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Reducing the Future to Climate:
A Story of Climate Determinism and Reductionism

by Mike Hulme[*]

ABSTRACT

This article traces how climate has moved from playing a deterministic to a reductionist role in discourses about environment, society, and the future. Climate determinism previously offered an explanation, and hence a justification, for the superiority of certain imperial races and cultures. The argument put forward here is that the new climate reductionism is driven by the hegemony exercised by the predictive natural sciences over contingent, imaginative, and humanistic accounts of social life and visions of the future. It is a hegemony that lends disproportionate power in political and social discourse to model-based descriptions of putative future climates. Some possible reasons for this climate reductionism, as well as some of the limitations and dangers of this position for human relationships with the future, are suggested.

> The general attitude of many critics, however, is in keeping with the reaction during the last few decades against the simple determinism [of Ellsworth Huntington] which led to what Lattimore . . . has described as "the romantic explanation of *hordes* of erratic nomads, ready to start for lost horizons at the joggle of a barometer in search of suddenly vanishing pastures."
>
> Gordon Manley, 1944[1]

> At plus-4 degrees, *hordes* of climate refugees would flee famine and extreme water scarcity. At plus-5 degrees, climate refugees would number in the tens of millions as massive uninhabitable zones spread.
>
> Joanne Ostrow, 2008[2]

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[1] Manley, "Some Recent Contributions to the Study of Climatic Change," *Quarterly Journal of the Royal Meteorological Society* 70 (1944): 197–220, on 220 (emphasis added).

[2] Ostrow, "'Six Degrees' Charts Climate Apocalypse in HD Television," Denverpost.com, February 8, 2008, http://www.denverpost.com/ostrow/ci_8190284 (accessed 19 January 2011; emphasis added). Ostrow's article is a review of *Six Degrees Could Change the World*, a National Geographic TV documentary based on Mark Lynas's award-winning book *Six Degrees* (New York, 2007).

INTRODUCTION

Human beings are always trying to come to terms with the climates they live with. This is as true for the ways the relationship between society and climate is theorized as it is for the practical challenges of living fruitfully and safely with climatic resources and hazards. The story of how the idea of climate has traveled through the human imagination is well told in Lucian Boia's *The Weather in the Imagination*,[3] and an exemplary account of how a society seeks practically to live with its climate is William B. Meyer's *Americans and Their Weather*.[4] When people reflect on these relationships between society and climate, they frequently adopt two intuitive positions. On the one hand it is obvious that climates influence and shape human psychological, biological, and cultural attributes. This is true for individual behaviors, cultural practices, and environmental resources. Yet it is equally true that an enduring strand of human encounters with climate seeks both to tame these climatic influences and constraints and to live beyond them. Human beings change microclimates, insulate themselves against climatic extremes, and adapt technologies and practices for survival and prosperity.[5]

Attempts to understand and theorize the relationship between climate and society are therefore prey to two distinct fallacies. The first is that of "climate determinism," in which climate is elevated to become a—if not *the*—universal predictor (and cause) of individual physiology and psychology and of collective social organization and behavior. The second fallacy is that of "climate indeterminism," in which climate is relegated to a footnote in human affairs and stripped of any explanatory power. Geographers have at times been most guilty of the former fallacy, historians at times most guilty of the latter.[6] Yet not even historical geographers or environmental historians have been always able to hold these two opposing fallacies in adequate and creative tension.[7]

At the beginning of the twentieth century, the determinist fallacy achieved considerable salience and popularity in European and, especially, American thought, championed by the likes of the geographers Friedrich Ratzel, Ellen Semple, and Ellsworth Huntington.[8] Climate was viewed as the dominant determinant of racial character, intellectual vigor, moral virtue, and the ranking of civilizations, ideas that had earlier appealed to Greek philosophers and European rationalists alike.[9] However, the ideological wars of the mid-twentieth century reshaped the political and moral worlds that had nourished such thinking, and determinism became discredited and marginalized within mainstream academic geography.

[3] Boia, *The Weather in the Imagination* (London, 2005).

[4] Meyer, *Americans and Their Weather* (New York, 2000).

