer is: not for at least another century" (Singer 2002, pp. 36–37).

76. This approach is reflected in the conventional environmental "polluter pays" principle and in Shue's first "commonsense principle" of equity (Shue 1999*b*, p. 534). (Shue suggests that his principle is wider than "polluter pays," since he claims that the latter is exclusively forward-looking, demanding only that future pollution costs should

might characterize the earth's capacity to absorb man-made emissions of carbon dioxide as a common resource, or sink (Traxler 2002, p. 120),[77] and claim that, since this capacity is limited, a question of justice arises in how its use should be allocated (Singer 2002, pp. 31–32).[78] On this approach, the obvious argument to be made is that the developed countries have largely exhausted the capacity in the process of industrializing and so have, in effect, denied other countries the opportunity to use "their shares." On this view, justice seems to require that the developed countries compensate the less developed for this overuse.

It is worth observing two facts about these two approaches. First, they are distinct. On the one hand, the historical principle requires compensation for damage inflicted by one party on another and does not presume that there is a common resource; on the other, the sink consideration crucially relies on the presence of a common resource and does not presume that any (further) damage is caused to the disenfranchised beyond their being deprived of an opportunity for use.[79] Second, they are compatible. One could maintain that a party deprived of its share of a common resource ought to be compensated both for that and for the fact that material harm has been inflicted upon it as a direct result of the deprivation.[80]

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be reflected in prices. But many writers seem to use 'polluter pays' in a wider sense than this.)

77. Shue characterizes the issue as one of an international regime imposing a ceiling on emissions and thereby creating an issue of justice, through making emissions a zero-sum good (see Shue 1995*b*, p. 385).

78. Singer suggests that it is this feature of the problem which renders the Lockean Proviso, of leaving "enough and as good" for others, inoperative under the circumstances for climate change.

79. Traxler suggests that they produce "very much the same results" (Traxler 2002, p. 120). But this might not turn out to be the case. For example, I might be responsible for some of the costs of upkeep of a common resource, so that the compensation due to me for a given level of pollution might be less than if there were no common property involved; or use of the resource might necessarily involve some imposed costs, of which I am expected to bear a fair share. Neither would be true on the other principle.

80. A further point to be made about the approaches is that they are potentially rebuttable. In particular, proponents of historical accounts of appropriation generally suggest that due compensation is typically paid, in the form of the increased standard of living for all that the appropriation allows. Singer, however, argues that such arguments will not work for climate change. For one thing, he says, the poor do not benefit from the increased productivity of the rich, industrialized world—"they cannot afford to buy its products"—and, if natural disasters ensue, they may even be made substantially worse off by it (Singer 2002, pp. 33–34). For another, he claims that the benefits received by the rich are wildly disproportionate. (Singer dismisses Adam Smith's argument that there is an invisible hand at work so that, though the rich take the "most precious" things, "they consume little more than the poor . . . [and] divide with the poor the produce of all their improvements." Instead, Singer claims, there is nothing even close to an equal distribution of the benefits of greenhouse gas emissions, because "the average American . . . uses more than fifteen times as much of the global atmospheric sink as the average

Offhand, the backward-looking considerations seem weighty. However, many writers suggest that in practice they should be ignored.[81] One justification that is offered is that, until comparatively recently, the developed countries were ignorant of the effects of their emissions on the climate and so should not be held accountable for past emissions (or at least those prior to 1990, when the IPCC issued its first report).[82] This consideration seems to me far from decisive, because it is not clear how far the ignorance defense extends.[83] On the one hand, in the case of the historical principle, if the harm inflicted on the world's poor is severe, and if they lack the means to defend themselves against it, it seems odd to say that the rich nations have no obligation to assist, especially when they could do so relatively easily and are in such a position largely because of their previous causal role. On the other hand, in the case of the sink consideration, if you deprive me of my share of an important resource, perhaps one necessary to my very survival, it seems odd to say that you have no obligation to assist because you were ignorant of what you were doing at the time. This is especially so if your overuse both effectively denies me the means of extricating myself from the problem you have created and also further reduces the likelihood of fair outcomes on this and other issues (Shue 1992).[84]

A second justification for ignoring past emissions is that taking the past into account is impractical. For example, Martino Traxler claims that any agreement which incorporates backward-looking considerations would require "a prior international agreement on what constitutes international distributive justice and then an agreement on how to translate these considerations into practical allocations" and that, given that "such an agreement is [un]likely in our lifetime," insisting on it "would

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Indian" and so effectively deprives the poor of the opportunity to develop along the same lines [see Singer 2002, pp. 34–35]. Shue argues that "whatever benefits the LDCs have received, they have mostly been charged for" [Shue 1999*b*, p. 535].)

81. Other considerations are discussed by Beckerman and Pasek (1995), Neumayer (2000), Shue (1993, pp. 44–45), and Grubb (1995, p. 491).

