EDITED BY
JOHN S. DRYZEK
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The Oxford Handbook *of* CLIMATE CHANGE AND SOCIETY

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OXFORD
UNIVERSITY PRESS

OXFORD
UNIVERSITY PRESS
Great Clarendon Street, Oxford OX2 6DP

Oxford University Press is a department of the University of Oxford.
It furthers the University's objective of excellence in research, scholarship,
and education by publishing worldwide in

Oxford New York

Auckland Cape Town Dar es Salaam Hong Kong Karachi
Kuala Lumpur Madrid Melbourne Mexico City Nairobi
New Delhi Shanghai Taipei Toronto

With offices in

Argentina Austria Brazil Chile Czech Republic France Greece
Guatemala Hungary Italy Japan Poland Portugal Singapore
South Korea Switzerland Thailand Turkey Ukraine Vietnam

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Published in the United States
by Oxford University Press Inc., New York

First published 2011

British Library Cataloguing in Publication Data
Data available

Library of Congress Cataloging in Publication Data
Data available

Typeset by SPI Publisher Services, Pondicherry, India
Printed in Great Britain
on acid-free paper by
CPI Antony Rowe, Chippenham, Wiltshire

ISBN 978–0–19–956660–0

1 3 5 7 9 10 8 6 4 2

Acknowledgements

The editors wish to thank all of the authors of this Handbook not only for their efforts in producing their chapters, but also for their attempts to make their approaches and arguments accessible to those in other fields, and to a broader audience. More generally, we want to express our appreciation for all of those who have taken on the issue of climate change in their disciplines, and brought a full array of approaches, frames, discourses, and tools to bear in helping us understand—and begin to respond to—the many crucial relationships between climate change and society. We received helpful suggestions and comments from an audience at a symposium at the University of Copenhagen in December 2009, thanks to Kasper Møller Hansen for making that possible. Thanks also to Richard Howarth, Daniel Bromley, Hayley Stevenson, and several anonymous reviewers for advice; and to Jeff Joyce for help with the cover image.

Our editor at Oxford University Press, Dominic Byatt, supported the idea of this Handbook from the very beginning, and helped with every step of the way thereafter. Also at OUP, Lizzy Suffling and Sarah Parker were exemplary in their attention to detail.

Finally, we must acknowledge the recent loss of one of the best exemplars of interdisciplinary understanding, public communication, and broad passion on the issue of climate change, Professor Stephen Schneider. His wide array of talents are needed now more than ever, and while he is already sorely missed, the best tribute to his work will be the expanded efforts of others dedicated to seeing his mission through.

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Contents

PART IV: SOCIAL IMPACTS

PART V: SECURITY

PART VI: JUSTICE

PART VII: PUBLICS AND MOVEMENTS

PART VIII: GOVERNMENT RESPONSES

PART IX: POLICY INSTRUMENTS

PART X: PRODUCERS AND CONSUMERS

PART XI: GLOBAL GOVERNANCE

PART XII: RECONSTRUCTION

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PART I

INTRODUCTION

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CHAPTER 1

CLIMATE CHANGE AND SOCIETY: APPROACHES AND RESPONSES

JOHN S. DRYZEK, RICHARD B. NORGAARD, AND DAVID SCHLOSBERG

Climate change presents perhaps the most profound challenge ever to have confronted human social, political, and economic systems. The stakes are massive, the risks and uncertainties severe, the economics controversial, the science besieged, the politics bitter and complicated, the psychology puzzling, the impacts devastating, the interactions with other environmental and non-environmental issues running in many directions. The social problem-solving mechanisms we currently possess were not designed, and have not evolved, to cope with anything like an interlinked set of problems of this severity, scale, and complexity. There are no precedents. So far, we have failed to address the challenge adequately. Problems will continue to manifest themselves—both as we try to prevent and as we try to adapt to the consequences of climate change—so human systems will have to learn how better to respond. One of the central social, political, and economic questions of the century is: how then do we act?

In this Handbook we have brought together a representation of the best scholars on climate change and society. We identified the key approaches and selected authors to represent and engage with their literatures in a manner that would be informative and interesting to scholars in other areas and to newcomers as well. We have encouraged authors to make linkages between approaches and to other chapters. We hope the Handbook will contribute to the integration of understanding needed to tackle so systemic and complex a problem as the relationship between climate change and society. At the same time, the Handbook is by no means a synthesis, nor does it provide a unified diagnosis of what is wrong (and right) with contemporary human systems, an integrated and coherent program for research, or a singular blueprint for collective action. While we have views of our own on such questions, some of which will come through in this introductory chapter, there is no unified line followed by our authors as they address the complex relationship between people, societies, and the natural world. Most (not all) agree on the magnitude and

severity of the problems. But there are substantial differences when it comes to identifying what matters, what is wrong, what is right, how it got to be that way, who is responsible, and, not least, what should be done.

Commissioning, reading, and editing these contributions has left us acutely aware of the limitations of human knowledge—and the major constraints on intelligent human action—when it comes to complex social-ecological systems. Climate change is, as Steffen explains in his opening chapter, a truly diabolical problem. It is additionally devilish in the mismatch between human capacities to act and the scale, scope, and immediacy of collective action seemingly demanded. Nevertheless we have to start somewhere, and we have aspired in this Handbook to commission and compile the best available set of intellectual resources for the multiple tasks ahead. Given the complexity of what we face, no single volume can offer commentary on absolutely everything that is needed. Yet we have aspired to a measure of comprehensiveness in addressing the range of ways climate change plays out in the social realm.

Our main task is, then, to lay out the various ways that climate change affects society, and what society might do in response. The authors represent a variety of disciplinary understandings and intellectual frameworks that can be brought to bear. In this chapter we introduce the key topics, themes, layers, and issues, before concluding with a discussion of our chosen structure. We begin with the science that first identified climate change as a problem, and how it is received by and in society and government.

1 Science and Society

While the effects of climate change—floods, drought, heat stress, species loss, and ecological change—can be experienced very directly, their conceptualization as connected phenomena with common causes is due to climate science, which therefore plays a very basic part when it comes to climate change and society. Natural scientists (such as Steffen in his chapter) tell us that there is now consensus in the climate science community about the reality of climate change, and near consensus on its severity and the broad range of attendant harms and risks. But that consensus does not of course mean the science is then accepted as the basis for policy. Climate science does not provide certain future projections of risks and damages. The projections are entangled in assumptions about how human systems respond over time—as well as natural ones. Climate is an outcome of a complex geo-atmospheric-ecological system, and complex systems always have a capacity to surprise by behaving in unanticipated ways. Climate change, furthermore, is only one of a range of interacting phenomena of global environmental change caused or affected by human activity. We may indeed be entering the unknown territory of an 'anthropocene' era where people drive truly major changes in global systems. Thus while the broad sweep of history shows climate change being taken ever more seriously as an issue within the scientific community and eventually far beyond (see Weart's chapter), we are dealing with complex processes with uncertain outcomes rather than simple facts, and the public and politicians have difficulty seeing the drivers to collective action in any simple way. The agendas of climate science are now affected by larger social and political processes (see the

chapter by von Storch et al.). Thus scientific findings and their action implications must seek validation not just within the scientific community itself, but also within the larger society, and different political systems have different means for validation (see Jasanoff's chapter).

But even getting to the point of taking science seriously can be difficult. The Intergovernmental Panel on Climate Change (IPCC) famously uses language seeped in uncertainty to qualify its predictions (likely, very likely, virtually certain, etc.), and there are a few dissenting scientists who claim there is little evidence of major and imminent climate change. As Dunlap and McCright discuss in their chapter, a thoroughly organized campaign has successfully used such scientific uncertainty to create political uncertainty, with those who fund the case against the reality of climate change having a massive stake in the fossil fuel economy. Skepticism is in some countries joined to a right-wing ideology such that, because climate change requires coordinated collective action of the kind that is anathema in this ideology, climate change should not exist. More insidiously, skepticism may also give the impression that it is empowering ordinary people to be able to question the assertions of a scientific elite. Any lapses in the practice and content of this science (of the sort alleged but unproven in the stolen e-mails from the University of East Anglia in 2009, and the admission of a mistaken claim about the rate of melting of Himalayan glaciers in an IPCC report) are seized upon by these ideologists to discredit climate science in its totality. The media, looking for 'balance' amid controversy, gives as much airtime to skeptics as it does to climate scientists and others who point to the reality and scale of change (Boykoff and Boykoff 2004). Science moves to the center of political controversy, and scientists respond in varied ways (Schneider 2009).

Unsurprisingly, scientists feel harassed by the attacks of organized skeptics and denialists. To the extent scientists respond with further insistence on the consensus within the scientific community about the veracity of their claims, the more they play into their critics' hands. The net result is that science enters a spiral of politicization. Scientists themselves in many cases cannot avoid becoming political actors, as they fight for the credibility of what they do in the larger public arena. Not surprisingly, they can and do make many false steps in this arena, and much can be done to improve the communication of science to the public (see Moser and Dilling in this volume). They are also faced with the quandary over whether to admit to uncertainties in the range of their own findings—and so leave themselves open to critics who discredit the scientists' lack of confidence—or to claim certainty greater than that actually warranted by these findings. Admission of a degree of uncertainty is the norm among colleagues, but fodder for skeptics. One thing we do know is that simply insisting on the rightful authority of science as the guide to action has failed. But the natural sciences are not the only politicized disciplines.

2 From Science to Economics

What do scientific findings mean in human terms? An answer is given by economics, which can attach cost estimates to the current impacts and projections of future impacts of climate change. One such set of estimates is provided in the chapter by Mendelsohn, who comes up

with relatively low estimates, with costs concentrated among the rural poor in developing countries. Economists such as Nicholas Stern in his famous 2006 report to the government of the United Kingdom come up with much higher estimates. A lot turns on seemingly technical factors such as the rate of discount used to calculate a present value for future costs. Depending on the discount rate chosen, we can end up with massive differences in the size of the present value of future costs, and so radically different implications for climate policy. The choice of discount rate turns out to be a major ethical issue, not just a technical economic matter (see the chapters by Howarth and R. Norgaard). Further contestation arises once we move beyond the confines of standard economic analysis to contemplate other ethical issues (Dietz's chapter), pertaining (for example) to basic human needs, and the distribution of burdens and benefits of action and inaction across rich and poor, within and across national boundaries, as well as between generations. Sagoff argues in his chapter that the asymmetry of burdens and benefits across generations means that economic thinking should not be at the core of climate policy analysis.

Once we get past controversies over cost estimates and distributions, economics also provides a powerful set of analytics for thinking about the choice of policy instruments to achieve the desired level of mitigation (expressed in terms of targets and timetables for total greenhouse gas emissions). The consensus among economists—at least those steeped in the neoclassical paradigm that dominates the discipline—is that market-based instruments are the most efficient, and in particular emissions trading or cap-and-trade (see the chapter by Harrison et al.). Governments have begun to experiment with such schemes, established for some time in connection with non-greenhouse pollutants such as sulfur dioxide in the United States, more recently extended to greenhouse gases and CO_2 in particular, especially in the European Union (see the chapter by Jordan et al.). Emissions trading requires that some authority sets a cap on total emissions, then issues permits for quantities that add up to that cap. These permits can then be traded, such that companies for which reducing pollution is expensive can buy permits from those for which reductions are cheaper. The economic theory is very clear, but the politics and policy making is much murkier. Even before we get to monitoring and compliance, polluters with sufficient political power will demand exemptions and/or free permits for themselves. So when emissions trading schemes are proposed or introduced, it is common to find whole economic sectors exempted (for example, agriculture in Australia), or established dirty industries (for example, coal-burning electricity generators) favored at the expense of more efficient but less established competitors (see Spash's chapter).

These real-world politics notwithstanding, market discourse is increasingly pervasive and powerful. It informs many discussions of national policy instruments, and extends to global policy and emissions trading across national boundaries. The discourse affects the content of global governance arrangements, which can even be privatized as carbon traders seek to escape international governmental authority (see Paterson's chapter). Market logic extends too to offsets, whereby polluters can compensate for their greenhouse gas emissions by paying somebody else, for example, to plant trees that will absorb an equal quantity of emissions. What actually happens at ground level in countries where there is weak monitoring capacity is another matter entirely. Unlike conventional markets where one party of the transaction can complain, or at least never transact with the other party again, both parties in offset transactions have every incentive to give misleading information to the public on the real number of trees planted and their actual effectiveness in

offsetting climate impacts. Again, complexity rules. But whatever their consequences for mitigation, new kinds of climate markets present many opportunities for traders to become wealthy, becoming a constituency pushing for further marketization (see Spash's chapter).

National governments are embedded in market economies that constrain what they can do, and the social realm is often limited by economistic frames and discourse. However, markets are not necessarily just a source of constraint. Markets are made up of producers and consumers who might themselves change their behavior in ways that reduce emissions. The most important producers here are large corporations. Why might they change their ways? In part, if they thought the world was moving in a low-carbon direction (whether by choice or necessity), positioning themselves to take advantage of this shift might be profitable. Of course this positioning would need to be more than the kind of rhetoric that enabled (for example) BP to market itself as 'Beyond Petroleum'—at least until an oil spill in the Gulf of Mexico in 2010 exposed a range of problems in its public relations approach (in addition to its safety practices). While there may be money to be made in producing goods for a low-greenhouse gas economy, the problem is that currently there is much more money to be made in climate-unfriendly activities. Corporate responses to the challenge of climate change have been highly variable (see Pulver's chapter), and there is little reason to suppose a significant number of corporations will play a leadership role if governments do not. The only corporations that do have a clear financial incentive to take the risks of climate change very seriously are insurance companies. This is especially true of the big reinsurance companies with potentially high exposure to damages caused by extreme weather events. The high hopes once vested in insurance companies by some analysts (Tucker 1997) on this score seem so far to have produced little in the way of comprehensive action.

A decarbonizing economy would of course have to involve changes in patterns of consumption, whether induced by government policy and price increases, or chosen by consumers through changing mores. Such basic individual and broad cultural changes that affect consumption have been promoted by a variety of social movements, religious actors, and celebrities. Many environmental organizations focus on consumer behavior—from the individual level up to the decarbonization and transition of towns and regions—both as a source of direct change and as a clear economic and political statement. The 'green governmentality' identified by Lipschutz and McKendry in their chapter would help mold citizens of a new ecological order, whose consumption demands could look quite different from those characteristic of industrial society. However, as Szasz points out in his chapter, consumption choices are limited by the social-economic structure, which conditions the range of easy options that individual consumers have. Luke also insists we understand the dangers of such forms of such behavioral control, even if it does look green. At any rate, changing consumer habits are no substitute for coordinated collective action.

3 The Public Realm, and its Problems

In a world where the legitimacy of public policies and other collective actions rests in large measure on the democratic credentials of the processes of their production, it matters a great deal what publics think, and what actions they consequently support, or are willing to

undertake themselves. Initially, many climate scientists, policy makers, and activists thought that the key here was simply getting publics to understand the facts by providing information (the point behind Al Gore's 2006 documentary film *An Inconvenient Truth*, for example). Yet as Moser and Dilling point out in their chapter, just providing information normally has little impact on behavior. And trying to instill fear in publics about possible impacts often turns out to be counter-productive, as people switch off. Most people get their information via the media, but as already noted there are structural features of mainstream media (the reporting only of controversy, which requires two opposing sides) that are problematic when it comes to communicating climate change. Face-to-face dialogue might work much better in terms of prompting people to think through the issues seriously; but that is extraordinarily hard to organize on any scale involving more than a handful of people. Thus there remain many failures in public cognition of the complex phenomena attending climate change (see Jamieson's chapter). Public opinion polls often show that people do care, and do want something to be done (see Nisbet's chapter); but there is no necessary urgency. In practice, many issues of more immediate concern (and which impose far fewer burdens of cognition) trump climate change when it comes to (for example) voting behavior.

Interlinked psychological, social, cultural, and political-economic processes can lead even those who in the abstract accept the need for action to in practice come to believe that they personally—or even the society in which they live—have no need to do anything that will impose any major disruptions on their own lives (see the chapter by K. Norgaard). Information, scientific or otherwise, is often processed through the lens of existing beliefs formulated in areas of life remote from climate science. Those beliefs can be very powerful, for better or for worse. Religious beliefs are particularly important in this respect (see Kearns's chapter). Sometimes religious beliefs line up on the side of ideological skepticism of the kind we have already noted; but sometimes these beliefs can join with the need for action (as in the 'creation care' movement among US evangelical Christians).