[5] William W. Kellogg and Stephen H. Schneider, "Climate Stabilization: For Better or for Worse?" *Science* 186 (1974): 1163–72.

[6] Gabriel Judkins, Marissa Smith, and Eric Keys, "Determinism with Human-Environment Research and the Rediscovery of Environmental Causation," *Geogr. J.* 174 (2008): 17–29.

[7] Oskar H. K. Spate, "Toynbee and Huntington: A Study in Determinism," *Geogr. J.* 118 (1952): 406–24.

[8] Richard Peet, "The Social Origins of Environmental Determinism," *Ann. Assoc. Amer. Geogr.* 75 (1985): 309–33; James Rodger Fleming, *Historical Perspectives on Climate Change* (New York, 2005); Innes Keighren, *Bringing Geography to Book: Ellen Semple and the Reception of Geographical Knowledge* (London, 2010); Georgina Endfield in this volume.

[9] David N. Livingstone, "Race, Space and Moral Climatology: Notes toward a Genealogy," *J. Hist. Geogr.* 28 (2002): 159–80.

Now, a hundred years later, and at the beginning of a new century, heightening anxieties about future anthropogenic climate change are fueling—and in turn being fueled by—a new variety of the determinist fallacy. Although this variety is distinct from the politically and ethically discredited climate determinism epitomized by Huntington and his followers, climate has regained some of its former power for "explaining" the performance of environments, peoples, and societies. In seeking to predict a climate-shaped future, proponents of this logic reduce the complexity of interactions between climates, environments, and societies, and a new variant of climate determinism emerges. I call this "climate reductionism," a form of analysis and prediction in which climate is first extracted from the matrix of interdependencies that shape human life within the physical world. Once isolated, climate is then elevated to the role of dominant predictor variable. I argue in this article that climate reductionism is a methodology that has become dominant in analyses of present and future environmental change—and that as a methodology it has deficiencies.

This way of thinking and analyzing finds expression in some of the balder (and bolder) claims made by scientists, analysts, and commentators about the future impacts of anthropogenic climate change. Here are some examples of claims that emerge from this climate reductionist form of analysis:

- "Every year climate change leaves over 300,000 people dead."
- "We predict, on the basis of mid-range climate-warming scenarios for 2050, that 15–37% of species . . . will be 'committed to extinction.'"
- "185 million people in sub-Saharan Africa alone could die of disease directly attributable to climate change by the end of the century."
- "The costs and risks of climate change will be equivalent to losing at least 5% of global GDP each year, now and forever . . . [rising to] 20% of GDP or more."
- "I think there will be substantial change [in climate] whatever we do. If we do nothing over the next 20 years it will be catastrophic. If we do nothing over the next 50 to 100 years it might even be terminal."[10]

Such reductionism is also contributing to the new discourse about climate change and conflict. For example, climate change is offered as an explanation of cycles of war and conflict in China over the last millennium: "It was the oscillations of agricultural production brought about by long-term climate change that drove China's historical war-peace cycles."[11] The civil war in Darfur is categorized in the media as a harbinger of future climate-driven disputes: "In decades to come, Darfur may be seen as one of the first true climate change wars."[12] The recent report *Climate Change as a Security Risk*, from the German Advisory Council on Global Change, was reported in similar neodeterminist tones in the media: "Climate Change to Cause Wars in North

[10] Respectively, these are quoted from Global Humanitarian Forum, *The Anatomy of a Silent Crisis* (Geneva, 2009), 1; Chris D. Thomas et al., "Extinction Risk from Climate Change," *Nature* 427 (2004): 145–8, on 145; Christian Aid, *The Climate of Poverty: Facts, Fears and Hope* (London, 2006), 3; Nicholas Stern, *The Economics of Climate Change: The Stern Review* (Cambridge, 2006), xv; Andrew J. Watson, "Gaia and Accelerating Climate Change," transcript of ABC Radio National program, broadcast January 20, 2007.

[11] David D. Zhang, Jane Zhang, Harry F. Lee, and Yuan-qing He, "Climate Change and War Frequency in Eastern China over the Last Millennium," *Human Ecology* 35 (2007): 403–14, on 413.

[12] J. Borcher, "Scorched," *Guardian*, April 28, 2007.