82. Singer and Jamieson both want to ignore emissions prior to 1990, and both mention ignorance as a relevant factor. However, their endorsement of the ignorance defence is lukewarm, and this may indicate that they are more concerned with practicality. (Singer suggests that there is a "strong case" for backward-looking principles but imagines that the poor countries might "generously" overlook it [Singer 2002, pp. 38–39, 48]. Jamieson argues that emissions prior to 1990 are at least not morally equivalent to those after, because they do not amount to an intentional effort to deprive the poor of their share [Jamieson 2001, p. 301].)

83. It is perhaps worth noticing that U.S. tort law allows for circumstances of strict liability—i.e., instances where a party causing harm is liable for damages even when not guilty of negligence—and that this concept has been successfully upheld in several environmental cases and employed in environmental legislation.

84. According to Shue, far from being irrelevant, backward-looking considerations exacerbate the problems through creating compound injustice.

amount to putting off any implementation concerning climate change indefinitely" (Traxler 2002, p. 128). Furthermore, he asserts that climate change takes the form of a commons problem and so poses a significant problem of defection:[85] "Each nation is (let us hope) genuinely concerned with this problem, but each nation is also aware that it is in its interest not to contribute or do its share, regardless of what other countries do. . . . In short, in the absence of the appropriate international coercive muscle, defection, however unjust it may be, is just too tempting" (Traxler 2002, p. 122).

Though rarely spelled out, such pragmatic concerns seem to influence a number of writers. Still, I am not convinced—at least by Traxler's arguments. For one thing, I do not see why a complete background understanding of international justice is required, especially just to get started.[86] For another, I am not sure that defection is quite the problem, or at least has the implications, that Traxler suggests. In particular, Traxler's argument seems to go something like this: since there is no external coercive body, countries must be motivated not to defect from an agreement; but (rich) countries will be motivated to defect if they are asked to carry the costs of their past (mis)behavior; therefore, past behavior cannot be considered, otherwise (rich) countries will defect. But this reasoning is questionable, on several grounds. First, it seems likely that if past behavior is not considered, then the poor countries will defect. Since, in the long run, their cooperation is required, this would suggest that Traxler's proposal is at least as impractical as anyone else's.[87] Second, it is not clear that no external coercive instruments exist. Trade and travel sanctions, for example, are a possibility and have precedents. Third, the need for such sanctions (and indeed, the problem of defection in general) is not brought on purely by including the issue of backward-looking considerations in negotiation, nor is it removed by their absence. So it seems arbitrary to disallow such considerations on this basis. Finally, Traxler's argument seems to assume (first)

85. I will comment on the appropriateness of describing the climate change problem in this way toward the end of the article.

86. One reason comes from historical precedent. Thomas Schelling argues that our one experience with redistribution of this magnitude is the post–World War II Marshall Plan. In that case, "there was never a formula . . . there were not even criteria; there were 'considerations' . . . every country made its claim for aid on whatever grounds it chose," and the process was governed by a system of "multilateral reciprocal scrutiny," where the recipient nations cross-examined each other's claims until they came to a consensus on how to divide the money allocated, or faced arbitration from a two-person committee. Though not perfect, such a procedure did at least prove workable (Schelling 1997).

87. This concern is exacerbated by the fact that the principle of "differentiated responsibilities" was explicitly agreed to long ago, under the Framework Convention for Climate Change, and ratified by all the major governments. So, LDCs would have a procedural as well as several substantive reasons to defect.

that the only truly urgent issue that needs to be addressed with respect to climate change is that of future emissions growth, and (second) that this issue is important enough that concerns about (i) the costs of climate change to which we are already committed, and (ii) the problem of inequity in the proceeds from those emissions (e.g., that the rich countries may have, in effect, stolen rights to develop from the poorer countries) can be completely ignored. But such claims seem controversial.[88]

The arguments in favor of ignoring past emissions are then, unconvincing. Hence, contrary to many writers on this subject, I conclude that we should not ignore the presumption that past emissions pose an issue of justice which is both practically and theoretically important. Since this has the effect of increasing the obligations of the developed nations, it strengthens the case for saying that these countries bear a special responsibility for dealing with the climate change problem.

VII. ALLOCATING FUTURE EMISSIONS

> The central argument for equal per capita rights is that the atmosphere is a global commons, whose use and preservation are essential to human well being. (Baer 2002, p. 401)
>
> Much like self-defense may excuse the commission of an injury or even a murder, so their necessity for our subsistence may excuse our indispensable current emissions and the resulting future infliction of harm they cause. (Traxler 2002, p. 107)

Let us now turn to the issue of how to allocate future emissions. Here I cannot survey all the proposals that have been made; but I will consider four prominent suggestions.[89]

1. Equal Per Capita Entitlements

The most obvious initial proposal is that some acceptable overall level of anthropogenic greenhouse emissions should be determined scientifically, and then that this should be divided equally among the world's population, to produce equal per capita entitlements to emissions.[90] This proposal seems intuitive but would have a radical redistributive

88. It should also be clear that to restrict concern to future emissions growth has the effect of addressing only the single issue that matters to the rich countries. Again, this heightens the risk of poor country defection.