Publics should not however be understood as simply *mass* publics, which are problematic when it comes to mastering complex issues simply by virtue of their mass nature. A public can also be a *concerned* public organized around an issue; Nisbet in his chapter estimates the concerned 'issue public' on climate change to constitute around 15 percent of Americans—quite high in comparison to other political issues. Publics of this sort can be found at many levels: local, national, transnational, and global. They are organized in many different ways, ranging from community groups to the translocal solidarity identified by Routledge in his chapter to global networks of activists depicted by Lipschutz and McKendry in their chapter. They also demand a range of behavioral and policy changes, from a radical transition to a post-carbon lifestyle to basic democratic demands for more public participation in decision making. Concerned publics almost by definition are geared for action in the way mass publics most of the time are not. But the extent of their influence in the face of structural political forces and powerful recalcitrant actors remains highly uncertain. Publics are often vocal and visible—for example, at meetings of the Conference of the Parties (COPs) of the United Nations Framework Convention on Climate Change (UNFCCC), or at local city council meetings, but that does not mean they are decisive. And yet, in the face of the intransigence of many governments, such non-governmental publics continue to provide ideas, energy, and pressure necessary to respond to climate change.

4 Justice and Vulnerability

Increasingly, concerned publics advance a discourse of climate justice. The political philosopher John Rawls (1971) once famously proclaimed that justice should be the first virtue of social institutions. Itself disputable, that ideal remains a distant aspiration when it comes to climate change. Considerations of justice have often been marginalized in favor of economic efficiency and aggregate welfare in public policies and intergovernmental negotiations. Yet climate justice does inform policy debates and positions taken in negotiations, as well as political activism.

The debate around climate justice has revived an argument within justice theory about the adequacy of proposing principles for ideal situations of the kind Rawls himself proposed. The alternative task for theory involves addressing major pressing and concrete social and political problems, concerning human rights, poverty, and now the changing climate. Increasingly, justice frameworks are being used in the development of climate policy strategies.

The fact is that existing vulnerabilities will be exacerbated by climate change. The costs of climate change and the unintended effects of some policy responses to it will not be evenly distributed, and we need, at the outset, some way to measure the vulnerabilities to be experienced in such an unequal way (see Polsky and Eakin's chapter). Many of the direct costs of climate change itself will, as Mendelsohn points out in his chapter, be felt by the poor in developing countries. Those costs are sufficiently severe to undermine human security in terms of rights and basic needs (see Barnett's chapter). Climate change can have many substantial direct impacts on human health, and many secondary impacts if health problems undermine the adaptive capacity of social systems (see Hanna's chapter). Many indigenous communities, already living on the margins, are particularly vulnerable (see Figueroa's chapter). Many initiatives done for the sake of global mitigation—such as biofuels and offsets—have negative impacts on the well-being of the rural poor in developing countries by taking land away from food production. These people are of course those with the least political power in global politics in general, and when it comes to climate change in particular. They may have justice on their side, but that alone will not give them an effective voice.

Environmental ethicists and climate justice theorists have examined the moral challenges that attend climate change, and what ought to be done in response. Beyond the science, the economic arguments, the policy differences, and the actions and frames of the various actors in the climate change drama, lies a normative dimension of the crisis. Emerging norms of justice may play a number of roles in regulating the relationships of the whole range of human actors as they confront climate change. As Gardiner in his chapter summarizes, questions of justice concern the procedures around which decisions are made, the unfairness of the distribution of existing vulnerabilities to climate change and the fair distribution of benefits and burdens in the present and near future (see also Baer's chapter), the extent and nature of our obligations to both those within and outside our own country (international or cosmopolitan justice), responsibility to future generations (or intergenerational justice—see Howarth's chapter), and even the potential injustice done to nature itself.

The discourse of climate justice increasingly pervades questions of global governance of climate change. For example, the concept of international justice takes nations as its basic unit of ethical considerability—and as such, national governments can deploy this discourse when it suits their interests to do so. So developing countries can point to the history of fossil fuel use on which developed countries built their economies, such that fairness demands that it is the developing countries that should shoulder the burden of mitigation. The response on the part of the wealthy countries is that for most of this history, their governments had no awareness that what they were doing could change the climate, and so ought not to be held uniquely responsible for future mitigation. This kind of response can be augmented by reference to the huge numbers of rich consumers in China, India, and Brazil who can have their own profligate lifestyles protected so long as justice is conceptualized in inter*national* terms—'hiding behind the poor'. Effective global action on mitigation could benefit from taking a more cosmopolitan approach to justice, one in which people rather than nations are the subjects of moral considerability and responsibility (see discussions in chapters by Harris, Baer, and Gardiner). Here, obligations of justice surpass those owed only to those in our own country. Given global climate change, such nationalist limits begin to look irrelevant—as our individual actions affect people outside our own nations, our obligations exceed those borders as well. In this light, rich consumers in China have a global climate responsibility equal to that of rich consumers in the United States. Pragmatically, as Harris points out, if it introduced measures to restrict the emissions of its own rich, China would then have more credibility in international negotiations when it asked the US cut its emissions. This is just one example of how ethical considerations could have real practical importance. The larger point is that while the discourse of climate justice can be put in the service of those most vulnerable to the effects of climate change, it can also facilitate resolution of collective problems.

5 Governments

Negotiating a context defined by concerned publics, experts, lobbyists, and structural limits on what they can do, governments can choose to act on climate issues. Some of them already do. Dealing with major climate change issues has however never been a part of the core priorities of any government. Of course environmental policy has been a staple of government activity (especially in developed countries) since the 1960s. But it remains the case that the environment is not core business in the same way that the economy is. Governments acted swiftly and with the expenditure of vast sums of money in response to global financial crisis in 2008–9. They have never shown anything like this urgency or willingness to spend on any environmental issue. The difference is easily explained: the first concern of any government in a market economy is always to maintain the conditions for economic growth, which normally also means maintaining the confidence of markets in the government's own operations (Lindblom 1982). The second concern of most governments in developed countries has been to operate and finance a welfare state (see Gough and Meadowcroft's chapter), which itself is predicated upon continued economic growth. The core security imperative of government—protection against external threats—has

receded with the increasing rarity of war between states, but remains important. Failure on one of these core priorities has the potential for swift catastrophe for any government, be it in terms of fiscal crisis and punishment by voters at the polls, or (in the case of security) erosion or even loss of sovereignty. Failure when it comes to climate change, where the risks, burdens, and benefits are distributed in complex fashion across space and time, does not yet mean anything at all comparable in the immediacy of its consequences for government.

While none of them performs adequately, some national governments do perform better when it comes to climate policy than others, though this variation is not easily explained (see Christoff and Eckersley's chapter). Historically the 'coordinated market economies' of northern Europe, accompanied by political systems that work on the basis of consensus rather than majority rule, have on most indicators done better when it comes to environmental performance in general than their more liberal counterparts in the Anglo-American countries, and that is reflected in climate policies. The surprising development here is that the UK has shown signs of trying to break the mold. In stark contrast to its counterparts in the United States and Australia, the leadership of the Conservative Party in the UK has decided to try to appeal to green voters. In the face of the failure—or in the US in the 2000s the blatant refusal—of national governments to substantively address the issue, subnational governments (US states such as California, regions, cities, and localities) have in many cases adopted policies to reduce emissions of greenhouse gases (see the chapter by Bulkeley). However, while insisting on the importance of subnational action, even its most ardent enthusiasts would not see it as a substitute for effective national (and international) policy action. The multi-leveled generation of the problem, and the sting of its impacts, demand multi-level governance (see Farber's chapter).

To date, very few national governments look at all like decarbonizing their economy, or redesigning energy systems to reverse growth in energy consumption (see the chapters by Diesendorf and Christoff/Eckersley). While countries like the UK, Iceland, Denmark, Spain, and Portugal have taken significant steps to increase conservation and the generation of carbon-free energy, they are still below 30 percent clean energy generation, and economic downturn may impede future progress. China deserves watching closely in these terms, because of the size and growth of its proportion of global emissions, its vulnerability to the effects of climate change, and uncertainty about the kind of political-economic development trajectory that it could take in future. Despite its seeming refusal to countenance any infringement on its sovereignty of the sort that agreeing as part of a global process to cut its emissions would connote, China could decide to make substantial unilateral cuts (see Schreurs's chapter). Chinese policy for the moment remains dominated by the economic growth imperative, but some of those exasperated by the kind of stalemate so common in liberal democratic states think that Chinese style authoritarianism might be capable of more decisive action. However, actually implementing such decisions amid complex circumstances may prove beyond the capacity of authoritarianism,

In the context of the UNFCCC, the G77 group of countries claimed a voice for the developing world in general (see Kartha's chapter). However, when it came to the Copenhagen Accord, China dropped the G77 for which it had been a spokesman in favor of a G2 deal with the United States. The governments that compose the G77 generally stress their right to very conventional forms of economic growth that may themselves do little for their rural poor. So state-based action does not exhaust the possibilities for the most vulnerable,

which might also include (for example) building translocal solidarities as described in Routledge's chapter, or mobilizing collectively to resist damaging outside initiatives.

What could induce national governments to do better? Aside from international agreements (of which more shortly), there is some scope for reframing climate issues in ways that would make effective national government action more likely. That reframing might involve recognition of the security dimension of climate change. Climate change can, as Gilman et al. point out in their chapter, threaten the security of populations and vital systems, even in some cases threaten the sovereign integrity of states (if for example there are catastrophes on their borders). Conceptualizing energy security as energy independence may also be helpful, as it would mean freedom from reliance on unstable and/or authoritarian foreign countries. Security could also refer to the basic security of human needs, as argued by Barnett in his chapter. The 'securitization' of climate issues also has its critics, such as Doyle and Chaturvedi, who in their chapter criticize the concept of 'climate refugees' for its construction of vulnerable people as security threats. A security framing does mean emphasizing threat and so fear, in a way that Moser and Dilling in their chapter have identified as problematic in moving public opinion. And as a comprehensive frame for climate issues, it probably makes most sense for the United States—a global superpower with security interests in all parts of the world that could therefore be affected by impacts of climate change that are only locally catastrophic. Yet such a frame failed to help the US develop a climate policy, despite being invoked (if weakly) by the Obama administration both before COP-15 in 2009, and after the BP oil spill in the Gulf of Mexico in 2010.

Another possible reframing might involve more widespread adoption of a discourse of ecological modernization, which puts economic growth and environmental protection in a mutually reinforcing, positive-sum relationship—rather than their traditional zero-sum conflict. In this light, mitigation might actually be an economically profitable option. This particular reframing has been adopted most extensively in the coordinated market economies of northern Europe (and Japan), and as Hajer and Versteeg point out in their chapter, can now also be found very prominently in international negotiations on climate change. But as they also note, there can be a large gap between discourse structuration and discourse institutionalization, where the discourse adopted actually conditions the content of public policies. A more radical reframing would see national governments adopting resilience rather than economic growth as their core priority (see the chapter by Adger et al.); but that is a more distant prospect, as it would involve a wholly new imperative, rather than modification of existing imperatives.

Despite the reframings that have occurred, they have not yet led to the broad type of action necessary to avoid large-scale climate change and deal with its growing impacts.

6 Global Action (and Inaction)

Neither coordinated collective action nor discursive reframings can stop at the national level. Climate change involves a complex global set of both causal practices and felt impacts, and as such requires coherent global action—or, at a minimum, coordination across some critical mass of global players. Without such coordination, there is substantial

incentive for every player to seek to impose the burdens of mitigation on others, while seeking to take as free a ride as possible on their efforts. Enough players doing this will of course result in little in the way of effective action. Such is the status quo.

The United Nations Framework Convention on Climate Change was established in 1992 to organize negotiations that eventually involved just about all the world's states. In 1997 the Kyoto protocol seemed to commit many of the World's developed countries—the 'Annex One' states—to reductions in the absolute level of greenhouse gases that they emitted by 5.2 percent overall by 2012, in relation to a baseline of 1990. But Kyoto failed to deliver much in the way of actual reductions. The world's largest emitter, the United States, did not ratify the agreement, which imposed no obligations at all on developing countries. So at the time of writing, the world's two largest economies and largest emitters, the USA and China, are not covered by Kyoto. These are also two of the states that cling most tightly to a notion of sovereignty that cannot be diminished by global governance. Even those states that did ratify the Protocol generally fell far short of the commitments they had registered. After Kyoto the UNFCCC process made its torturous way forward, with expectations centered on the 15th Conference of the Parties (COP-15) in Copenhagen in 2009, when representatives of 190 states gathered. What happened at the eleventh hour in Copenhagen was that G190 was supplanted by G2. China and the United States, two of the most problematic participants in the prior negotiations and when it comes to the very idea of global governance in general, produced a Copenhagen Accord with no binding targets for anyone and no enforcement mechanism for the weak targets that were proclaimed. While most countries agreed to take note of the Accord, few did so with any enthusiasm, or with any intention to do anything much in consequence.

This Handbook goes to press in the shadow of the disappointing outcome of COP-15. Our authors disagree about the best response to this kind of disappointment, and the very weak international climate regime that it leaves in place. Biermann suggests a number of ways to strengthen the regime, including the establishment of a World Environment Organization on a par with the World Trade Organization, a strengthening (rather than abandonment) of the UNFCCC itself, and a stronger institutionalized role for civil society organizations (many of which push for stronger action on the international stage). Young suggests institutionalization of fairness principles of a sort that would induce more serious participation from China and key developing countries. Harris suggests that a cosmopolitan interpretation of fairness might be a circuit-breaker in international negotiations because it would enable China to demonstrate that it sought to impose burdens of mitigation on its own wealthy citizens. China would then have more credibility when it demanded that developed nations commit to more effective emissions reductions. Young also suggests more attention to intersections with other regimes (such as that for international trade) in a way that would induce more mitigation, and perhaps an enhanced role for effective minilateralism—negotiation among a small number of key parties. While at first glance this looks exclusive, that could be ameliorated to the degree representatives of those likely to suffer most from climate change are also at the table. Baber and Bartlett suggest that a common law approach to the establishment of international environmental norms may be just as productive as negotiation of international treaties—though the time scale on which any such bottom-up approach could work makes that insufficient in and of itself.

While these and other ideas for its improvement are being canvassed, Paterson in his chapter points out that what is happening in practice is that the international climate

regime is being marketized. Whether in the context of internationally agreed targets and timetables or outside such agreements, emissions trading and offsets grow in prominence, to the point they are poised to dominate global climate governance. This may well continue whether or not such use of markets is ultimately effective in containing climate change.

Analysis of the global climate regime might focus on particular deficiencies and proposals for reform, but it is also worth taking a step back to consider the whole idea of a comprehensive, inclusive, negotiated, global approach to climate change mitigation. Perhaps that is asking more than the international system is capable of delivering. Comprehensive self-transformation of the basic parameters of the international system has only ever been negotiated in the wake of total war: the Treaty of Westphalia in 1648, the Congress of Vienna in 1815, the Versailles settlement in 1919, Bretton Woods in 1945. The first three of these concerned only security; the fourth added economics. While comparisons are sometimes made between climate change and war (e.g. Lovelock 2010), there is no total war-like catastrophe to spur global action; and even if there were, there is no obvious mechanism to ensure that mitigation would be at the top of the agenda.

Perhaps we need to think in very different terms about the coordination of a global response. Such terms would recognize the inherent complexity of multi-level governance in the global system, and the multiple points of leverage. It would involve attending to the roles that stakeholder communities, shared norms, evolving discourses, local practices, and regional agreements, could play—while not necessarily renouncing global negotiation in its entirety. This sort of thinking has barely begun (but see Bäckstrand's chapter). The problem is that the pace at which the mechanisms it identifies could change and take effect in positive fashion may be too slow to match the pace at which climate change is arriving. In addition, governance mechanisms need to be anticipatory rather than reactive when it comes to future change. Governments are not used to acting in this kind of way; nor do more diffuse governance mechanisms necessarily compensate.

7 Organization of this Handbook

The complexity of the issues of climate change and society means that an element of arbitrariness is inescapable when breaking down the whole into component areas of scholarship, and then ordering those areas. The interconnections are many and strong. There are few independent subsystems of scholarship with significant findings that stand on their own. Responding effectively to the challenges of climate change will require coordination of efforts across different ways of looking at the problems. Understanding all the social dimensions of climate change requires us to embrace these complexities and interrelationships. Nevertheless, publishing the contributions between covers requires putting them in a linear order. We have chosen to do as follows.