Africa" and "Climate Change 'Likely to Cause Wars.'"[13] And a team of agricultural and resource economists went even further in predicting the effect of temperature increases on future battle deaths in Africa: "[The] historical response to temperature suggests an additional 393,000 battle deaths [by 2030] if future wars are as deadly as recent wars."[14]

In a view related to this belief that climate plays an explanatory role in determining war, climate refugees are seemingly set to threaten global, regional, and national security in a rerun of the Mongol invasions of Europe alluded to by Owen Lattimore in his caricature of Huntington's climatic theory of world history, quoted in this article's first epigraph. The term "climate refugees" was invented by Norman Myers in a 1993 article,[15] and his estimate of between 150 and 250 million climate refugees by 2050 has been subsequently widely cited. It is a claim that easily translates into powerful rhetoric, as in this example from the Royal United Services Institute in the United Kingdom: "If we fail to stop polluting, we will be committed to catastrophic and irreversible change . . . which will directly displace hundreds of millions of people and critically undermine the livelihoods of billions."[16] And recent work has sought to quantify this climate change effect on migration more precisely: "By approximately the year 2080, climate change is estimated to induce 1.4 to 6.7 million adult Mexicans to emigrate [to the United States] as a result of declines in agricultural productivity alone."[17]

In this new mood of climate-driven destiny the human hand, as the cause of climate change, has replaced the divine hand of God as being responsible for the collapse of civilizations, for visitations of extreme weather, and for determining the new twenty-first-century wealth of nations.[18] And to emphasize the message and the mood, the New Economics Foundation and its partners have wound up a climate clock that is now ticking, second by second, until December 1, 2016, when human fate will be handed over to the winds, ocean currents, and drifting ice floes of a destabilized global climate: "We have 100 months to save the planet; when the clock stops ticking we could be beyond the climate's tipping point, the point of no return."[19] Such eschatological rhetoric offers a post-2016 world where human freedom and agency are extinguished by the iron grip of the forces of climate. Such a narrative offers scant

[13] See, respectively, German Advisory Council on Global Change, *Climate Change as a Security Risk* (London, 2008); "Climate Change to Cause Wars in North Africa," Jordan Environment Watch, January 19, 2008, http://www.arabenvironment.net/archive/2008/1/444843.html (accessed 6 July 2009; site now discontinued); "Climate Change 'Likely to Cause Wars,'" *Daily Telegraph*, December 10, 2007.

[14] Marshall B. Burke, Edward Miguel, Shanker Shatyanath, John A. Dykema, and David Lobell, "Warming Increases the Risk of Civil War in Africa," *Proceedings of the National Academy of Sciences* 106 (2009): 20670.

[15] Myers, "Environmental Refugees in a Globally Warmed World," *Bioscience* 43 (1993): 752–61; although see also Svante Arrhenius, *Worlds in the Making: The Evolution of the Universe* (New York, 1908), 53, where the concept, although not the language, is also mentioned.

[16] Nick Mabey, *Delivering Climate Security: International Security Responses to a Climate Changed World*, Whitehall Papers, no. 69 (London, 2007).

[17] Shuaizhang Feng, Alan B. Krueger, and Michael Oppenheimer, "Linkages among Climate Change, Crop Yields and Mexico-US Cross-Border Migration," *Proceedings of the National Academy of Sciences* 107 (2010): 14257.

[18] See, respectively, Jared Diamond, *Collapse: How Societies Choose to Fail or Succeed* (London, 2005); Vladimir Jankovic, "Change in the Weather," *Bookforum*, February/March 2006, 39–40; Stern, *Economics of Climate Change* (cit. n. 10).