89. For critiques of some other possibilities, see Baer 2002; and Jamieson 2001.

90. Versions of this proposal are made by Agarwal and Narain 1991; Jamieson 2001; Singer 2002, pp. 39–40; and Baer 2002. Politically, it is also advocated by China, India, and most of the LDCs.

effect. Consider the following illustration. Singer points out that stabilizing carbon emissions at current levels would give a per capita rate of roughly one tonne per year. But actual emissions in the rich countries are substantially in excess of this: the United States is at more than 5 tonnes per capita (and rising); and Japan, Australia, and Western Europe are all in a range from 1.6 to 4.2 tonnes per capita (with most below 3). India and China, on the other hand, are significantly below their per capita allocation (at 0.29 and 0.76, respectively).[91] Thus, Singer suggests (against the present President Bush's claim at the beginning of the previous section), an "even-handed approach" implies that India and China should be allowed increases in emissions, while the United States should take a massive cut (Singer 2002, pp. 39–40).[92]

Two main concerns have been raised about the per capita proposal.[93] The first is that it might encourage population growth, through giving countries an incentive to maximize their population in order to receive more emissions credits (Jamieson 2001, p. 301).[94] But this concern is easily addressed: most proponents of a per capita entitlement propose indexing population figures for each country to a certain time. For example, Jamieson proposes a 1990 baseline (relevant due to the initial IPCC report), whereas Singer proposes 2050 (to avoid punishing countries with younger populations at present). The second concern is more serious. The per capita proposal does not take into account the fact that emissions may play very different roles in people's lives. In particular, some emissions are used to produce luxury items, whereas others are necessary for most people's survival.

91. Agarwal, Narain, and Sharma point out that "in 1996, one U.S. citizen emitted as much as . . . 19 Indians, 30 Pakistanis, 107 Bangladeshis . . . and 269 Nepalis" (Agarwal, Narain, and Sharma 1999, p. 107).

92. This is even without taking into account the historical issues. The IPCC 1995 report says: "If the total CO_2 absorption were assigned on an equal per capita basis, most developing countries are in fact 'in credit'—their cumulative emissions are smaller than the global average per capita absorption, and so on this basis their past contribution is not merely small but actually negative" (IPCC 1995, p. 94).

93. Other issues include the need, in practice, to assign the rights to countries rather than to individuals and the need for large transfers of resources from rich countries to poor. The former undermines the egalitarianism of the proposal, since governments might have other objectives; the latter may undermine its political feasibility. For discussion, see Baer 2002, pp. 402–4; and Beckerman and Pasek 2001, p. 183.

94. Singer suggests merely that it will give nations insufficient incentives to combat population growth and that this is an issue because under a fixed ceiling such growth effectively reduces other country's shares (Singer 2002, p. 40). But note that whether there is an incentive to increase population is an empirical issue, involving more than one factor: while it is true that the growing country's allocation will go up, that country will then have an extra person to look after. So, a larger population is desirable only if an extra person "costs" notably less than their emissions allotment.

2. Rights to Subsistence Emissions

This concern is the basis for the second proposal on how to allocate emissions rights. Henry Shue argues that people should have inalienable rights to the minimum emissions necessary to their survival or to some minimal quality of life.[95] This proposal has several implications. First, it suggests that there might be moral constraints on the limitation of emissions, so that establishing a global emissions ceiling will not be simply a matter for climatologists or even economists. If some emissions are deemed morally essential, then they may have to be guaranteed even if this leads to an overall allocation above the scientific optimum. Traxler is explicit as to why this is the case. Even if subsistence emissions cause harm, they can be morally excusable because "they present their potential emitters with such a hard choice between avoiding a harm today or avoiding a harm in the future" that they are morally akin to self-defense.[96] Second, the proposal suggests that actual emissions entitlements may not be equal for all individuals and may vary over time. For the benefits that can actually be drawn from a given quantity of greenhouse gas emissions vary with the existing technology, and the necessity of them depends on the available alternatives. But both vary by region, and will no doubt evolve in the future, partly in response to emissions regulation. Third, as Shue says, the guaranteed minimum principle does not imply that allocation of any remaining emissions rights above those necessary for subsistence must be made on a per capita basis. The guaranteed minimum view is distinct from a more robust egalitarian position which demands equality of a good at all levels of its consumption (Shue 1995*a*, pp. 387–88); hence, above the minimum some other criterion might be adopted.

The guaranteed minimum approach has considerable theoretical appeal. However, there are three reasons to be cautious about it. First, determining what counts as a "subsistence emission" is a difficult matter, both in theory and in practice. For example, Traxler defines subsistence

95. Shue views the "maintain an adequate minimum" requirement as a no-fault principle and so as having the advantage that no inquiry needs to be conducted to see who is to blame. (Resources are to be generated through an "ability to pay" criterion.) See Shue 1993, pp. 53–54. (Moellendorf endorses an "ability to pay" criterion as a no-fault principle, but only to the extent that the rich countries should pay 40 percent of the costs, which is equivalent to their current percentage of global emissions; see Moellendorf 2002, p. 100.) Traxler accepts Henry Shue's argument for the importance of subsistence emissions but argues that the difference between subsistence and luxury emissions is one of degree and that a fair allocation of costs would involve a "fair chore division" between nations based on their marginal costs. See below.