Part II, 'The Challenge and its History,' lays out the key challenges climate change presents, and how matters got to be that way. Complexity means that a range of perspectives and discourses can be brought to bear (in both the history of climate change and the rest of this Handbook). The climb up the scientific agenda took place over a century. The climb up the political agenda was slow, but eventually reached a point where climate

change became the archetypical environmental problem. These ascents have been accompanied by changing conceptualizations of climate and the way it plays into social, political, and economic discourses that condition the responses of actors and institutions. The impact of those discourses now itself merits critical scrutiny.

Natural science is obviously central when it comes to understanding climate change and responding to it, but the relationship of the science to society and public opinion as addressed in Part III, 'Science, Society, and Public Opinion,' proves problematic. The natural sciences themselves need to understand the complex relationship between 'pure' science and the way that scientific agendas interact with society at large. Knowledge claims are processed in politically variable ways. In the face of organized skepticism, conventional ways of communicating science to the public have come unstuck. We know what does not work when it comes to communicating climate change; we know much less about what does work.

Part IV turns to 'Social Impacts.' Economists have devoted a great deal of effort to estimating the present and likely future costs of climate change. Some economists (represented here by Mendelsohn) reach modest estimates. Much turns not just on technical matters such as choice of a discount rate, but also on what kind of economic paradigm ought to be applied. Even economists who reach relatively small estimates of total costs recognize that particular vulnerable populations such as the rural poor in developing countries and indigenous peoples living in ecosystems at the margins of industrial society may be hit hardest, be it in terms of health, livelihood, or culture. So costs need to be understood not only in economic terms, but also in broader social and cultural terms.

Many of the negative social impacts of climate change (and of adaptive responses to it) will be felt in the form of an undermining of the 'Security' of nations and peoples, and these issues are addressed in Part V. In one sense, it is a matter of the security of collectivities such as nations, populations, and the social and economic systems that support them. Security concerns therefore range from national security to basic human needs. The securitization of climate change and the very use of categories such as 'climate refugees' also have their critics.

Threats to human security are just one kind of social justice issue that arises in connection with climate change; a range of issues is covered in Part VI, 'Justice.' These issues include the distribution of benefits and burdens across nations and, perhaps more fundamentally, across people, but climate justice also entails issues of basic needs, procedures, corrective justice, and the nature of the obligation of those living in the present to future generations. Justice is in part a matter for philosophical analysis, but can also be used to challenge utilitarian economic analysis, influence international policy discourse, and rally social movements.

Such movements are just one kind of relevant public. The range of 'Publics and Movements' is addressed in Part VII. At an aggregate level public opinion exists in terms of percentages of people concerned about or willing to respond to climate change. Only the most engaged participate in movements, which can be organized locally, nationally, and globally, and in networks transcending these levels. The impact of movements in promoting cultural change may however be blunted by psychological and sociological denial mechanisms. Opinion and activism on climate change do not exist in isolation, but are also affected by factors such as economic interests and religious beliefs.

Responding more or—more often—less effectively to concerns raised by publics and movements, the actions of governments do of course matter a great deal, and are the subject of Part VIII, 'Government Responses.' Performance currently varies substantially across different countries. The case of China gets special treatment, because of the size and growth of its economy, its authoritarian response to climate issues, and its potentially massive international impact. In an era of multi-level governance, responsibility for action is going to be shared across different levels, subnational, regional, local, national, and international. The way states are currently organized to facilitate economic growth and, at least in most developed countries, provide social welfare constrains the possibilities for effective action on climate change, and the positions governments can adopt and targets to which they can commit in international negotiations. From the perspective of the governments of the Global South, without developed welfare states and without the history of growth that made them possible, matters look very different indeed.

The 'Policy Instruments' governments can deploy to meet their obligations are analyzed in Part IX. Market-based instruments, especially cap-and-trade, offsets, and carbon taxes, are especially prominent in the recommendations of economists, and in some cases the actions of governments. The most extensive experience with such instruments when it comes to climate change is in Europe, so that experience receives special attention. The redesign of energy systems is high on the list of possible policy initiatives.

'Producers and Consumers,' the subjects of Part X, can both respond to the policy instruments of government and take actions on their own initiative in the context of climate change. Our authors examine the role of corporations and consumers in both impeding and facilitating action against climate change.

Public and movements, national and subnational governments, producers and consumers all have roles to play in climate change mitigation and adaptation, but much still turns on what happens at the global level. Especially after the frustrations and failures evident in UN-based negotiations, rethinking 'Global Governance,' is central, and the topic of Part XI. Our authors look at the problematic history and performance of such governance, the lessons we might draw from existing global regimes, the moral foundations of alternative institutional arrangements, and the role of international law.

Finally, Part XII, 'Reconstruction,' contemplates the reworking of political, economic, and social arrangements as we adapt to the reality of coming climate change. The emphasis is on new forms of governance (especially at the global level), and more resilient social-ecological systems. After all of the challenges, opinions, impacts, actors, and responses, the task, of course, is to look forward to adaptation, transition, and rebuilding a society immersed in climate change.

8 Conclusion

The broad scope of this Handbook encompasses a range of issues and approaches beyond the basic science of climate change, from the philosophical to the political, from the psychological to the sociological, from the historical to the geographical, from the economic to the legal. On how science is disseminated, on how we assign economic value, on how

states negotiate and govern, on the meaning of justice, and on the experience of those affected by climate change, we see contested concepts, frames, meanings, and responses.

As we said at the outset, climate change presents perhaps the most profound and complex challenge to have confronted human social, political, and economic systems. It also presents one of the most profound challenges to the way we understand human responses. In this collection, we have tried to lay out the variety and complexity of the issues at the intersection of climate change and human society. Our goal has been to be as comprehensive as possible within the limits of space. We offer the reader a broad-ranging collection of ways to think about one of the most difficult issues we human beings have brought upon ourselves in our short life on the planet.

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PART II

THE CHALLENGE AND ITS HISTORY

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CHAPTER 2

A TRULY COMPLEX AND DIABOLICAL POLICY PROBLEM

WILL STEFFEN

1 Introduction

Climate change is like no other environmental problem that humanity has ever faced. Ross Garnaut, in his exhaustive review of the climate change problem for the Australian Government, called it a 'diabolical policy problem' (Garnaut 2008: xviii) and concluded his report with the statement: 'On a balance of probabilities, the failure of our generation would lead to consequences that would haunt humanity until the end of time' (Garnaut 2008: 597). Nicholas Stern, who carried out the first comprehensive economic analysis of the climate change problem, said that 'this (climate change) is an externality like none other. The risks, scales and uncertainties are enormous. . . . There is a big probability of a devastating outcome' (Stern 2009).

Perhaps no other problem—environmental or otherwise—facing society requires such a strong interdisciplinary knowledge base to tackle; research to support effective policy-making and other actions must cut across the full range of natural sciences, social sciences (including economics), and humanities. The research remit is so large because (i) a shift in global climate represents a fundamental change in the life support system for humans—the basic physical, chemical, and biological conditions necessary for life; and (ii) climate change cuts to the core of contemporary society—energy systems, lifestyles, institutions and governance, forms of economic organization, and basic values.

2 Nature of Climate Change

Climate change is a complex problem by its very nature, and will confound any attempts by policy makers or environmental managers to simplify it. Complexity here refers to a system

that is characterized by multiple driving forces, strong feedback loops, long time lags, and abrupt change behavior. As an example of multiple driving forces, the current observed warming trend is driven primarily by a suite of greenhouse gases, including methane, nitrous oxide, and tropospheric ozone in addition to carbon dioxide (the most important of the gases). In contrast, simple systems are dominated by linear cause-effect phenomena. Six features of climate change are particularly important in terms of its complexity.

First, climate change is truly global in that it is centered around the two great fluids—the atmosphere and the ocean—that transport material and energy around the planet. Greenhouse gases, the emission of which represent the primary human influence on the climate system (IPCC 2007a), are well mixed in the atmosphere; emissions from any particular location are transported around the Earth in a matter of weeks. Ocean circulation connects far distant parts of the Earth; a slowdown or shutdown of the thermohaline circulation in the north Atlantic Ocean (often popularly known as the Gulf Stream) would cause regional cooling in northern Europe but would increase the rate of warming in much of the southern hemisphere (IPCC 2007a). Changes associated with the atmosphere and the ocean are often called 'systemic global changes' because of the mixing power of these fluids.

By contrast, changes in land cover, for example conversion of forest to cropland, invariably change the functioning of the terrestrial biosphere in the context of the climate system. While these effects are primarily local and regional in scale, when aggregated they are sometimes referred to as 'cumulative global changes.' Changes in land cover occur at specific locations, and have long been the province of local and regional decision making within the context of national sovereignty. They can, however, have global impacts via teleconnections in the atmosphere-ocean system. For example, large-scale deforestation of the Amazon rainforest would affect temperature and precipitation over Tibet (Snyder et al. 2004).

Human-driven climate change operates on a time scale that is beyond the experience of decision makers today. Many of the projections of changes in climate are carried out on a century timescale out to 2100, which is so far in the future that it is meaningless for nearly all political or economic analyses, based on discount rates that are normally used. Yet 2100 is, in fact, a rather early waypoint in the trajectory of contemporary climate change. The human-driven changes to the climate system that have occurred since the industrial revolution up to the present will still be discernible at least 1,000 years into the future, regardless of the future trajectory of emissions (Solomon et al. 2009).

Below are several characteristics of the climate system that operate on timescales that are significantly longer than those typical of human affairs.

Carbon dioxide. In addition to being well mixed in the atmosphere, carbon dioxide has a very long residence time—on average, about 100 years. This means, however, that a significant fraction of the carbon dioxide emitted at any one time will still be present 500 years into the future (IPCC 2007a). The policy implication of this characteristic of carbon dioxide is that delays in reducing emissions lead to an accumulation of the gas in the atmosphere that will continue to influence climate for a very long time.

Temperature increase. Even if greenhouse gas emissions could be reduced to zero tomorrow, the global average temperature would continue to rise for several decades into the future. This inertial effect also implies that the rate of temperature increase over the next two or three decades is largely insensitive of the level of emissions over that period (IPCC 2007a). Thus, policy decisions taken now will not have demonstrable effects on the

trajectory of climate change until mid-century. For example, deep emission cuts now, with their likely economic and social costs, will not yield benefits for two or three decades.

Sea-level rise. Until recently, the primary factor driving sea-level rise has been thermal expansion of the oceans (Domingues et al. 2008). However, as climate change continues, melting and dynamic changes in the large polar ice sheets on Greenland and Antarctica will become increasingly important. A 2°C rise in temperature above pre-industrial would likely lead to an eventual sea-level rise of about 25 meters above current levels (Dowsett and Cronin 1990; Shackleton et al. 1995). However, although the 2 °C temperature rise would be realized this century, it would take many more centuries or even a millennium or two for the full sea-level rise to be realized (IPCC 2007a).

Extinction of biological species. Climate change is projected to lead to an enhanced rate of extinctions, probably increasing the current, high rate of extinctions by a factor of 10 (MA 2005). Extinctions are irreversible; once a species is lost, it cannot be retrieved. This represents the ultimate human impact on the global environment.

Arguably the most demanding of the challenges facing climate change negotiators is the suite of equity issues that separate the perspectives of various countries and regions (see Gardiner's chapter in this volume). Climate change is inherently unfair.

The long residence time of carbon dioxide leads to one of the most profound of the inequities. The cumulative emissions from about 1750 to present drive the currently experienced level of climate change and will continue to dominate the trajectory until about mid-century. About 75 percent of these cumulative emissions come from the OECD countries and the former Soviet Union (Figure 2.1; Raupach et al. 2007). In effect, the

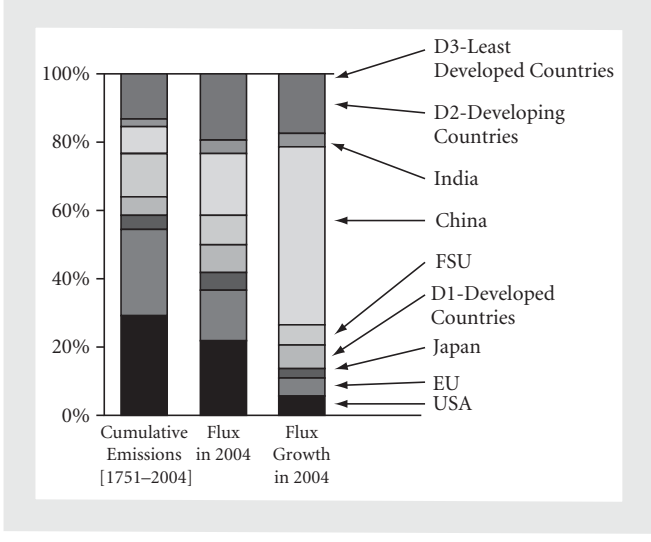

FIGURE **2.1** Various aspects of human carbon emissions by country/region (Raupach et al. 2007); FSU is the Former Soviet Union. The first column shows the cumulative emissions from the beginning of the industrial revolution to 2004. It is these stocks of carbon in the atmosphere that are largely driving observed climate change. The second column shows the flow rate of human carbon emissions into the atmosphere in 2004. The third column shows the annual rate in 2004 by which the flows of carbon into the atmosphere are growing.

wealthy countries have largely consumed the capacity of the atmosphere to absorb the wastes of industrial metabolism, leaving very little for the developing world to use in their quest to bring their populations out of poverty. This presents a dilemma of profound moral and ethical dimensions (see Baer in this volume).

The equity issue can be also be cast in terms of per capita emissions rather than national aggregates, thus focusing on the principle of equal rights to the atmosphere for each individual human regardless of where he or she lives. Although China has recently overtaken the USA as the largest emitter of carbon dioxide in a nationally aggregated sense, the per capita figures tell a different story. The average American emits over 20 tons of carbon dioxide per annum compared to less than 4 tons for the average Chinese citizen (UNDP 2007). One approach to bridging this gap is the 'contract and converge' strategy, aiming for a per capita emission entitlement in 2050 of about 2 tons of carbon dioxide for each human on Earth (Richardson et al. 2009).

Other aspects of the equity issue, which are temporal and inter-species in nature, raise important questions. What are the obligations of our generation to those to come in the future? (See Howarth's chapter in this volume). Do they have a fundamental right to an environment they can live in? Do humans have the ethical right to allow their actions to eradicate other living organisms?

The definition of what constitutes 'dangerous climate change' highlights another aspect of the equity issue. The distribution of the consequences of climate change is highly uneven around the world (IPCC 2007b). Developing countries are suffering the impacts of climate change much more than the industrialized world. There are several reasons for this. First, many of the industrialized countries lie in the northern mid- and high latitudes, where low temperatures limit important aspects of the economy, such as agriculture. Thus, modest levels of climate change are beneficial. Second, although rainfall is increasing overall with a warmer climate, regions in the sub-tropics that are prone to drought are experiencing intensifying and prolonged droughts with climate change (IPCC 2007a). With the exception of Australia, these regions primarily consist of developing countries. Third, because of their higher wealth and levels of education, industrialized countries have higher adaptive capacity than developing countries. A synthesis of these types of argument lies behind the '2 °C guardrail' (limiting temperature rise to no more than 2 °C above pre-industrial levels), first proposed by the European Union and then adopted by the Copenhagen Accord in 2009.

Small island states represent a special case. Because many of them are low lying, they are exceptionally vulnerable to sea-level rise. For the most vulnerable of them, such as Kiribati, the climate system has already moved into what they consider to be the dangerous zone. The small island states, for example, argued vigorously at the COP-15 for a 1.5 °C guardrail because of their extreme vulnerability to sea-level rise.