[19] "One Hundred Months" Web site, New Economics Foundation, http://www.onehundredmonths.org (accessed 19 January 2011).

chance for humans to escape a climate-shaped destiny.[20] James Lovelock offers the most vivid melodrama of such a predetermined fate. We are traveling, he says, on "a rocky path to a Stone Age existence on an ailing planet, one where few of us survive among the wreckage of our once biodiverse Earth."[21]

My argument in this article is that these sentiments, and many others that invade contemporary public and political discourses of climate change, are enabled by the methodology of climate reductionism (i.e., a form of neoenvironmental determinism). Simulations of future climate from climate models are inappropriately elevated as universal predictors of future social performance and human destiny. I am not alone in making this argument, even if my focus here is exclusively on climate rather than on the role of the wider physical environment. For example, geographers Andrew Sluyter, Christopher Merrett, and Gabriel Judkins (lead author of a study with Marissa Smith and Eric Keys) have all detected evidence of a resurgence of the determinist fallacy, citing examples from the work of Jared Diamond in *Guns, Germs and Steel* and *Collapse* and Geoffrey Sachs in *The End of Poverty* and *Common Wealth*.[22]

After offering a brief account of how climate reductionism has come to prominence, I turn my attention to understanding why this should be. Why should an explanatory logic—if not an ideology—dating from earlier intellectual and imperial eras, a logic subsequently dismissed by many as seriously wanting, have reemerged in different form in a new century to find new and enthusiastic audiences? Rather than offering an explanation, and hence a justification, for the superiority of imperial societies, cultures, and races—as in past ideological variants of determinism—I will suggest here that climate reductionism holds a different attraction for contemporary audiences, and I will demonstrate how it has come to prominence.

I suggest that the hegemony exerted by the predictive natural sciences over human attempts to understand the unfolding future opens up the spaces for climate reductionism to emerge. It is a hegemony manifest in the pivotal role held by climate (and related) modeling in shaping climate change discourses. Because of the epistemological authority over the future claimed, either implicitly or explicitly, by such modeling activities, climate becomes the one "known" variable in an otherwise unknowable future. The openness, contingency, and multiple possibilities of the future are closed off as these predicted virtual climates assert their influence over everything from future ecology, economic activity, and social mobility to human behavior, cultural evolution, and geosecurity. It is climate reductionism exercised through what I call "epistemological slippage"—a transfer of predictive authority from one domain of knowledge to another without appropriate theoretical or analytical justification.

Before elaborating this proposition, I first offer a brief account of the decline in climate determinism through the twentieth century and illustrate the recent rise of reductionist thinking. I then defend my thesis—that climate reductionism results from the enterprise of climate prediction and the practice of epistemological

[20] Christina R. Foust and William O. Murphy, "Revealing and Reframing Apocalyptic Tragedy in Global Warming Discourse," *Environmental Communication* 3 (2009): 151–67; Stefan Skrimshire, ed., *Future Ethics: Climate Change and Apocalyptic Imagination* (London, 2010).

[21] Lovelock, *The Revenge of Gaia: Why the Earth Is Fighting Back—and How We Can Still Save Humanity* (London, 2006), 4.

[22] See, respectively, Sluyter, "Neo-environmental Determinism, Intellectual Damage Control and Nature/Society Science," *Antipode* 35 (2003): 813–7; Merrett, "Debating Destiny: Nihilism or Hope in *Guns, Germs and Steel*?" *Antipode* 35 (2003): 801–6; Judkins, Smith, and Keys, "Determinism" (cit. n. 6).

slippage—drawing upon key events, developments, and texts from the 1960s to 1990s. In particular I demonstrate the asymmetry between representations of future climate and social change that has persisted in the conduct of climate impact assessments. I conclude the article by placing this reductionist tendency within a wider cultural context of Western pessimism and loss of confidence about the future and by pointing toward some correctives that involve restructuring ideas about how the future can be imagined and made known.

THE DEMISE OF CLIMATE DETERMINISM

The story of environmental determinism, and especially the climatic variant on which I focus, is well known—at least it is well known to academic geographers who have had to wrestle with the difficult relationships between environmental conditions and human agency ever since the discipline took form in the later nineteenth century.[23] The argument of previous generations of determinists was that aspects of climate exerted a powerful shaping influence on the physiology and psychology of individuals and races, which in turn shaped decisively the culture, organization, and behavior of the society formed by those individuals and races. Tropical climates were said to cause laziness and promiscuity, while the frequent variability in the weather of the middle latitudes led to more vigorous and driven work ethics. Evidence of these discourses has been well reviewed for the period up to 1800 by Clarence Glacken and for the late nineteenth century in a series of papers by David Livingstone as well as by Mark Carey.[24]