96. Traxler does admit that those committing the harm have an obligation to minimize the damage inflicted on others and may still owe compensation for the damage they cause (Traxler 2002, pp. 107–8).

emissions in terms of physiologically and socially necessary emissions but characterizes social necessity as "what a society needs or finds indispensable in order to survive" (Traxler 2002, p. 106). But this is problematic. For one thing, much depends on how societies define what they find "indispensable." (It is hard not to recall the first President Bush's comment, back in 1992, that "the American way of life is not up for negotiation.") For another, and perhaps more importantly, there is something procedurally odd about the proposal. For it appears to envisage that the climate change problem can be resolved by appealing to some notion of social necessity that is independent of, and not open to, moral assessment. But this seems somehow backwards. After all, several influential writers argue that part of the challenge of climate change is the deep questions it raises about how we should live and what kinds of societies we ought to have (Jamieson 1992, p. 290; and IPCC 2001*a*, 1.4; questioned by Lomborg 2001, pp. 318–22).

Second, in practice, the guaranteed approach may not differ from the per capita principle, and yet may lack the practical advantages of that approach. On the first issue, given the foregoing point, it is hard to see individuals agreeing on an equal division of basic emissions entitlements that does anything less than exhaust the maximum permissible on other (climatological and intergenerational) grounds; and easy to see them being tempted to overshoot it. Furthermore, determining an adequate minimum may turn out to be almost the same task as (*a*) deciding what an appropriate ceiling would be and then (*b*) assigning per capita rights to the emissions it allows. For *a* would also require a view about what constitutes an acceptable form of life and how many emissions are necessary to sustain it. On the second issue, the subsistence emissions proposal carries political risks that the per capita proposal does not, or at least not to the same extent. For one thing, the claim that subsistence emissions are nonnegotiable seems problematic given the first point (above) that there is nothing to stop some people claiming that almost any emission is essential to their way of life. For another, the claim that nonsubsistence emissions need not be distributed equally may lead some in developed countries to argue that what is required to satisfy the subsistence constraint is extremely minimal and that emissions above that level should be either grandfathered or else distributed on other terms favorable to those with existing fossil-fuel intensive economies. But this would mean that developing countries might be denied the opportunity to develop, without any compensation.

3. Priority to the Least Well-Off

The third proposal I wish to consider offers a different justification for departing from the per capita principle: namely, that such a departure might maximally (or at least disproportionately) benefit the least well-

off.[97] The obvious version of this argument suggests, again, that the rich countries should carry the costs of dealing with global warming, and the LDCs should be offered generous economic assistance.[98] But there are also less obvious versions, some of which may be attributable to some global warming skeptics.

The first is offered by Bjorn Lomborg. Lomborg claims that the climate change problem ultimately reduces to the question of whether to help poor inhabitants of the poor countries now or their richer descendents later. And he argues that the right answer is to help now, since the present poor are both poorer and more easily helped. Kyoto, he says, "will likely cost at least $150 billion a year, and possibly much more," whereas "just $70–80 billion a year could give all Third World inhabitants access to the basics like health, education, water and sanitation" (Lomborg 2001, p. 322).

But this argument is far from compelling. For one thing, it seems falsely to assume that helping the poor now and acting on climate change are mutually exclusive alternatives (Grubb 1995, p. 473, n. 25).[99] For another, it seems to show a giant leap of political optimism. If their past record is anything to go by, the rich countries are even less likely to contribute large sums of money to help the world's poor directly than they are to do so to combat climate change (Singer 2002, pp. 26–27).

A second kind of priority argument may underlie the present President Bush's proposal of a "greenhouse gas intensity approach," which seeks to index emissions to economic activity.[100] Bush has suggested

97. I have in mind both the Rawlsian requirement of fairness, captured in his famous Difference Principle, and the milder views of present-day "prioritarians." For the former, see Rawls 1999; for the latter, see Parfit 1997 and, for climate change in particular, Beckerman and Pasek 2001.

98. Offhand, one would expect utilitarian approaches to recommend the same thing, based on global inequalities in welfare and diminishing marginal returns to utility. But two things make the utilitarian approach difficult. The first is logistical: calculating the maximally happiness-inducing climate policy seems to be impossible; the second is ethical: the rich might claim that they have become so used to emissions-intensive lifestyles that they will suffer more from losing them than the poor will through being denied access to them and, hence, should be required to sacrifice less. Singer claims that the logistical problem can be dealt with by treating the other distributive criteria as secondary principles to utilitarianism and that there is no ethical problem since the rich have a legitimate concern, but one that can be accommodated by allowing them to buy emissions permits from the poor (Singer 2002, pp. 45–48). Beckerman and Pasek are more pessimistic (Beckerman and Pasek 1995, p. 406).