One of the most striking scientific advances over the past decade is the analysis of the climate as a complex system. A prominent feature of a complex system is threshold/abrupt change behavior, in which an apparently small, insignificant change in a forcing variable can trigger an unexpectedly large and rapid or irreversible change in a major feature of the climate system—a so-called 'tipping element' (Lenton et al. 2008). This type of behavior is especially dangerous in the context of anthropogenic climate change because an apparently safe change in a variable, such as carbon dioxide concentration in the atmosphere, can suddenly trigger a massive

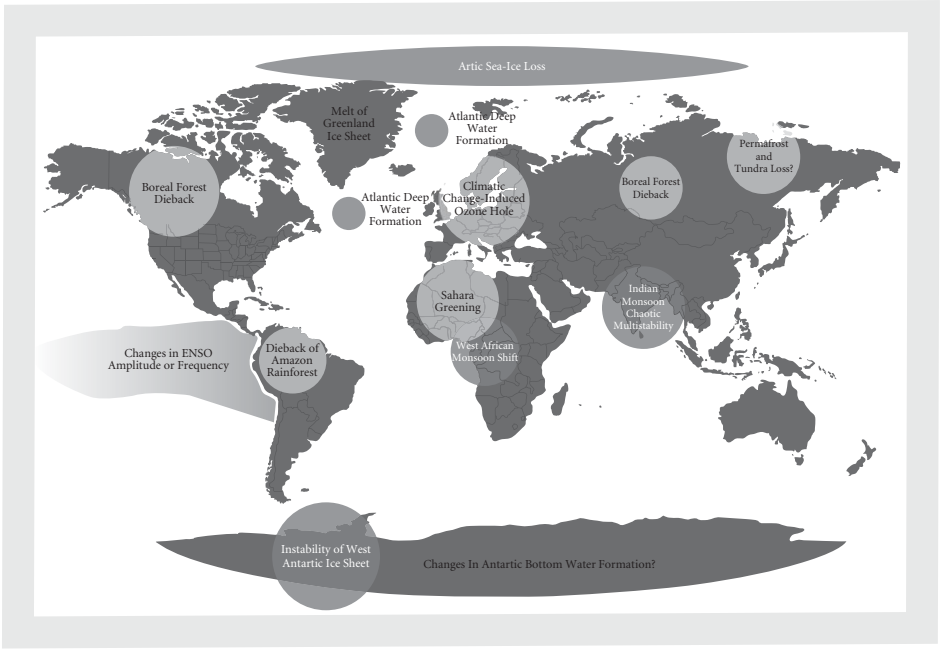

FIGURE **2.2** Map of potential climatic 'tipping elements' (after Lenton et al. 2008). Tipping elements are regional-scale features of the climate that could exhibit threshold-type behavior in response to human-driven climate change—that is, a small amount of climate change at a critical point could trigger an abrupt and/or irreversible shift in the tipping element. The consequences of such shifts in the tipping element for societies and ecosystems are likely to be severe. Question marks indicate systems whose status as tipping elements is particularly uncertain.

impact in some part of the climate system with very serious or even catastrophic consequences for humanity (Figure 2.2). Three examples of potential tipping elements are:

Large polar ice sheets. The Greenland and West Antarctic ice sheets, which together carry enough land-based ice to raise global sea levels by 13 metres if they totally disappeared, are vulnerable to modest increases in global average temperature above pre-industrial. Temperature rises of around 2 or 3 °C may be close to the tipping point for these ice sheets, although it would take many centuries or perhaps a couple of millennia for them to disappear completely (Gregory and Huybrechts 2006; Lenton et al. 2008).

Amazon rainforest. The world's largest contiguous rainforest is subject to rapid conversion to a grassland or savanna ecosystem if the climate warms and dries sufficiently, or if human-driven deforestation reaches a critical level, currently thought to be around 20 percent (Oyama and Nobre 2003; Foley et al. 2007). The combination of a warming climate and continuing deforestation may further hasten the tipping of the Amazon rainforest into a savanna.

South Asian monsoon system. Past evidence shows that this monsoon system can oscillate between wet and dry states. This behavior is crucial for the well-being of over a

billion people, as the population in the region has risen sharply over the past century when the monsoon system has consistently been in a wet state. Modeling suggests that the monsoon is vulnerable to changes in aerosol concentration (pollution) over the subcontinent coupled to a warming global climate; the flip to a dry state could occur, without warning, as rapidly as one year (Zickfield et al. 2005).

Such behavior challenges the 2 °C definition of dangerous climate change. Furthermore, it presents profound challenges for institutional frameworks and legal systems, which have experience in dealing with simple cause-effect aspects of science but are ill-equipped to cope with complex systems. These challenges will be described in detail in the next two sections.

3 Specific Challenges for Governance

The characteristics of the climate system and the nature of the human influence on climate lead to profound challenges for governance. A recent review (Young and Steffen 2009) has analyzed the most important of these challenges, some of which are highlighted below.

The core science of climate change—the reality of the greenhouse effect, the observed warming of the Earth's surface over the past century, and the dominant role of human emissions of greenhouse gases in driving the observed changes—is beyond doubt in the credible climate science community, although challenged in the popular media and the blogosphere by non-experts. However, many uncertainties remain in more detailed aspects of the science, uncertainties that can have important implications for governance. Here are two examples: (i) The land and the ocean 'carbon sinks' currently absorb over half of the human emissions of carbon dioxide, thus acting as a powerful brake on the rate of temperature increase (Canadell et al. 2007). However, the future behavior of these sinks is highly uncertain, with the ocean sink already showing signs of weakening and the land sink projected to weaken later this century (Le Quéré et al. 2009). In addition, additional new sources of carbon may be activated later this century, but 'if and when' are highly uncertain. One of the most important of these potential new sources is the large amount of methane stored in the permafrost of the northern high latitudes; large-scale release of this methane could cause a sharp acceleration of warming, perhaps adding over a degree to the global mean temperature rise (Tarnocai et al. 2009). (ii) A critical uncertainty that bedevils the international negotiations on emission reductions surrounds the sensitivity of the climate system to a given concentration of greenhouse gases in the atmosphere. That is, even if we could stabilize greenhouse gas concentrations at a precise, desired level—say, 450 ppm CO_2-equivalent—we could not be sure of the precise level to which the temperature will eventually rise. For example, for 450 ppm CO_2-equivalent, there is only a 50 : 50 chance that the ultimate temperature increase will be below 2 °C above pre-industrial level (Hare and Meinshausen 2006).

The MRV (Measurement, Reporting, Verification) issues were highly contested at the COP-15 in Copenhagen, and when applied to biological gain or loss of carbon (in contrast to industrial emission reductions), climate science has a significant role to play. Measuring the amount of carbon lost from or stored in terrestrial ecosystems has always been a technically challenging aspect of emissions reporting, but has become even more important

as carbon becomes a financial commodity. Reliable and precise measurements of the change in carbon storage in soils, where two-thirds of all terrestrial carbon resides, is particularly challenging.

The multiple scales at which climate change is manifest pose serious challenges for governance. The governance challenges associated with mitigation (emissions reductions) are well known. As CO_2 is a well-mixed gas globally, only an international solution, involving at least the most important emitters in a coordinated way, will begin to address the nature of the challenge. Although many of the individual actions required to reduce emissions will need to occur at local and regional (subnational) scales, most of the policy settings and financial instruments will need to be nationally determined and administered.

The adaptation imperative presents a different type of scalar challenge. At fine scale, climate change is highly differentiated, with much heterogeneity in the way in which climate is actually experienced—rainfall patterns, cyclones, bushfires, and other extreme events. Adapting to climate change is thus strongly a local and regional issue, with most of the policy and management burden falling on local and state/provincial jurisdictions. However, some of the broad-scale policy settings as well as much of the funding for adaptation may well need to come from national governments. Multi-level interactions in governance are thus required, especially when the inevitable interactions and trade-offs between mitigation and adaptation activities arise. A well-known example is the simultaneous need to adapt terrestrial ecosystems to continue to provide food and conserve biodiversity under a changing climate while increasing their capacity to store carbon and produce biofuels.

The nature of nonlinearities in the climate system, described above, strongly suggests that an early warning system would be very useful from a governance perspective. However, science is still a long way from being able to provide the knowledge base for early warning systems. Some preliminary analyses suggest that complex, dynamical systems slow down in terms of their natural fluctuations (measured mathematically as an increase in autocorrelation) when they are approaching a tipping point (Dakos et al. 2008). Such behavior has been observed in past abrupt changes in the climate system and offers hope for being able to anticipate tipping points in future. But even if science could provide the basis for a reliable early warning system, how quickly and decisively could contemporary society respond to avert disaster? In terms of governance, a further complicating factor is the long timescale and thus irreversibility (in a human timeframe) of many of the tipping elements in the climate system. Once a tipping point has been crossed, there is no way for humanity to reverse the change, no matter how deleterious or even catastrophic the new behavior of the climate system might be. This feature of the climate system argues for a careful application of the precautionary principle.

The scientific community is accelerating its efforts to understand the climate system, and even the IPCC reports—the 'gold standard' of scientific information—need to be updated soon after they are published (e.g. Richardson et al. 2009; Steffen 2009). For example, just as the international policy community is gradually coalescing around the 2 °C guardrail and a consequent need for stabilization of greenhouse gas concentrations at no more than 450 ppm CO_2-equivalent, the scientific community is moving towards a target of 350 ppm CO_2-equivalent to avoid serious or even catastrophic climate impacts (e.g. Rockström et al. 2009; Smith et al. 2009; Figure 2.3). Much of this rapidly accumulating knowledge is interdisciplinary, aiming to understand complex system behavior through integration of natural and

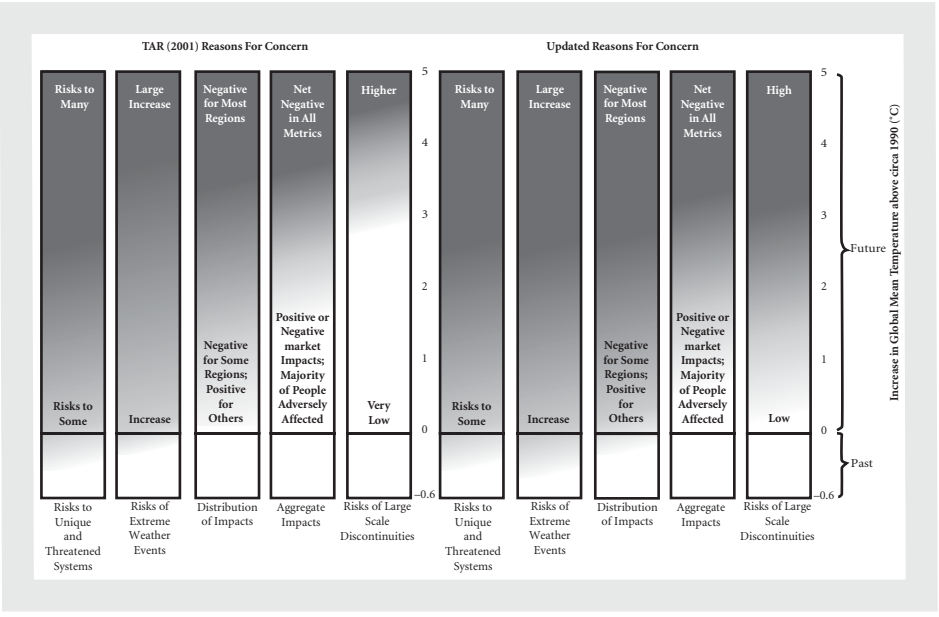

FIGURE **2.3** Diagram relating the potential impacts of climate change to the rise in global average temperature. Zero on the temperature scale corresponds approximately to 1990 average temperature, and the bottom of the temperature scale to pre-industrial average temperature. The level of risk or severity of potential impacts increases with the intensity of grey colour. The panel on the left is from Smith et al. in the IPCC Third Assessment Report (2001). The panel on the right is an updated version from Smith et al. (2009), using the same methodology as the TAR, based on expert judgement.

social science research. Much is directly policy relevant. For example, in terms of adaptation, just as local councils and the insurance industry are planning for a global mean sea-level rise of around 0.5 meter by 2100, the more recent analyses are suggesting that rises of upwards of 1 meter or more are likely (Rahmstorf 2007; Rahmstorf et al. 2007). In summary, the climate system is moving faster than science can understand, and new scientific knowledge is being generated at a rate with which governance is struggling to keep up.

4 Novel Approaches to Meeting the Climate Change Challenge

The targets-and-timetable approach to reducing greenhouse gas emissions has dominated the policy dialogue for the last two decades. However, very recently the scientific community has proposed a somewhat different approach, based on aggregate emissions, that may facilitate the interaction between the scientific and the policy communities

(e.g. Meinshausen et al. 2009). But what if attempts to reduce greenhouse gas emissions fall well short of the targets needed to avoid what most people consider to be dangerous climate change? Given this distinct possibility, there is a growing global dialogue on the possibility of geoengineering approaches to meet the climate change challenge (Royal Society 2009).

Conceptualizing the mitigation challenge as a limit on total, aggregate global emissions rather than on percentage reductions at certain time intervals has, in some ways, simplified the challenge and connected it more directly to the scientific underpinning (Meinshausen et al. 2009; Allen et al. 2009; England et al. 2009; Rogelj et al. 2009). The concept is simple. Starting from a normative judgement about the level of climate change humanity is willing to accept—say, a 2 °C increase in global mean temperature above pre-industrial—the concentration of greenhouse gases in the atmosphere to limit the temperature to this level can be calculated, and from that the allowable cumulative emissions of additional greenhouse gases can be obtained. There are two important caveats. First, there is still significant uncertainty surrounding the temperature increase associated with any given concentration of greenhouse gases in the atmosphere, so the relationship between cumulative emissions and temperature increase is a probabilistic one. Second, it is assumed that the fraction of human emissions of carbon dioxide currently absorbed by the ocean and land sinks and thus removed from the atmosphere will continue into the future as cumulative emissions rise (but see section 3 above).

A probabilistic analysis based on this approach (Meinshausen et al. 2009) and assuming the 2 °C guardrail shows that to keep the probability of exceeding the 2 °C limit to 25 percent, humanity should emit no more than a total of 1,000 Gt CO_2 (Gt = Gigaton = 1 billion tons) in the 2000–50 period. Given that we have already emitted about 350 Gt in the 2000–9 period, there are only 650 Gt of permitted emissions remaining over the next 41 years to stay within the 1,000 Gt limit. This is an exceptionally challenging target! If we accept only a 50 : 50 chance of limiting the temperature rise to 2 °C or less, then the permitted emissions through the 2000–50 period become 1,440 Gt CO_2.

How are we tracking towards this cumulative emission target as we approach the end of the first decade of the twenty-first century? An analysis of stated national positions on emissions reductions going into the COP-15 meeting in Copenhagen showed that intentions at that time fell well short of what is required (Rogelj et al. 2009). For example, aggregating the stated commitments of Annex I countries as a group give an emission reduction by 2020 of 8–14 percent below 1990 levels. This figure would have to be 25–40 percent to be on track to stay within the 2 °C guardrail. When the intentions of developing countries are included in the analysis, the conclusion is even clearer: the current pathway gives virtually no chance of limiting warming to 2 °C or less.

With the likelihood that climate change may well move into the 'dangerous zone' later this century, increasing attention is being given to geoengineering approaches (Royal Society 2009). The term 'geoengineering' is applied to a range of possible technologies or methodologies that can be divided into two groups: (i) techniques that remove carbon dioxide from the atmosphere, and (ii) techniques that modify the radiation balance at the Earth's surface by changing the amount of incoming solar radiation that the Earth absorbs. The scientific bases for the two approaches are fundamentally different from the perspective of Earth as a complex system. The first approach attempts to address the source of the problem by removing CO_2 from the atmosphere, while the second attempts to manipulate the functioning of the Earth System itself. From a risk perspective, the second approach is

Table 2.1 The nine proposed planetary boundaries, showing the Earth System process or subsystem, the control variable (parameter), the proposed boundary value, the current status, and the pre-industrial value (Rockström et al. 2009). The rows shaded dark grey indicate boundaries that humanity has already transgressed.

PLANETARY BOUNDARIES

Earth-system process	Parameters	Proposed boundary	Current status	Pre-industrial value
Climate change	(i) Atmospheric carbon dioxide concentration (parts per million by volume)	350	387	280
	(ii) Change in radiative forcing (watts per metre squared)	1	1.5	0
Rate of biodiversity loss	Extinction rate (number of species per million species per year)	10	<100	0.1–1
Nitrogen cycle (part of a boundary with the phosphorus cycle)	Amount of N_2 removed from the atmosphere for human use (millions of tonnes per year)	35	121	0
Phosphorus cycle (part of a boundary with the nitrogen cycle)	Quantity of P flowing into the oceans (millions of tonnes per year)	11	8.5–9.5	−1
Stratospheric ozone depletion	Concentration of ozone (Dobson unit)	276	283	290
Ocean acidification	Global mean saturation state of aragonite in surface sea water	2.75	2.90	3.44
Global freshwater use	Consumption of freshwater by humans (km^3 per year)	4,000	2,600	415
Change in land use	Percentage of global land cover converted to cropland	15	11.7	Low
Atmospheric aerosol loading	Overall particulate concentration in the atmosphere, on a regional basis		To be determined	
Chemical pollution	For example, amount emitted to, or concentration of persistent organic pollutants, plastics, endocrine disrupters, heavy metals and nuclear waste in, the global environment, or the effects on ecosystem and functioning of Earth system thereof		To be determined	

far more dangerous as it entails potentially deleterious or even catastrophic side effects that are very difficult or even impossible to anticipate a priori.