99. Lomborg himself seems to recognize the criticism at the end of his chapter (Lomborg 2001, p. 324).

100. This would give the United States a larger share of global emissions than per capita principles, since it has a large share of the global economy. Raul A. Estrada-Oyuela suggests a more complex, international "standard of efficiency for work performed approach," with different criteria for different economic sectors (Estrada-Oyuela 2002, p. 44).

reducing the amount of greenhouse gas per unit of U.S. GDP by 18 percent in ten years, saying "economic growth is the solution, not the problem" and "the United States wants to foster economic growth in the developing world, including the world's poorest nations" (Singer 2002, p. 43). Hence, he seems to appeal to a Rawlsian principle.

Peter Singer, however, claims that there are two serious problems with this argument. First, it faces a considerable burden of proof: it must show that U.S. economic activity not only makes the poor better off, but maximally so. Second, this burden cannot be met: not only do CIA figures show the United States "well above average in emissions per head it produces in proportion to per capita GDP,"[101] but "the vast majority of the goods and services that the US produces—89 per cent of them—are consumed in the US" (Singer 2002, pp. 44–45). This, Singer argues, strongly suggests that the world's poor would be better off if the majority of the economic activity the United States undertakes (with its current share of world emissions) occurred elsewhere.

4. Equalizing Marginal Costs

A final proposal superficially resembles the equal intensity principle but is advocated for very different reasons. Martino Traxler proposes a "fair chore division" which equalizes the marginal costs of those aiming to prevent climate change. Such a proposal, he claims, is politically expedient, in that it (*a*) provides each nation in the global commons with "no stronger reasons to defect from doing its (fair) share than it gives any other nation" and so (*b*) places "the most moral pressure possible on each nation to do its part" (Traxler 2002, p. 129).

Unfortunately, it is not clear that Traxler's proposal achieves the ends he sets for it. First, by itself, *a* does not seem a promising way to escape a traditional commons or prisoner's dilemma situation. What is crucial in such situations is the magnitude of the benefits of defecting relative to those of cooperating; whether the relative benefits are equally large for all players is of much less importance.[102] Second, this implies that *b* must be the crucial claim, but *b* is also dubious in this context. For Traxler explicitly rules out backward-looking considerations on practical grounds. But this means ignoring the previous emissions of the rich countries, the extent to which those emissions have effectively denied the LDCs "their share" of fossil-fuel-based development in the future, and the damages which will be disproportionately visited on the

101. It is worth noting that the "per capita" clause makes all the difference. Developed countries typically produce more GDP per unit of energy than LDCs; see Jamieson 2001, p. 295.

102. For a discussion of the commons in reference to climate change, see Gardiner 2001.

LDCs because of those emissions. So, it is hard to see why the LDCs will experience "maximum moral pressure" to comply. Third, equal marginal costs approaches are puzzling for a more theoretical reason. In general, equality of marginal welfare approaches suffer from the intuitive defect that they take no account of the overall level of welfare of each individual. Hence, under certain conditions, they might license taking large amounts from the poor (if they are so badly off anyway that changes for the worse make little difference), while leaving the rich relatively untouched (if they are so used to a life of luxury that they suffer greatly from even small losses).[103] Now, Traxler's own approach does not fall into this trap, but this is because he advocates that costs should be measured not in terms of preferences or economic performance but, rather, in terms of subsistence, near subsistence, and luxury emissions. Thus, his view is that the rich countries should have to give up all of their luxury emissions before anyone else need consider giving up subsistence and near-subsistence emissions. But this raises a new concern.[104] For in practice this means that Traxler's equal burdens proposal actually demands massive action from the rich countries before the poor countries are required to do anything at all (if indeed they ever are). And however laudable, or indeed morally right, such a course of action might be, it is hard to see it as securing the politically stable agreement that Traxler craves, or, at least, it is hard to see it as more likely to do so than the alternatives. So, the equal marginal costs approach seems to undercut its own rationale.

VIII. WHAT HAS THE WORLD DONE? THE KYOTO DEAL[105]

> This has been a disgraceful performance. It is the single worst failure of political leadership that I have seen in my lifetime. (Al Gore, quoted by Hopgood 1998, p. 199)[106]

103. This kind of point is made by Amartya Sen in a classic piece (Sen 1980).

104. One might also object that there are plenty of rich people in poor countries, and poor people in rich countries, so that it doesn't seem fair to deny some rich people (those in rich countries) their luxuries, while leaving the luxuries of others (the rich in poor countries) untouched.

105. The best guide to the Kyoto agreement is Grubb et al. 1999. Also very informative is Victor 2001. On the role played by ethical considerations in international environmental agreements in general, see Albin 2001.

106. Gore, then a U.S. senator, was criticizing the first Bush administration's performance in Rio. The subsequent irony of this remark is, perhaps, tempered by Gore's subsequent comment, early in his term as vice president, that "the minimum that is scientifically necessary [to combat global warming] far exceeds the maximum that is politically feasible" (McKibben 2001, p. 38).