Examples of carbon dioxide removal techniques include direct engineered capture of CO_2 from the free atmosphere, enhancement of natural carbon sinks in terrestrial ecosystems, and the enhancement of oceanic uptake of CO_2 by increasing the amount of micronutrients like iron. The last approach, however, carries a high risk of significant impacts on the structure and functioning of marine ecosystems. The most prominent example of changing the radiation balance is by injecting sulphate aerosols into the lower stratosphere. This approach, however, has some severe side effects that are already well known—it would do nothing to counteract the increasing acidity of the ocean, and it could reduce precipitation in the Asian and African summer monsoon systems and impact the food supplies of billions of people (Robock et al. 2008).

The governance implications of geoengineering, dealt with at some length in the Royal Society analysis (2009), are enormous. For example, many of the geoengineering approaches are transboundary in nature, especially those that modify the Earth's radiation balance, and will require new international institutions and/or mechanisms that are not yet in place. Others, such as the proposed iron fertilization of the ocean, could be handled by existing instruments (the International Law of the Sea in this case) but they would likely require significant modification.

An opposite approach to geoengineering is the planetary boundaries framework (Rockström et al. 2009), which focuses on the complex-system nature of the Earth and, in particular, on the risk for abrupt and/or irreversible changes in important features of the Earth System. Rather than trying to engineer solutions to global environmental change after it has occurred, the planetary boundaries approach attempts to define the 'safe operating space' for humanity by defining 'no-go zones' in a global environmental context. The initial analysis has identified nine planetary boundaries, one of which relates directly to climate change (Table 2.1). This boundary has been proposed as 350 ppm CO_2 concentration and, concurrently, a + 1 watt per meter squared increase in radiative forcing (the aggregate of all of the factors—natural and anthropogenic—that influence the energy balance at the Earth's surface). Thus, we are currently in overshoot.

5 Reconceptualizing the Climate Change Problem

The climate change problem has been cast largely as one of changing the energy systems of contemporary society away from fossil fuel-based systems towards low- or no-carbon systems. There is no doubt scientifically that the emission of greenhouse gases, predominantly carbon dioxide, from the combustion of fossil fuels lies at the heart of the climate change problem. Meeting the challenge of reducing these emissions is undoubtedly the highest priority climate mitigation action facing humanity. However, there is a significant—and growing—body of scholarship that focuses on global change rather than only on climate change, and views climate change as a symptom of a much deeper problem that centers on the fundamental relationship of humanity with the rest of nature (Steffen et al. 2004).

One of the most striking conceptual frameworks now used to describe the changing relationship between humanity and our environment is that of the Anthropocene, a new geological era proposed by Nobel Laureate Paul Crutzen (2002). The concept of the Anthropocene encompasses climate change, but goes on to consider the many other changes to the global environment that have occurred since the industrial revolution—changes in global element cycles such as nitrogen and phosphorus, the rapid loss of biodiversity, the changes in the water cycle, the vast changes to the Earth's land cover, the depletion of many of the world's fisheries, and so on—all of which are driven ultimately by human numbers and human activities. Taken together, these changes demonstrate unequivocally that the human enterprise has now become so powerful in terms of its impact at the global scale that it rivals some of the great forces of nature (Figures 2.4 and 2.5; Steffen et al. 2004).

Global change has clearly moved the planetary environment out of its 10,000-year-old Holocene state and into the new state of the Anthropocene (Steffen et al. 2007). This has enormous implications for the future of humanity, as our societies and civilizations, and the ecosystems on which we depend for essential services, are tuned to the environmental envelope of the Holocene. For example, agricultural systems are now finely tuned (optimized) for the temperature ranges and rainfall patterns of the last century or two; our emergency management services have been resourced and trained to deal with the natural disasters of the recent past; and even our own fundamental physiology is not equipped to deal with the temperature extremes associated with a 2 or 3 °C rise in average temperature above the long-term Holocene average. As we move out of the Holocene envelope, we are sailing into planetary *terra incognita*, with an uncertain outcome in terms of the viability of contemporary civilization beyond this century, or even the next few decades.

As humanity moves more deeply into the unknown world of the Anthropocene, the question arises as to whether our society will even survive this transition, or will collapse as many other civilizations have done in the past. This existential question is driving a new area of scholarship that is reconceptualizing history by integrating palaeo-environmental research with anthropology, archaeology, and history (Costanza et al. 2007). The aim is to explore the reasons that some earlier civilizations collapsed in the face of environmental stresses of various kinds, while other civilizations, facing similar stresses and constraints, engineered relatively smooth transformations into different societies that were much better equipped to deal with the stresses. Such knowledge can inform humanity's present situation, and suggest pathways that may help guide us towards a more sustainable future.

Although we can learn much from the past, the present situation is fundamentally different in that contemporary society is much more interconnected at the global scale than ever before. If contemporary, globalized society collapses, there is no alternative waiting in the wings to rescue humanity. Our society is strongly driven by a core value of continuing economic growth and ever-increasing material wealth for larger numbers of humans. The implicit assumptions behind this core value are that the Earth's resources are essentially infinite (or can be made so through substitution) and its capacity to absorb societies metabolic wastes is also limitless. Climate change and other environmental changes are challenging this assumption.

At its most fundamental level, then, climate change may represent the canary in the coal mine for our own species. Is it another environmental problem to be solved at the margins of society in its continual march of progress, or does it signal the end of the era of ever-expanding population, continuous economic growth, and increasing material wealth?

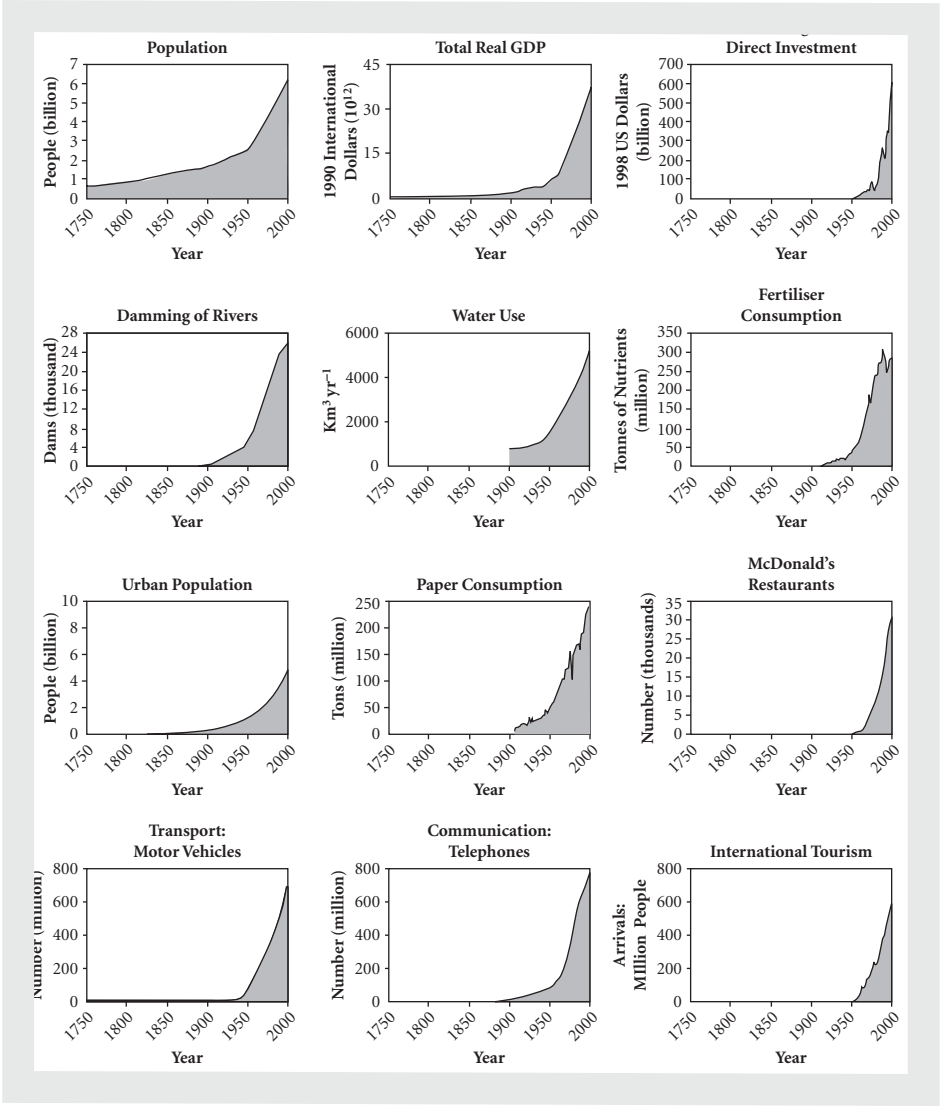

FIGURE **2.4** The increasing rates of change in human activity since the beginning of the industrial revolution. Significant increases in rates of change occur around the 1950s in each case and illustrate how the past fifty years have been a period of dramatic and unprecedented change in human history. From Steffen et al. (2004), which includes references to the individual databases from which the panels are derived.

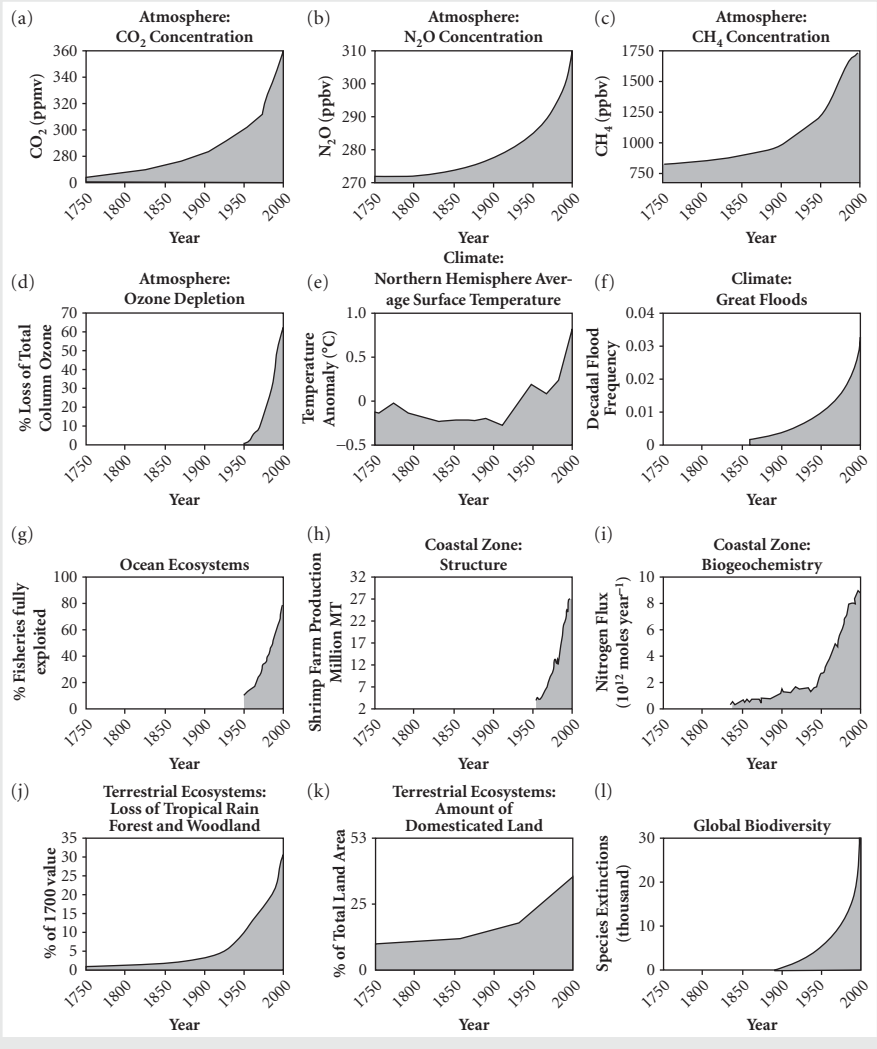

FIGURE **2.5** Global-scale changes in the Earth System as a result of the dramatic increase in human activity: (a) atmospheric CO_2 concentration; (b) atmospheric N_2O concentration; (c) atmospheric CH_4 concentration; (d) percentage total column ozone loss over Antarctica, using the average annual total column ozone, 330, as a base; (e) northern hemisphere average surface temperature anomalies; (f) natural disasters after 1900 resulting in more than ten people killed or more than 100 people affected; (g) percentage of global fisheries either fully exploited, overfished, or collapsed; (h) annual shrimp production as a proxy for coastal zone alteration; (i) model-calculated partitioning of the human-induced nitrogen perturbation fluxes in the global coastal margin for the period since 1850; (j) loss of tropical rainforest and woodland, as estimated for tropical Africa, Latin America, and South and Southeast Asia; (k) amount of land converted to pasture and cropland; and (l) mathematically calculated rate of extinction. From Steffen et al. (2004), which includes references to the individual databases from which the panels are derived.

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CHAPTER 3

THE NATURE OF THE PROBLEM

DALE JAMIESON*

1 Introduction

Almost everything about climate change is contested: whether it is occurring, whether it is anthropogenic, whether it is a problem, whether it is soluble, what would be the solutions, and even what would even count as a solution. While not every view is as good as every other, it is important to understand why the juxtaposition of climate and humanity provides such fertile soil for a diversity of interpretations and perspectives. In this chapter I characterize some of these interpretations and perspectives, and explain what it is about climate and humanity that supports them. I provide my own view of the nature of the problem, but my most robust conclusion is that it is extremely difficult for creatures like us to arrive at common understandings about climate change, much less to respond in ways that involve acting in concert.

2 Change and Stability

By definition, climate change involves change, but it is not easy to identify either climate or change, either empirically or conceptually. Climate is an abstraction from the weather that people experience. In a highly variable system, it is difficult to distinguish climate change from variability. During the twentieth century there was a 148 °C difference between the warmest and coldest recorded temperatures. In Rapid City, South Dakota, the temperature once dropped 26 °C in 15 minutes; in Spearfish, South Dakota the temperature rose 27 °C in

* An earlier version of this chapter was delivered as the Wayne Morse Lecture at the University of Oregon. I am grateful to Margaret Halleck for making this lecture possible, and to everyone who participated in the discussion. I also thank John S. Dryzek, Richard B. Norgaard, and David Schlosberg for their comments on an earlier draft.

2 minutes. In New York City there is on average about a 25 °C difference between summer and winter temperatures; in Berlin, the day/night gradient is usually about 10 °C. As I write these words, there is a 48 °C difference between Barrow, Alaska, and Singapore. Against this background, a 1.4–6.4 °C warming over this century, which the Intergovernmental Panel on Climate Change (IPCC) predicts, is difficult to detect and does not seem very dramatic. If you want climate change, get on an airplane. Or just wait a few hours, not a century.

Of course this response embodies confusions, but it also expresses a deep truth. The very idea of climate change involves a particular paradigm—call it the 'stability/change' paradigm. From an array of data points that could fairly be described as 'all over the place,' certain values are identified as anomalous, and then questions are asked about whether these anomalies are harbingers of change. Were we to drop the stability/change paradigm, we might see the record as displaying spatial and temporal variation rather than anomalies. Indeed, even from within the stability/change paradigm, we need only to shift the temporal dimension to see change as variability. For example, what appears to be climate change from a nineteenth-century baseline may appear to be variability from the perspective of millennia. This is why examining the paleo-climate record sometimes induces people to become climate change skeptics.[1]

There are considerations concerning the basic science of the climate system that support viewing the data in terms of the stability/change paradigm, but it is important to recognize that even raising the question of climate change involves interpreting the climate record in a particular way.[2] Climate data do not come marked 'change' or 'variability,' anymore than the works of fourteenth-century Florentine artists are stamped with the words, 'Renaissance artwork.'

3 Problems

Even if we accept that climate change is occurring, as we should, we do not yet have a problem. Dramatic changes occur all the time that we do not consider to be problems (e.g. summer changes to autumn, black holes devour stars). What is minimally required for a change to be a problem is that it adversely affects what we care about. But this may not be enough. Some people would say that if the climate change that is now under way were due to purely natural (i.e. non-anthropogenic) factors, then it would not be a problem. There are two distinct grounds one might have for this view. Some people may think that it is necessary for a change to be a problem that it is caused by human agency. On this view, natural occurrences that affect us adversely are unfortunate, but they are not problems. A second, more plausible ground is that if we cannot in some way remedy a change that adversely affects us, then the change is not a problem. On this view, problems imply solutions. For example, dying prematurely of a curable disease is a problem; being mortal is not. There are people who think that nothing can be done about climate change. If they also have the view that problems require solutions, then they do not think that climate change is a problem, however regrettable they may think it is that it is occurring. Of course they are wrong in thinking that we cannot respond to climate change in ways that make a difference. But what counts as making a difference depends enormously on what exactly we think the problem is.

4 Framing

Viewing climate as changing and seeing change as a problem involves framing our knowledge and experience of climate in a particular way. The meaning of climate is extremely dense, and so there are many ways in which people frame climate and climate change (Hulme 2009).

At the deepest level, for some people, climate change is a version of the biblical story of Adam's Fall, though the connection is not usually acknowledged or even perhaps consciously in mind. In that story Adam and Eve were banished from the Garden of Eden because Eve, having been seduced by a serpent, disobeyed God and ate the forbidden fruit from the tree of the knowledge of good and evil. Their descendents—all of us—bear the mark of this original sin, though there is hope of redemption through a messiah or savior.[3] The Garden of Eden is the stable climate regime, untouched by humanity. The serpent is industrial civilization, which has given us the forbidden fruit of disposable consumer goods which satisfy our immediate desires, and the greenhouse emissions that they entail. Original sin is expressed in the fact that once we are introduced to this shallow consumer culture, there is no turning back for ourselves or our children. Redemption requires an apocalypse on some views, or merely a 'cap and trade' system on others. Some think that Al Gore is the messiah, while others put their faith in the IPCC (though in the wake of Climategate, many have found their faith shaken). Rather than the messiah, other people see Al Gore as the Antichrist and they see climate change as a hoax rather than as a crisis having 'the potential to end human civilization as we know it.'[4] For them climate change is a conspiracy on the part of scientists, bankers, and politicians seeking to line their pockets, and a cynical pretext for those who want to cede American sovereignty to the United Nations.[5] Interestingly, while both of these framings can be seen as theological in inspiration, they are typically expressed in the language of science.[6]

Scientists were extremely influential in the initial framing of the climate change issue. While some concerns were expressed earlier, until the 1980s climate change was mainly portrayed as a matter of scientific curiosity and research (Wearth, this volume). In an extremely influential 1957 article, Roger Revelle and Han Suess wrote, without a hint of alarm or serious concern:

> Human beings are now carrying out a large-scale geophysical experiment of a kind that could not have happened in the past nor be repeated in the future . . . Within a few centuries we are returning to the atmosphere and oceans the concentrated organic carbon stored in sedimentary rocks over hundreds of millions of years. (Revelle and Suess 1957: 27)

The 1988 Toronto Conference on 'The Changing Atmosphere' marked a turning point. There, an international group of scientists and government officials called for a 20 percent reduction of carbon dioxide emissions by 2005 from the 1988 baseline (Environment Canada, WMO, and UNEP 1988). That same year the quasi-scientific, quasi-political IPCC was created, in part to bring science to bear on climate policy, but also to blunt the activism that was beginning to emerge in the scientific community (Agrawala 1998).

In the run-up to the 1992 Rio Earth Summit large oil, coal, and auto companies felt threatened by the possibility of an international agreement that would lead to phasing out

fossil fuels. They mobilized scientists who were already on their payroll, and enlisted the support of a handful of academic and government scientists including Fred Singer, Patrick Michaels, and Richard Lindzen (Leggett 1999; Hoggan 2009). In the background was a small group of prestigious physicists who had been active in cold war politics, and saw the emerging concern with climate as a threat to American national sovereignty, their own anti-regulatory values, and the institutional power of their own discipline and fields of research. One of these scientists, William Nierenberg, chaired an early National Academy of Sciences study of climate change (National Academy of Sciences 1983), and went on to co-found the George Marshall Institute with Frederick Seitz and Robert Jastrow. The Marshall Institute was originally established to support Ronald Reagan's Strategic Defense Initiative, but soon became an institutional home for scientists with anti-environmental agendas. Several of those involved in climate change denial also worked to cast doubt on the science behind acid precipitation and ozone depletion, and also worked for the tobacco industry in its campaign to refute the claim that second-hand smoke causes cancer (Oreskes and Conway 2010).[7]

Framing climate change as a scientific issue invites these kinds of responses. Skepticism about scientific claims is generally appropriate and often contributes to scientific progress. However, it is not always easy to distinguish a constructive skeptic from a dogmatic denier, especially when a claim is said to be uncertain. Since science is fallible and probabilistic, uncertainty is always lurking in the background, though it is often ignored ('blackboxed'). It is essential to scientific practice that we take some claims as fixed, since progress would not be possible if every proposition were problematized in every investigation. Nevertheless, when the stakes are high and society is fractious, deviant scientists, especially those who are backed by interest groups, will pry open the black box. Scientific uncertainty, rather than being a cause of controversy, is often a consequence of controversy.[8] For this reason as well as others, science, which often has a privileged role in identifying issues of public concern, cannot by itself bring such issues to policy closure (Jamieson 1996; Sarewitz 2004).

In addition, scientists have not always been effective advocates for their causes, nor generally very adept in dealing with the broad social landscape in which the climate policy drama is enacted (Moser and Dilling in this volume).[9] The media, because of the way in which they frame the issue, have often made things extremely difficult for mainstream climate scientists. For many years in the United States the science of climate change was covered as if it were a political story: every assertion had to be balanced by a counter-assertion. Allegations of fraud or misconduct particularly catch media attention because they fit the 'he said/she said' model even better than competing scientific claims.[10] After the IPCC won the Nobel Peace Prize in 2007 the political frame on climate science began to recede, but not for long. Controversies over hacked e-mails from the Climate Research Unit at East Anglia University, allegations about IPCC Chair R. K. Pachauri's role as a corporate consultant, and the discovery of errors in the 2007 IPCC report have brought the political frame roaring back.[11] In any case, the scientific framing of the climate change issue has led to many people feeling confused, unmoved, or even alienated from the discussion.

From the beginning, many American environmental groups had difficulty with climate change. The American environmental movement has deep roots in the anti-nuclear movement, and concerns about climate change seem to strengthen the case for nuclear

power. Moreover, some environmental groups sensed, correctly, that climate change would be a difficult issue to champion, compared to such vivid and immediate issues as clean air and water, and even the protection of charismatic species.[12]

5 Prudence and Policy

Those who want to take action on climate change often frame it as an issue about self-interest, where 'our' self-interest is thought of as the aggregate of the interests of each of us. One way of trying to understand our interests, from this point of view, is through an economic assessment of the aggregate expected damages of climate change and the costs of avoiding them. Nordhaus (2008), working in this tradition, tells us that optimal climate policy would involve a carbon tax of about $17 per ton in 2005, ramping up to $270 per ton in 2100.

There are obvious problems with this approach. It assumes that all preferences are commensurable and can be monetized, yet diverse values are at risk from climate change, not only income and economic assets, but also biodiversity and social solidarity (for example). It is not clear that all such values can be monetized, or even meaningfully placed on the same scale. Indeed some would say that even if in some sense this could be done, it would be wrong to do so, just as it would be wrong to monetize the value of a friend or lover (Sagoff, this volume).[13] Even if we leave these concerns aside, the idea that one can know enough to reliably calculate the benefits and costs of climate change and climate stabilization policies into the distant future is patently absurd. We can barely predict the state of the economy from one quarter to another.[14]

The Stern Review provides a different perspective on the economics of climate change, claiming that the optimal carbon tax now is $311 per ton (Stern 2006).[15] The core of the difference between Stern and Nordhaus concerns how to value costs and benefits that occur in the further future. Nordhaus discounts them at 3 percent for pure time preference, declining to 1 percent in 300 years; he derives these rates from what he takes to be people's actual discounting behavior. Stern rejects pure time preference altogether on ethical grounds. His point is that those in the further future who will bear the costs and benefits of present policies are different people from those who bear them at present. When time horizons are so long, discounting for pure time preference does not express an attitude about how consumption should be scheduled over time, but rather expresses an attitude about how different people should be valued, and this involves questions of ethics. The fact that present people may value future people less than they value themselves should not for that reason alone be built into an economic analysis without further scrutiny, any more than the fact that people have racial or gender biases should be built into an economic analysis.

There are other, more subtle differences between Stern and Nordhaus. While both aggregate damages and work to identify the marginal social cost of carbon, Nordhaus does this in order to identify economically efficient mitigation strategies, while Stern is more interested in evaluating pathways that avoid unacceptable atmospheric concentrations of greenhouse gases while identifying trade-offs. Nordhaus is working towards a global benefit–cost analysis. He takes this to be an empirical exercise and seems confident about what a competent study can hope to achieve. Stern, on the other hand, views climate

change as a risk management problem involving great uncertainties and diverse values, not all of which can be quantified. He thinks that the ethical dimensions of the problem are so central that we should not be very confident about what even the best economic study can hope to achieve.

One way of thinking about risk management is in terms of insurance. As Steve Schneider has said, 'we buy fire insurance for our house and health insurance for our bodies. We need planetary sustainability insurance.'[16]

However there are important disanalogies between investing in climate protection and purchasing insurance. First, insurance compensates for losses that are suffered; it does not directly mitigate or prevent losses. Fire insurance, for example, does not reduce the probability of fire occurring or diminish the damage that a fire would cause if it were to occur, but reducing greenhouse gas emissions is supposed to reduce the probability and severity of climate change damages. Second, we have no actuarial tables for the climate protection market in the way that we have for accidents and fires. We have very little idea about the specific impacts of climate change on societies like ours, living on planets like this, much less data about how specific changes in the composition of the atmosphere are likely to bring about specific impacts. Finally, insurance is typically purchased by an agent to benefit herself or, in some cases, those whom she loves or to whom she feels responsible. But in this case, we would be asking people who are now living very well, who under many scenarios have adequate resources for adaptation, to buy insurance that will mainly benefit poor people who will live in the future in some other country; and to do this primarily on the basis of predictions about the future based on climate models, expert reports, and so on. Rich people for the most part do not love or feel responsible for their poor contemporaries, especially those who live across national boundaries, much less those who will live in the future.

There are other reasons for doubting that the case for responding aggressively to climate change can be made simply on prudential grounds. This approach views the human community as a single agent, and compares the aggregate costs and benefits of various policies. Human communities are diverse, involving individuals with different interests, and are not (in the economists' sense) perfectly rational, or even in many cases aspiring to be so. Any climate change will have distributional effects, and the model of humanity as a single agent, presupposed by the prudential perspective, cannot adequately reflect such distributional conflicts.[17]

6 Morality and Justice

Distributional concerns are the terrain of ethical concepts, and the idea that climate change is fundamentally a matter of ethics has been gaining traction in recent years. Nobel Peace Prize co-recipients Al Gore and R. K. Pachauri have both endorsed it.[18] One version of this view is that climate change is a matter of individual moral responsibility; another version is that it presents questions of justice between states.

The idea that the problem of climate change is fundamentally a matter of individual moral responsibility is inspired by the insight that at its core the problem is that some people are appropriating more than their share of a global public good and harming other people by causally contributing to extreme climatic events such as droughts, hurricanes,

and heat waves. Moreover, much of this behavior is unnecessary, even for maintaining the profligate lifestyles of the global rich. Though this view is plausible, once we begin to model climate change on more familiar cases of individual moral responsibility, significant differences begin to emerge.

A paradigm case of individual moral responsibility is one in which an individual acting intentionally harms another individual; both the individuals and the harm are identifiable; and the individuals and the harm are closely related in time and space.[19] Consider Example 1, the case of Jack intentionally stealing Jill's bicycle.[20] The individual acting intentionally has harmed another individual, the individuals and the harm are clearly identifiable, and they are closely related in time and space. If we vary the case on any of these dimensions, we may still see the case as posing a moral problem, but its claim to be a paradigm moral problem weakens. Consider some further examples. In Example 2, Jack is part of an unacquainted group of strangers, each of which, acting independently, takes one part of Jill's bike, resulting in the bike's disappearance. In Example 3, Jack takes one part from each of a large number of bikes, one of which belongs to Jill. In Example 4, Jack and Jill live on different continents, and the loss of Jill's bike is the consequence of a causal chain that begins with Jack ordering a used bike at a shop. In Example 5, Jack lives many centuries before Jill, and consumes materials that are essential to bike manufacturing; as a result, it will not be possible for Jill to have a bicycle. While it may still seem that moral considerations are at stake in each of these cases, this is less clear than in Example 1, the paradigm case with which we began. The view that morality is involved is weaker still, perhaps disappearing altogether for some people, if we vary the case on all these dimensions at once. Consider Example 6: acting independently, Jack and a large number of unacquainted people set in motion a chain of events that causes a large number of future people who will live in another part of the world from ever having bikes. For some people the perception persists that this case poses a moral problem. This is because it may be thought that the core of what constitutes a moral problem remains: Some people have acted in a way that harms other people. However, most of what typically accompanies this core has disappeared. In this case it is difficult to identify the agents and the victims or the causal nexus that obtains between them; thus, it is difficult for the network of moral concepts (for example, responsibility, blame, and so forth) to gain traction.

These 'thought experiments' help to explain why many people do not see climate change as a moral problem. For climate change is not a matter of a clearly identifiable individual acting intentionally so as to inflict an identifiable harm on another identifiable individual, closely related in time and space. Structurally, climate change is most analogous to Example 6: A diffuse group of people is now setting in motion forces that will harm a diffuse group of future people.

There is a deeper problem about whether contributing to climate change is a matter of individual moral responsibility. The paradigm that I have been discussing views the causation of harm as being at the center of what makes an act a matter of moral concern. Even if harm causation is neither necessary nor sufficient for an act or omission to be of moral concern, the view that some such connection exists has been very influential in modern moral philosophy.[21] However, recent work in social psychology suggests that when it comes to construing an act or omission as within the domain of morality, other considerations are just as important to people as harm causation. Jonathan Haidt and his

colleagues have claimed that considerations involving fairness and reciprocity, in-group and loyalty, authority and respect, and purity and sanctity are, in addition to considerations about the causation of harm, at the foundation of morality as conceived by most people.[22] Since these considerations can come apart, often people will deny that harm-causing activity is within the moral domain, while at the same time considering behavior that does not cause harm to be of moral import. Daniel Gilbert brings these considerations to bear on the question of climate change when he writes that

> global warming doesn't . . . violate our moral sensibilities. It doesn't cause our blood to boil (at least not figuratively) because it doesn't force us to entertain thoughts that we find indecent, impious or repulsive. When people feel insulted or disgusted, they generally do something about it, such as whacking each other over the head, or voting. Moral emotions are the brain's call to action. Although all human societies have moral rules about food and sex, none has a moral rule about atmospheric chemistry. And so we are outraged about every breach of protocol except Kyoto. Yes, global warming is bad, but it doesn't make us feel nauseated or angry or disgraced, and thus we don't feel compelled to rail against it as we do against other momentous threats to our species, such as flag burning. The fact is that if climate change were caused by gay sex, or by the practice of eating kittens, millions of protesters would be massing in the streets.[23]

Rather than being a matter of individual moral responsibility, climate change can be seen as presenting a problem of global justice. Ugandan President Yoweri Museveni has been quoted as saying that climate change is 'an act of aggression by the rich against the poor.'[24] The data seem to bear him out. The rich countries of the North do most of the emitting, but the poor countries of the South do most of the dying (Patz et al. 2005).

When we look at some countries in particular the case becomes more vivid. A recent paper suggests that climate change will lead to a 1 meter change in sea level by the end of the century (Grinsted et al. 2010). Such a sea level rise will flood one-third of Bangladesh's coastline and create an additional 20 million environmental refugees. Saline water will intrude even further inland, fouling water supplies and crops, and harming livestock. This will occur as cyclones and other natural disasters become more frequent and perhaps more intense. In order to begin to adapt to climate change by building embankments, cyclone shelters, roads, and other infrastructure, it is estimated that four billion dollars would be required. Yet Bangladesh's total national budget in 2007 was less than $10 billion. Bangladesh suffers in all these ways, yet its carbon dioxide emissions per capita are one-twentieth of the global average. Such facts seem to lead to the conclusion that climate change poses questions of global justice.