> The system is made in America, and the Americans aren't part of it. (David Doniger)[107]

We have seen that there is a great deal of convergence on the issue of who has primary responsibility to act on climate change. The most defensible accounts of fairness and climate change suggest that the rich countries should bear the brunt, and perhaps even the entirety, of the costs. What, then, has the world done?

The current international effort to combat climate change has come in three main phases. The first came to fruition at the Rio Earth Summit of 1992. There, the countries of the world committed themselves to the Framework Convention on Climate Change (FCCC), which required "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system" and endorsed a principle of "common but differentiated responsibilities," according to which, the richer, industrialized nations (listed under "Annex I" in the agreement) would take the lead in cutting emissions, while the less developed countries would pursue their own development and take significant action only in the future.[108] In line with the FCCC, many of the rich countries (including the United States, European Union, Japan, Canada, Australia, New Zealand, and Norway) announced that they would voluntarily stabilize their emissions at 1990 levels by 2000.

Unfortunately, it soon became clear that merely voluntary measures were ineffective. For, as it turned out, most of those who had made declarations did nothing meaningful to try to live up to them, and their emissions continued to rise without constraint.[109] Thus, a second phase ensued. Meeting in Berlin in 1995, it was agreed that the parties should accept binding constraints on their emissions, and this was subsequently achieved in Japan in 1997, with the negotiation of the Kyoto Protocol. This agreement initially appeared to be a notable success, in that it required the Annex I countries to reduce emissions to roughly 5 percent below 1990 levels between 2008 and 2012. But it also contained two major compromises on the goal of limiting overall emissions, in that it allowed countries to count forests as sinks and to meet their commitments through buying unused capacity from others, through permit trading.

107. Doniger, a former Kyoto negotiator and director of climate programs for the Natural Resources Defense Council, is quoted by Pohl 2003.

108. Articles 2 and 3.1, FCCC. This treaty was later ratified by all the major players, including the United States.

109. The United States, e.g., posted a 12 percent increase for the decade. Only the European Union looked likely to succeed; but this was merely because, by a fortuitous coincidence, the United Kingdom and Germany posted sharp reductions in emissions for economic reasons unrelated to climate change.

The promise of Kyoto turned out to be short lived. First, it proved so difficult to thrash out the details that a subsequent meeting, in the Hague in November 2000, broke down amid angry recriminations. Second, in March 2001, the Bush administration withdrew U.S. support, effectively killing the Kyoto agreement. Or so most people thought. For, as it turned out, the U.S. withdrawal did not cause immediate collapse. Instead, during the remainder of 2001, in meetings in Bonn and Marrakesh, a third phase began in which a full agreement was negotiated, with the European Union, Russia, and Japan playing prominent roles,[110] and sent to participating governments for ratification. Many nations swiftly ratified, including the European Union, Japan, and Canada, so that, at the time of writing, the Kyoto Treaty needs only ratification by Russia to pass into international law.[111]

On the surface, then, the effort to combat global climate change looks a little bruised, but still on track. But this appearance may be deceptive. For there is good reason to think that the Kyoto Treaty is deeply flawed, both in its substance and its background assumptions (Barrett 2003; Gardiner 2004*b*). Let us begin with two substantive criticisms.

The first is that Kyoto currently does very little to limit emissions. Initial projections suggested that the Bonn-Marrakesh agreement would reduce emissions for participants by roughly 2 percent on 1990 levels, down from the 5 percent initially envisaged by the original Kyoto agreement (Ott 2001). But recent research suggests that such large concessions were made in the period from Kyoto to Marrakesh that (*a*) even full compliance by its signatories would result in an overall increase in their emissions of 9 percent above 2000 levels by the end of the first commitment period; and (*b*) if present slow economic growth persists, this would actually match or exceed projected business-as-usual emis-

110. The latter two countries won substantial concessions on their targets, and so a further weakening of the overall goal.

111. At the time of writing, the situation with Russia is unclear. President Putin promised in 2002 to have the process under way by the beginning of 2003, but by October 2003 this had still not occurred. Many commentators had initially assumed that Russia would be eager to ratify, since the economic collapse following the end of communism had reduced its own emissions and therefore appeared to give it a large surplus of permits to sell once the Kyoto targets were in place. More recently, however, some have expressed doubts about this scenario. For example, in October 2003, Andrei Illarionov, an advisor to President Putin on economic policy, was widely reported to oppose Russian participation, saying that it would "doom Russia to poverty, weakness and backwardness" (Hirsch 2003). And by December, Illarionov was reported to have said that Russia definitely would not ratify (Myers and Revkin 2003). However, accounts of the Conference of the Parties meeting in Milan suggest that other countries did not take this statement as decisive (Pew Center 2003; Earth Negotiations Bulletin 2003, p. 18). Russian reticence seems to be caused in part by the low price of its excess permits, given the United States' refusal to participate in Kyoto.

sions (Babiker et al. 2002). Coupled with emissions growth in the LDCs, this means that there will be another substantial global increase by 2012.[112] This is nothing short of astounding given that by then we will be "celebrating" twenty years since the Earth Summit (Gardiner 2004*b*).

It is worth pausing to consider potential objections to this criticism. Some would argue that, even if it achieves very little, the current agreement is to be valued either procedurally (as a necessary first step),[113] symbolically (for showing that some kind of agreement is possible),[114] geopolitically (for showing that the rest of the world can act without the United States),[115] or as simply the best that is possible under current conditions (Athanasiou and Baer 2001, 2002, p. 24). There is something to be said for these views. For the current Kyoto Protocol sets targets only for 2008–12, and these targets are intended as only the first of many rounds of abatement measures. Kyoto's enthusiasts anticipate that the level of cuts will be deepened and their coverage expanded (to include the developing countries) as subsequent targets for new periods are negotiated.[116]

Nevertheless, I remain skeptical. This is partly due to the history of climate negotiations in general, and the current U.S. energy policy in particular; and partly because I do not think future generations will see reason to thank us for symbolism rather than action. But the main reason is that there are clear ways in which the world could have done better (Gardiner 2004*b*).

This leads us to the second substantive criticism of Kyoto: that it contains no effective compliance mechanism. This criticism arises because, although the Bonn-Marrakesh agreement allows for reasonably

112. Grubb suggests that non–Annex I emissions will grow by 114 percent during the period and that (even if the United States had been included in Kyoto) this would have led to a global emissions rise of 31 percent above 1990 levels; see Grubb et al. 1999, p. 156. A recent United Nations report anticipates that developed country emissions will increase by 8 percent from 2000 to 2010 (http://www.usinfo.state.gov/topical/climate/03060501.htm, June 3, 2003).

113. For example, Eileen Claussen, the president of the Pew Center on Global Climate Change, concedes that "the protocol does not do much of anything for the atmosphere" but goes on to say that "you've got to get a framework in place before you can take more than relatively small steps" (Revkin 2002). See also Desombre 2004.

114. For example, Kate Hampton of Friends of the Earth said when the Bonn deal was made: "The Kyoto Protocol is still alive. That in itself is a triumph. But the price of success has been high. It has been heavily diluted" (Clover 2001).

115. For example, Jennifer Morgan of the World Wildlife Fund said in Bonn: "The agreement reached today is a geopolitical earthquake. Other countries have demonstrated their independence from the Bush administration on the world's most critical environmental problem" (Kettle and Brown 2001).

116. Grubb et al. 2003 is one recent, broadly optimistic, assessment.

serious punishments for those who fail to reach their targets,[117] these punishments cannot be enforced.[118] For the envisioned treaty has been set up so that countries have several ways to avoid being penalized. On the one hand, enforcement is not binding on any country that fails to ratify the amendment necessary to punish it (Barrett 2003, p. 386).[119] On the other, the penalties take the form of more demanding targets in the next decade's commitment period—but parties can take this into account when negotiating their targets for that commitment period, and in any case a country is free to exit the treaty with one year's notice, three years after the treaty has entered into force for it (FCCC, article 25).[120]

The compliance mechanisms for Kyoto are thus weak. Some would object to this, saying that they are as strong as is possible under current institutions.[121] But I argue that this is both misleading and, to some extent, irrelevant. It is misleading because other agreements have more serious, external sanctions (e.g., the Montreal Protocol on ozone depletion allows for trade sanctions), and also because matters of compliance are notoriously difficult in international relations, leading some to suggest that it is only the easy, and comparatively trivial, agreements that get made. It is somewhat irrelevant because part of what is at stake with climate change is whether we have institutions capable of responding to such global and long-term threats (Gardiner 2004*b*).

Kyoto is also flawed in its background assumptions. Consider the following three examples. First, the agreement assumes a "two track" approach, whereby an acceptable deal on climate can be made without addressing the wider issue of international justice. But this, Shue argues, represents a compound injustice to the poor nations, whose bargaining power on climate change is reduced by existing injustice (Shue 1992,

117. It allows for parties who do not meet their targets in a given period to be assigned penalties in terms of tougher targets in subsequent periods (subject to a multiple of 1.3 times the original missed amount) and to have their ability to trade emissions suspended (United Nations Framework Convention on Climate Change 2002, decision 24/CP.7, p. 75).

118. My reasons for skepticism here all have to do with the particular format of the Kyoto Treaty. But some claim that it is also true that countries cannot be forced to keep to their international agreements (Barrett 1990, p. 75).

119. Article 18 of the Kyoto Protocol requires that the enforcement of compliance rules be approved by amendment to the Protocol. But article 20 allows that such an amendment would be binding only on those parties that ratify the amendment.