However, there are complications. Since the atmosphere does not attend to national boundaries and a molecule of carbon has the same effect on climate wherever it is emitted, climate change is largely caused by rich people, wherever they live, and suffered by poor people, wherever they live. A recent study suggests that global carbon emissions can be reduced 50 percent by 2030, simply by reducing the emissions of the richest one-sixth of the people in the world (Chakravarty et al. 2009). These high emitters are roughly distributed equally in four regions: the US, the OECD minus the US, China, and the non-OECD minus China. On this view, there is as much emissions reduction to be done among high-emitting Chinese as there is among high-emitting Americans, and more emissions reduction to be done in both of these countries than in the European Union.[25]

Moreover, since poor people will suffer most from climate change, wherever they live, it is plausible to suppose that they too are distributed around the globe. The societal factors that caused Hurricane Katrina to be so devastating in New Orleans—high levels of inequality, large populations living in poverty, poor public services, and so on—will lead to similar consequences in the future. Indeed, there is reason to suppose that poor people in the United States will suffer more from climate change than similarly situated people in a country such as Cuba, which has less inequality and a more effective public sector in responding to climate and weather-related disasters (Mas Bermejo 2006).

Just as the problem of climate change has some of the dimensions of problems of morality but strays from the paradigm, so too with justice. In several important respects, causing climate change is not like one country unjustly invading another country. The nation-state is one level of social organization that is relevant to addressing climate change because it is casually efficacious, but the nation-state is not the primary bearer or beneficiary of ethical responsibilities in this regard.

7 Politics and Governance

Another perspective on climate change emphasizes the ways and the extent in which it challenges our systems of governance. Since the end of the Second World War, humans have attained a kind of power that is unprecedented in history. While in the past entire peoples could be destroyed, now all people are vulnerable. While once particular human societies had the power to upset the natural processes that made their lives and cultures possible, now people have the power to alter the fundamental global conditions that permitted human life to evolve and that continue to sustain it. There is little reason to suppose that our systems of governance are up to the task of managing such threats (Speth and Hass 2006; Adger and Jordan 2009; Hulme 2009: ch. 9).

Thus far, the most systematic attempts at climate governance have been through the international system, taking nation-states as primary agents.[26] The crowning achievement in climate governance is the Framework Convention on Climate Change (FCCC), opened for signature at the Rio Earth Summit in 1992, and now ratified by 192 countries. The parties to the FCCC committed themselves to stabilizing 'greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system.'[27] The Kyoto Protocol provided mechanisms for beginning to implement this commitment. The Kyoto Protocol was opened for signature in December 1997, and has been ratified by 187 countries, but not by the United States, the second largest emitter among nations. While its modest targets are likely to be met, it is unclear to what extent this will be due to the Protocol.[28] The December 2009 Copenhagen Climate Conference was supposed to result in a successor agreement to the Kyoto Protocol, but it ended in disarray and confusion. While some remain confident that this approach to climate governance will continue and bear fruit, many others are skeptical.

There are many specific problems with the existing governance structure (e.g. the requirement for consensus, the crude division between developed (Annex I) and developing (non-Annex I) countries, etc.). However, the heart of the problem is that climate change has many of the properties of being the world's largest collective action problem, and it is

difficult for any country that is responsive to its citizens to do its part in securing the global public good of climate stability. In part, this is because of self-interest. People as individuals want climate to be stabilized, but they also want to benefit from their own greenhouse gas emissions while others reduce their emissions. High-emitting rich countries do not want developing countries to follow in their footsteps, but developing countries want rich countries to take the first steps in reducing emissions. Even among the rich countries there is a 'you first, then me' attitude. To a great extent, this behavior simply follows from the logic of a collective action problem: for each of us, defection dominates cooperation, however others act.

Climate change also poses an intergenerational collective action problem (Gardiner 2003). Since every generation benefits from its own emissions but the costs are deferred to future generations, they have an incentive not to control their emissions. Moreover, since each generation (except the first) suffers from the emissions of previous generations, benefiting from their own present emissions may even appear to be just compensation for what they have suffered. But of course, this reasoning leads to the continuous build-up of greenhouse gases in the atmosphere over time.

Indeed, these problems are even worse than they seem, for climate change does not involve just single, intra- and intergenerational collective action problems. Jurisdictional boundaries and competing scales cause multiple, overlapping, and hierarchically embedded collective action problems. A vast variety of behaviors by individuals, nations, and other entities affect climate, but they are governed by an equally vast array of different regimes with different mandates and even in many cases different parties. For example, decisions about trade and intellectual property affect greenhouse gas emissions, but each of these areas is governed by its own legal regimes. While this may seem abstract, we witness policy failures and dysfunctions driven by the same dynamics on a daily basis with respect to simpler problems. When a city provides services for residents who live in outlying areas and do not pay city taxes, this is an example of the sort of problem that occurs with respect to climate change.

Well-functioning democracies act in the interests of the governed rather than on behalf of all those whose interests are affected. The benefits from the activities that cause climate change primarily accrue to those who are members of particular political communities, while the costs are primarily borne by those who are not. In the case of climate change, costs are borne by those who live beyond the borders of the major emitters, future generations, animals, and nature. Perhaps surprisingly, this seems relatively well understood by the American public, as the Figure 3.1 indicates.[29]

One reason it is difficult to reform and restructure governance is because people and institutions have strong status quo biases (Samuelson and Zeckhauser 1988). The United States, which has been particular unresponsive with respect to climate change, has a political system designed to strengthen this bias. Some of these elements are constitutional: for example, the division between the three branches of government, and the two, independent, legislative branches. Practices have also developed that strengthen status quo biases, such as the Senate filibuster, and the system of campaign finance.

One way of solving or softening these collective action problems, even when institutional mechanisms are not available, is through love, sympathy, and empathy. However, these seem in short supply in diverse, fragmented, modern societies; and in their more systematized forms as ethical systems and principles of justice, they are not fully adequate responses to the problem of climate change, as we discussed in the previous section.

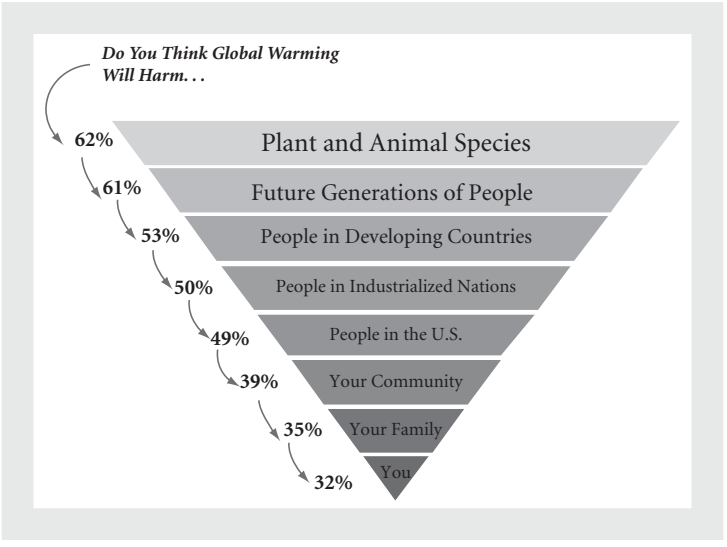

FIGURE 3.1 Climate change in the American mind

8 Cognition and Complexity

In the background of our attempts to address climate change is the fact that evolution did not design us to solve or even to recognize this kind of problem. We have a strong bias towards dramatic movements of middle-sized objects that can be visually perceived, and climate change does not typically present itself in this way.

The onset of climate change is gradual and uncertain rather than immediate and obvious. Increments of climate change are usually barely noticeable, and even less so because we re-norm our expectations to recent experiences. Some have suggested that the strong reaction to the severe winter of 2009–10 in Eurasia and the United States can be partly explained by the fact that as the world warms, people lose their memory of cold winters. Bizarrely enough, against the background of a warming world, a winter that would not have been seen as anomalous in the past is viewed as unusually cold, thus as evidence that a warming is not occurring. In fact, regional data from a single season is not the sort of evidence that could overturn a climatological theory like global warming.[30] Global warming does not mean that every region will become warmer, nor does it mean that every day in a warmer world will be warmer than a comparable day at present. Schneider (1989) explains this with a gambling metaphor: global warming loads the dice in favor of increased temperatures, changes in precipitation, and extreme climatic events, but it doesn't determine the outcome. A global warming increases the probability for particular regions to be affected by these changes, but does not necessarily bring about such changes in every season of every year in every region. The basic problem here is that climate change is a technical, complex issue that is best represented probabilistically. Many people, probably most people, are not scientifically equipped to understand more than the rudiments of the problem, and all of us are bad at probabilistic thinking, at least when we are thinking intuitively.

Another feature of climate change that makes it difficult for us to respond is that its causes and effects are geographically and temporally unbounded. Earth system scientists study the earth holistically and think on millennial timescales and beyond, but this perspective is foreign to most people. Most of us pay little attention to events that occur beyond national boundaries, unless they are 'one-off' disasters. The idea that turning up my thermostat in New York will affect people living in Malaysia in a thousand years is virtually beyond comprehension to most of us.[31]

Climate change will have multiple, sometimes paradoxical, indirect effects, and many of its impacts on human welfare will be relatively invisible. Effects of climate change will include sea level rises and increased frequency of droughts, storms, and extreme temperatures. In some regions these effects may also include an increased frequency of cold days. In addition to these first-order impacts, climate change will have indirect, second-order impacts such as species extinctions and changes in agricultural patterns, as well as third-order impacts affecting social and political relationships, and human and national security. Many people will be killed or harmed by first-order effects but many more will be affected by the second- and third-order effects that are mediated by economic status, food availability, disease burdens, and so on. However, many of these effects will be relatively invisible since they will involve 'statistical' rather than 'identifiable' lives (Schelling 1968). Climate change will cause the deaths of many people, but there will be no obituary that will say that Dale Jamieson (for example) died yesterday, cause of death: climate change. While we can be very responsive to individual victims we have difficulty empathizing with statistical victims. We mobilize huge resources around highly publicized cases of little girls falling into wells, while we do comparatively little to save children when they are the invisible victims of policy choices.

9 Concluding Remarks

The juxtaposition of climate and humanity provides fertile ground for a diversity of interpretations and perspectives. Seeing climate as changing and construing it as a problem requires assumptions that are not shared by everyone. Even among those who agree that climate change is a problem there are serious differences about solutions, reflecting in part disagreements about causes. If the problem is fundamentally one of global governance, then new agreements and institutions are what are needed. If the problem is market failure, then carbon taxes or a cap and trade system is what is required. If the problem is primarily a technological failure, then we need an Apollo program for clean energy or perhaps geoengineering. If climate change is just the latest way for the global rich to exploit the global poor, then the time has come for a global struggle for justice. If there was ever a problem to which Kaplan's 'law of the instrument' applied, this is it.[32]

My view, is that climate change is an unprecedented problem that exhibits some dimensions of familiar problems, but in novel combination, and some new features as well. Thus climate change poses fundamental challenges to our existing systems of value, ways of knowing, and institutions of governance. What we can hope for is not that 'the' problem of climate change will be solved, but that we will learn from our failures to prevent or seriously mitigate climate change thus far, and go on to manage the change that is under

way, and rebuild our institutions and ways of life so that they are appropriate to the high-population, high-consumption, high-technology world in which we now live.

Notes

1. This can be seen on various climate contrarian websites; for a somewhat more sophisticated version, see Richard Lindzen, 'Resisting Climate Hysteria,' available at <http://www.quadrant.org.au/blogs/doomed-planet/2009/07/resisting-climate-hysteria>.
2. Indeed, among the interpretations is the fact that the IPCC understands climate change as change in the climate system rather than as change in climate (thought of as an abstraction from weather); see Hajer and Versteeg in this volume for discussion. For discussion of how expectations of change and stability affect experience see Weber (2010).
3. This is a Christian flourish on a Jewish story, but of course there are many different interpretations of this story throughout the Judeo-Christian-Islamic tradition.
4. <http://ourchoicethebook.com/chapter1>
5. These views are all over the web; as examples, visit the following sites: <http://www.globalwarminghoax.com/news.php>, <http://climatedepot.com/>. Some may think that the language of 'messiah' and 'Antichrist' is excessive, even in the service of a metaphor, but these concepts are very active at least in the political imagination of many people in the United States. Three US presidents and two vice-presidents have won the Nobel Peace Prize, and they have all been messianic figures in the eyes of some while reviled by others. According to a recent Harris survey 14 percent of Americans say that President Obama may be the Antichrist (<http://www.livescience.com/culture/obama-anti-christ-100325.html>); this is about half the number of those who strongly approve of his presidency (<http://www.rasmussenreports.com/public_content/politics/obama_administration/obama_approval_index_history>).
6. The validity of Michael Mann's 'hockey stick' figure of the temperature record is one of the central battlegrounds between those who believe in anthropogenic climate change and those who deny it. For an introduction to the controversy, visit <http://www.realclimate.org/index.php/archives/2005/02/dummies-guide-to-the-latest-hockey-stick-controversy/>.
7. At times the contrarian influence has been felt not just in government policy but also in the management of scientific information and the treatment of government scientists. James Hansen (2009) tells his own story, but see also Bowen 2008.
8. The growth of scientific knowledge can also give rise to additional uncertainty. In unpublished work Jessica O'Reilly discusses an example of this regarding estimates of the vulnerability of West Antarctic ice sheets to disintegration.
9. For first-person accounts of the experience of two influential scientist-advocates, see Schneider 2009 and Hansen 2009.
10. Many dedicated scientists have been damaged by their treatment in the media. A particularly egregious and well-documented case concerns the treatment of Ben Santer in the so-called 'Chapter 8' controversy, in which he was accused of secretly altering text in an IPCC report in order to exaggerate the case for anthropogenic climate change. For his account, see <http://www.realclimate.org/index.php/archives/2010/02/close-encounters-of-the-absurd-kind/>. For a scholarly treatments, see Lahsen 2005 and Oreskes and Conway 2010: ch. 6.
11. For a more nuanced discussion see Boykoff 2008. See also <http://www.realclimate.org/index.php/archives/2010/02/whatevergate/>

12. Exceptions are the Environmental Defense Fund and the Natural Resources Defense Council, which began working on this issue in the late 1980s, largely because of their scientific advisors (Michael Oppenheimer and Dan Lashof). Eventually, for reasons that cannot be explored here, virtually all American environmental groups began advocating for climate stabilization policies, but they have been under vigorous attack for how they have framed the issue (see Shellenberger and Nordhaus 2007).
13. For what may be a contrary view, see Becker 1991.
14. Of course, sometimes long-term predictions are more reliable than short-term predictions, at least at a very general level. For example, my prediction that every reader of this chapter will be dead by 2100 is much more reliable than any prediction I could make about the deaths of particular readers in the next twelve months. However, what is needed for a benefit–cost analysis that is helpful with respect to climate policy is detailed predictions that are reliable both in the short term, and throughout the century or even longer.
15. For a third view of the economics of climate change, see <http://realclimateeconomics.org/briefs.html>.
16. <http://www.pnas.org/content/102/44/15725.full>. Weitzman 2007 discusses the insurance analogy in his review of Stern. While Diamond 2005 does not explicitly employ this analogy, this book has become a popular *locus classicus* for the view that we have prudential reasons to be concerned about environmental degradation.
17. Appeals to environmental security are another version of a prudential approach that I cannot discuss here. For discussion, see Part V of this volume.
18. Gore claims this in his Academy Award winning film, *An Inconvenient Truth*; R. K. Pachauri indirectly makes this point in his Nobel Lecture (given on behalf of the IPCC, which actually won the prize), available at <http://nobelprize.org/nobel_prizes/peace/laureates/2007/ipcc-lecture_en.html>. For websites devoted to climate justice, see <http://climateethics.org/>, <http://www.ecoequity.org/>. Schneider 2009 and Hansen 2009 also see climate change as posting questions of ethics and values but their treatments of such claims are not very detailed or sophisticated. For a collection of academic papers of this topic see Gardiner et al. 2010. See also Part VI of this volume.
19. I briefly discuss other paradigms of moral responsibility in Jamieson, 2010.
20. I first introduced this series of examples in Jamieson 2007.
21. The most thorough treatment of the normative significance of harm causation is Joel Feinberg's magisterial four-volume work (1984–8). Though criminal law is Feinberg's main concern, much of what he says applies to morality as well.
22. For an introduction to this work visit <http://faculty.virginia.edu/haidtlab/mft/index.php?t=home> 123.
23. <http://www.randomhouse.com/kvpa/gilbert/blog/200607its_the_end_of_the_world_as_we.html>
24. See *The Economist*, 10 May 2007, p. 123.
25. For somewhat different calculations that sustain the basic point that those responsible for changing the climate are well represented in countries throughout the world, see Jamieson 2010 and Grubler and Pachauri 2009.
26. For criticism of this approach, see Harris in this volume.
27. Framework Convention on Climate Change, Article 2, available at <http://unfccc.int/essential_background/convention/background/items/1353.php>.
28. The former claim is due to the Netherlands Environmental Assessment Agency; visit <http://www.pbl.nl/en/dossiers/Climatechange/FAQs/index.html?vraag=6&title=Will%

20countries%20with%20an%20emission%20target%20meet%20their%20Kyoto%20target%3F>. For a skeptical view, see the 'Hartwell Paper,' available at <http://www.lse.ac.uk/collections/mackinderProgramme/theHartwellPaper/Default.htm>.