120. For more extensive discussions, see Barrett 2003, pp. 384–86; and Gardiner 2004*b*.

121. For example, Doniger called it "by far the strongest environmental treaty that's ever been drafted, from the beginning to the end, from the soup of measuring emissions to the nuts of the compliance regime. . . . The parties have reached complete agreement on what's an infraction, how you decide a case and what are the penalties. That's as good as it gets in international relations" (Revkin 2001*a*).

p. 373). Furthermore, this injustice appears to be manifest, in that the treaty directly addresses only the costs of preventing future climate change and only indirectly (and minimally) addresses the costs of coping with climate change to which we are already committed (Shue 1992, p. 384).[122] Second, the Bonn-Marrakesh deal eschews enforcement mechanisms external to the climate change issue, such as trade sanctions. Given the apparent fragility of such a commitment on the part of the participant countries, this is probably disastrous. Third, Kyoto takes as its priority the issue of cost-effectiveness. As several authors point out, this tends to shift the focus of negotiations away from the important ethical issues and (paradoxically) to tend to make the agreement less, rather than more, practical.[123]

Why is Kyoto such a failure? The reasons are no doubt complex and include the political role of energy interests, confusion about scientific uncertainties and economic costs, and the inadequacies of the international system. But two further factors have also been emphasized in the literature. So, I will just mention them in closing. The first is the role of the United States, which, with 4 percent of the world's population, emits roughly 25 percent of global greenhouse gases. From the early stages, and on the most important issues, the United States effectively molded the agreement to its will, persistently objecting when other countries tried to make it stronger. But then it abandoned the treaty, seemingly repudiating even those parts on which it had previously agreed. This behavior has been heavily criticized for being seriously unethical (e.g., Brown 2002; Harris 2000*a*).[124] Indeed, Singer even goes so far as to suggest that it is so unethical that the moral case for economic sanctions against the United States (and other countries which have refused to act on climate change) is stronger than it was for apartheid South Africa, since the South African regime, horrible as it was, harmed only its own citizens, whereas the United States harms citizens of other countries.

The second reason behind Kyoto's failure is its intergenerational aspect. Most analyses describe the climate change problem in intra-

122. Kyoto allows for help with coping through its Clean Development Mechanism (CDM) and Joint Implementation (JI) programs.

123. For the first claim, see Brown (2002). Victor makes the second claim in relation to Kyoto's provisions for international permit trading, saying that "under international law . . . it is not possible to create the institutional conditions that are necessary for an international tradable permit system to operate effectively" (Victor 2001, p. xiii). Shue makes both claims in his objections to the workings of the CDM and JI (Shue, in press).

124. Harris argued in 2000 that the Clinton administration had not in fact repudiated "common but differentiated responsibilities" but merely wanted something ("virtually anything") which indicated that the LDCs would aim to limit their projected future emissions (Harris 2000*b*, p. 239).

generational, game theoretic terms, as a prisoner's dilemma (Barrett 2003, p. 368; Danielson 1993, pp. 95–96; Soroos 1997, pp. 260–61) or battle-of-the-sexes problem (Waldron 1990).[125] But I have argued that the more important dimension of climate change may be its intergenerational aspect (Gardiner 2001). Roughly speaking, the point is this. Climate change is caused primarily by fossil fuel use. Burning fossil fuels has two main consequences: on the one hand, it produces substantial benefits through the production of energy; on the other, it exposes humanity to the risk of large, and perhaps catastrophic, costs from climate change. But these costs and benefits accrue to different groups: the benefits arise primarily in the short to medium term and so are received by the present generation, but the costs fall largely in the long term, on future generations. This suggests a worrying scenario. For one thing, so long as high energy use is (or is perceived to be) strongly connected to self-interest, the present generation will have strong egoistic reasons to ignore the worst aspects of climate change. For another, this problem is iterated: it arises anew for each subsequent generation as it gains the power to decide whether or not to act. This suggests that the global warming problem has a seriously tragic structure. I have argued that it is this background fact that most readily explains the Kyoto debacle (Gardiner 2004*b*).[126]

IX. CONCLUSION

This article has been intended as something of a primer. Its aim is to encourage and facilitate wider engagement by ethicists with the issue of global climate change.[127] At the outset, I offered some general reasons why philosophers should be more interested in climate change. In closing, I would like to offer one more. I have suggested that climate change poses some difficult ethical and philosophical problems. Partly as a consequence of this, the public and political debate surrounding climate change is often simplistic, misleading, and awash with conceptual confusion. Moral philosophers should see this as a call to arms. Philosophical clarity is urgently needed. Given the importance of the problem, let us hope that the call is answered quickly.

125. A battle-of-the-sexes analysis is also briefly suggested by some remarks of Mabey et al. (1997, pp. 356–59, 409–10); and, for the specific issue of ratification of the Kyoto Protocol, by Barrett (1998, pp. 36–37). Against this, I have argued (Gardiner 2001) that the intragenerational problem is more likely a prisoner's dilemma and that we have reason to treat it as if it were if there is any doubt.

126. A theoretical analysis of the intergenerational problem is to be found in Gardiner 2003. Other intergenerational problems relevant to global warming include Derek Parfit's infamous Non-Identity Problem (Parfit 1985; Page 1999).

127. This has the paradoxical consequence that, if it succeeds, this survey will soon appear obsolete and simplistic.

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