29. Figure 3.1 is based on figure 22 in a report from the Yale Project on Climate Change and the George Mason University Center for Climate Change Communication, available at <http://www.climatechangecommunication.org/images/files/Climate_Change_in_the_American_Mind.pdf>. I regret that I have been unable to identify the person who constructed it.
30. See James Hansen, Reto Ruedy, Makiko Sato, and Ken Lo 'If It's That Warm, How Come It's So Darned Cold?,' available at <http://www.columbia.edu/~jeh1/Mailings/2010/20100115_Temperature2009.pdf>. It is also noteworthy that the occurrence of an El Niño is at least part of the explanation for the winter weather of 2009–10.
31. For evidence that the warming that has already occurred will affect the future of the planet for more than a millennium, see Solomon et al. 2009.
32. 'Give a small boy a hammer, and he will find that everything he encounters needs pounding' (Kaplan 1968: 28).

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CHAPTER 4

THE POVERTY OF CLIMATE ECONOMICS

MARK SAGOFF*

A *New Yorker* cartoon illustrates the intergenerational aspect of climate change. It shows an Eskimo mother, father, and young child as they wave a tearful goodbye to an old man, presumably a grandparent, whom they have placed on an ice floe. The family itself stands on a floating piece of ice. Which generation is responsible for the plight of which?

I want to argue that the intergeneration aspect of climate change makes economic reasoning about it more problematic than one might think. Economic reasoning looks for ways more efficiently to allocate or exchange property rights and—sometimes by determining those rights—to resolve collective action dilemmas. I shall argue that this kind of analysis cannot apply to our relations to people in the further future because we have no reason to trust them and, even if we did, they can do nothing for us. If ability to pay is a prerequisite of willingness to pay (WTP), moreover, then future generations cannot be willing—because they are not able—to pay us anything. Since they do not yet exist, they cannot have property rights. Even if they did exist, if they are made destitute by climate change, they will not be in a position to pay anyway. There can be no 'benefit of trade' or 'reciprocity of advantage' with them. I shall argue that the passivity of future generations undermines economic instruments to 'cap' and 'trade' greenhouse gas (GHG) allowances. The economic value of these allowances is more likely to reflect bets on the likelihood of enforcement than the marginal costs of 'clean' energy technologies.

This chapter will argue that an efficient allocation of resources, since it depends on exhausting the benefits of trade among the people who can trade (the living), cannot in any direct way respond to the needs or interests of future generations. An efficient policy therefore cannot be a sustainable policy. That economic theory is limited in this way suggests we must rely on other reasons and rationales to justify a response to climate change.

* The author gratefully acknowledges support from the National Science Foundation Grant No. SES 0924827. The views expressed are those of the author alone and not necessarily of any foundation or agency.

1 Climate Change Is Not a Collective Action Problem

According to one commentator, 'Climate change is a collective action problem *par excellence*' (Harris 2007: 196). One can see the appeal of this analysis. In 1965, Mancur Olsen in *The Logic of Collective Action* showed that when each individual acts on self-interest, for example, to 'free ride' on the more socially motivated action of others, public goods will not be produced. Olson wrote, 'Unless the number of individuals in a group is quite small, or unless there is coercion or some other special device to make individuals act in their common interest, rational, self-interested individuals will not act to achieve their common or group interests' (1965: 2). In a much-cited article popularizing this analysis, Garrett Hardin argued that the rational proclivity of each individual to except him or herself from cooperation (to 'free ride' on the rest) made the destruction of public goods the likely result of liberty. 'The only kind of coercion I recommend is mutual coercion, mutually agreed upon by the majority of the people affected' to preserve or provide a public good (Hardin 1968: 1243–8).

A little reflection, however, suggests that the 'tragedy of the commons' analysis does not fit the problem of climate change. In the typical collective-action problem, such as managing a commons or preventing defections in a 'prisoner's dilemma' game, each person will gain if all cooperate and all will lose if each acts in his or her own individual self-interest. In the case of climate change, however, people alive today and through the next generation will sacrifice, for example, by forgoing the consumption of inexpensive fossil fuels. A different collection of people, whom one might call 'posterity,' will benefit. Olsen defines a 'group' as 'a number of individuals with a common interest.' It is not clear, however, that people alive today share a common interest with posterity. People alive today have a conflicting interest—not a common interest—with those who will inhabit the earth after we are all dead.

The coercion necessary to solve a collective action problem is justified by the mutual reciprocity of advantage, that is, the idea that each person gains more by the restriction of the freedom of others than he or she loses by accepting that same restriction. In the context of climate change, however, the winners and the losers are different—so different, in fact, that those who make sacrifices (or accept restrictions) may be long gone before posterity appears to enjoy the fruits of the sacrifices earlier generations had made for them. If one assumes—as I shall for the sake of argument—that those who make sacrifices to mitigate climate change will all be dead before those who benefit from their sacrifices appear, no relevant 'common interest' exists to establish a collective action dilemma. This hardly implies that we have no responsibility for the further future. The justification for sacrifice, however, would seem to lie in extraordinary altruism rather than in enlightened self-interest.

I am hardly the first to argue that climate change cannot be analyzed in terms of the logic of collective action. Stephen Gardiner, for example, has noted that climate change represents a lagging phenomenon 'because some of the basic mechanisms set in motion by the greenhouse effect—such as sea level rise—take a very long time to be fully realised.' Because of this, the mechanism of mutual coercion mutually agreed upon is unavailable. The

obstacle to bargaining 'arises because the parties do not coexist, and so seem unable to even influence each other's behaviour through the creation of appropriate coercive institutions' (Gardiner 2006).

The irrelevance of the logic of collective action to climate change becomes even more apparent when we reflect that we have no way to control the behavior of future generations. Even if we conceive of them as partners in arranging a system of controls that greatly reduces GHGs, there is no way to bind them to whatever discipline we manage to exert over ourselves. We have to 'go first' in this game. They could undo what we had done.

2 An Objection

To this argument a reader might object that a collective action problem arises because we can act individually to provide our great-grandchildren some things, like trust funds, but not other things, like a stable climate. A collective action problem, however, arises only if two conditions are met: (1) individuals can achieve some common goal together that they cannot achieve alone; and (2) they gain more from the sacrifice of others than they lose from making the same sacrifice. To see the importance of the second condition, consider the example of light pollution. We would all like to be able to see the stars at night—but in cities we cannot because there is too much diffused light pollution from household illumination, streetlights, and headlamps. If I turn out my lights and wander about in the dark, I do little to restore the splendor of the stars. Since everyone is in the same situation, we might seem to have a collective action problem. To get to see the stars in all their glory, we all have to turn off our lights—car lights, street lights, and houselights. Is the collective gain worth the individual cost? People may not think it worth the candle—in other words, they might rationally believe that the collective benefit of a magnificent starscape is not worth the individual cost of stumbling around in the dark.

We may think about climate change the same way. We may share a fine sentiment that it would be nice, if all else were equal, that our great-great-grandchildren had the same 'option' to screw up the climate as we have today. Yet few of us may be willing even in common with others to make the necessary sacrifices to act on that shared sentiment. To show otherwise, one may need to provide evidence that political conditions have changed since 22 February 1977, when President Jimmy Carter, voted out of office after one term, in a cardigan sweater urged the nation to conserve energy. As of this writing, John Boehner (Republican, Ohio), who has publicly scoffed at the idea that carbon dioxide is a pollutant, is likely to become the Speaker of the House.

3 Climate Change is Not a Market Failure

In a much discussed report issued in 2006, British economist Nicholas Stern described climate change as 'a unique challenge for economics: it is the greatest and widest-ranging market failure ever seen.' William Nordhaus (2009) stated, 'Emissions of carbon dioxide are externalities, i.e, social consequences that are not accounted for in the market place.'

Jonathan Weiner (2003) described climate change as 'a classic market failure, an "externality" that ordinary market operations . . . will not correct.' Law professor Jedediah Purdy (2008) has written, 'Climate change threatens to be, fairly literally, the externality that ate the world.'

Climate change represents an 'externality' if we mean any cost to any party not directly involved in a decision or activity that affects him or her. Since we cannot bargain with people in generations past, however, their effects on us—which are pervasive and ubiquitous—cannot be considered market failures although these effects are 'externalities' in an extended sense. Is an 'unpriced' harm to unborn or hypothetical people a market failure? A market fails when it does not implement gains that can be achieved through trade. A market that implements the gains that can be achieved through trade may ignore the interests of those who cannot trade. Individuals not yet born cannot trade. An efficient market, then, may ignore the interests of later generations.

The idea of market exchange or market activity—and therefore the model of market failure—depends on the existence of WTP to acquire goods and willingness to accept (WTA) compensation to relinquish them. An economist who asked respondents how much they would accept as payment from future generations to mitigate GHG emissions could not expect an answer. The only payments that can be made to current people must come from current sources—thus people would have to pay themselves. If WTP is the way we measure welfare effects, moreover, it is completely meaningless in the case of future generations.

In an influential analysis, Ronald Coase (1960) argued that the fundamental reason that externalities arise lies in the costs third parties would have to bear to enter or influence the relevant activities or decisions. Richard Zerbe and Howard McCurdy (2000) have written, 'The externalities on which market failure analysts tend to focus are defined by transactions costs. In essence, externalities exist because the transactions costs of resolving them are too high. In this sense, every story about externalities and market failures is also a story about transactions costs.'

What kind of story about transaction costs explains climate change as a market failure? In the usual case of pollution, one may refer to the costs of bargaining with or bringing a legal action against a polluter. With climate change the problem is that the victims do not yet exist and thus that the concept of a transaction cannot apply. If there cannot be transactions there cannot be associated costs, however large or even infinite. Because no one can tell a plausible story about market exchange or transaction costs, no one may be able to show that climate change is a market failure at least as Coase understood that concept. This may have more to do with metaphysics than with markets.

The essential problem is that future generations play a passive role in our decisions. We can affect them but they cannot affect us. They are epiphenomenal. Our relation to them is not a market relationship but an ethical, political, or spiritual one. A market analogy—the idea of market failure—provides a poor model for understanding climate change and might have the untoward effect of misleading us about the motives and reasons that justify GHG limits. Since future generations do not exist, they cannot pay for anything. Nor can they accept payment. Nor are they likely to be able and thus willing to pay us anything when they come into being because they will not be able to find us (whatever they pay in 'travel costs') or by that payment alter what we had already done. To invoke a market-based justification may be to defeat regulation.

4 Property Rights

Consider the hoary Pigouvian example of the uncompensated damage done to a woods by sparks from railway engines. The operator of the railroad owns the right to use the woods in this way—as a catchment for engine sparks—as long as there is no legal rule against it and the wind blows the sparks this way or that. One may regret that things work this way; if one owns the forest one might sue the railroad to enjoin this right—but the right belongs to the railroad until it is taken (by a legal judgment, for example) and awarded to the owner of the forest.

Both the railroad owner and the forest owner have equal rights to uses of the forest but, because the land cannot in fact be used simultaneously to grow trees and catch sparks (let us assume), these rights conflict. The forest owner sues. Whether the courts impose an injunction, award damages, or just let the chips (or sparks) fall where they may is a question to be answered by judges and juries through the incremental wisdom of common law. One cannot show within economic theory that one party (the forester) really or originally or fundamentally 'owns' the right to its use of the forest, while the other creates an illegitimate 'externality.' As Coase argued, it takes two to create an 'externality'—the forest owner contributes by insisting on growing trees, for example, just where the railroad engine throws sparks (Coase 1960). Each side has an equal property right—the legal system or the government does not create the right asserted by the railroad owner or by the forester but decides which of these uses prevails when they conflict.

Now consider the analogy between the Pigouvian railroad and climate change. The GHGs we emit will harm future generations just as the sparks the railroad emits harm the forester. This tells us nothing, however, about property rights. These have to be adjudicated; they are not determined by God or found in nature. The relevant property rights belong to those who use them—emitters of GHGs included—until a judgment, rule, or settled expectation decides which right should prevail. The legal, social, and political institutions that typically adjudicate conflicts, however, are not good at recognizing future generations.

In liberal political theory, property rights to previously unowned aspects of nature have been associated with priority of acquisition and with the labor needed to develop wild lands and raw materials. The famous Lockean proviso that no one could acquire resources out of the commons except if there were as much and as good for others—or 'no prejudice to any others'—has often been repeated. For example, Michael Otsuka (2003: 24) has written, 'You may acquire previously unowned worldly resources if and only if you leave enough so that everyone else can acquire an equally advantageous share of unowned worldly resources.' Who is it that 'everyone else' includes? If 'everyone else' includes all future generations then there is a paradox. At some point at least in the distant future virtually any currently unowned resource may become scarce. If one had to assure an 'equally advantageous share' to future as well as contemporary potential claimants, no one might ever be able to take anything from the commons. But if one had to assure only the share of contemporary claimants, then possibly catastrophic acquisitions or alterations of the commons with long lag times or delayed effects may be permitted.

Consider an analogy. My neighbor at the top of the road maintains a magnificent garden which I enjoy each time I drive by it. I believe I have the right to gaze at her garden—a property right, if you will, in that use of it. What is wrong with that? Is it that I fail to compensate her for her efforts? That I have not reached an agreement with her beforehand? It is clear that she owns her garden from the point of view of the land and I own it from the point of view of the spectacle, at least when I view it. Since there is no conflict between her using the garden to putter and my using it to admire, we keep our rights and nothing is done to characterize or codify them.

Now suppose that scientists found out that when passers-by admire a garden they deplete it in some way so that gardeners a hundred years from now will have to plant different kinds of flowers to withstand further admiration or build high walls to keep admirers from seeing them. At that point we face a puzzle. How should we deal with the conflict between my admiring the garden now and the ability of my neighbor's great-grandchildren (if they still live in the house) to raise the same sort of flowers or to do so without building high walls? Do homeowners in the further future have a right to grow the kinds of gardens we grow now in the places we grow them? How do these future people claim or exercise those rights? How do these rights cancel my own—turn my enjoyment of the garden from a right into an uncompensated harm or an 'externality'? To be sure I have no right to harm my neighbor, but my enjoyment of her garden is harmless to her. I do not share the environment with future generations as I do with my neighbor. It is unclear how I share the environment with them.

Future generations may not have claims against those who acquire or privatize unowned resources even when this may be prejudicial to them. On this view, people could continue to emit GHGs right up to the time that the ill consequences weigh on them and their contemporaries. This seems to be the view of Hugo Grotius (1583–1645): '[H]e who is not yet born, can have no right, as that Substance which is not yet in Being has no Accidents. Wherefore if the People (from whose Will the Right of Government is derived) should think fit to alter that will, they cannot be conceived to injure those that are unborn, because they have not as yet obtained any Right' (Grotius 1625). According to Matthias Risse (2010), Grotius held that 'the domain of what is commonly owned simply is whatever is left to any given generation. It is up to each generation how much it leaves behind.' This seems as far as market-based notions take us. We must look to concepts of equity not efficiency to find a basis for dealing with climate change.

5 Cap and Trade

I have argued so far that climate change cannot usefully be diagnosed in terms of a collective action problem, a market failure problem, or a problem in defining and exchanging property rights. One can concede this and propose nevertheless that a market model should inform our response to the threat of climate change. Let us say that society decides to limit GHGs to an 'acceptable' level. One could contend that a market should be constructed to allocate efficiently the emissions that are allowed in order to minimize the pain to consumers.