This is a determinism that *makes* human and social character. There is also a form of climate determinism that *moves* people. Thus Lattimore's "hordes of erratic nomads" cited at the beginning of this article are driven, almost involuntarily, by climate variations in search of better pastures, while accounts of Viking arrivals and departures to and from Greenland have sometimes given the impression that they were driven solely by the oscillations of warmth and cold.[25] Both these manifestations of climate determinism—the making of character and the moving of people—emphasize the agency of climate over the agency of humans. In more extreme articulations of the idea—"strong determinism," according to Judkins[26]—the human will becomes hostage to the fortunes of climate, too passive and powerless to respond proactively, or even reactively, to changes in environmental fortune.

The apparent simplicities of climate determinism appealed to philosophers of the Grecian Empire (such as Herodotus and Hippocrates) and to rationalists of the European Enlightenment (such as Montesquieu and Hume).[27] They also appealed to late nineteenth- and early twentieth-century European and, especially, American geographers. The work of Yale geographer Ellsworth Huntington (1876–1947) best en-

[23] Harold MacKinder, "On the Scope and Methods of Geography," *Proceedings of the Royal Geographical Society* 9 (1887): 141–60.

[24] Glacken, *Traces on a Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century* (Berkeley, Calif., 1967); Livingstone, "Tropical Climate and Moral Hygiene: The Anatomy of a Victorian Debate," *Brit. J. Hist. Sci.* 32 (1999): 93–110; Livingstone, "Race, Space and Moral Climatology" (cit. n. 9); Carey in this volume.

[25] Ian Whyte, *World without End? Environmental Disaster and the Collapse of Empires* (London, 2008).

[26] Judkins, Smith, and Keys, "Determinism" (cit. n. 6).

[27] Fleming, *Historical Perspectives* (cit. n. 8).

capsulates the theory's rise during the apogee of modern European and American imperialism. Huntington's major works—from his 1915 *Civilisation and Climate* to his 1945 *Mainsprings of Civilisation*—gained him a contemporary popularity, but among his academic colleagues he generated a range of contrary reactions. As one of his protégés, Stephen Visher, admiringly remarked in an obituary published in 1948, "His eagerness to arrive at the big truths, the ultimate principles that crown scientific work, was disturbing to cautious scholars."[28] For example, anthropologist Franz Boas was consistently irked by Huntington's simplistic statistical methods, which, Boas argued, offered merely a fig leaf of scientific credibility to Huntington's claims.

Based on his belief that there were optimal—and universally optimal—climates for physical and mental activity, Huntington drew upon a number of empirical studies of factory workers in America to suggest that 20°C and a humidity of 60 percent maximized productivity.[29] It was a short step from here to postulate that the energy and vigor needed to develop and sustain civilizations was also related to these climatic optima, giving rise to his "mainsprings of civilization" hypothesis. And for Huntington a further short step into the emerging field of genetic selection was to bring him in the 1920s under the influence of the American eugenics movement.

Huntington's determinism was centrally concerned with the tracing of patterns of climate in history, rather than with predicting the future fates of civilizations. The British politician and writer Sydney Markham, however, later developed and applied some of these determinist arguments in a different direction. In *Climate and the Energy of Nations*, published in 1942, Markham argued that climate variations could not only explain the rise and fall of past civilizations, but could also explain and predict the changing geopolitical balance of power in his mid-twentieth-century world. The dependence of contemporary social and economic factors such as trade, wealth creation, and human mortality rates on climate offered Markham a way of interpreting the tumultuous decade in which he wrote—the 1940s—and foreseeing the political prospects of nations such as Russia, China, and the United States as well as of Europe.[30]

As with its rise, there is no shortage of accounts of the demise of environmental determinism in geographic thought. Noel Castree claims that the "excesses of determinism" had been countered by the 1930s,[31] while others from different sectarian perspectives suggest earlier timelines for this demise. Kent McGregor suggests that environmental determinism was subjected to increasing skepticism from the 1920s onward and "by mid-century had run its course,"[32] and the climatologist Richard Skaggs also claims that "environmental determinism lost intellectual efficacy . . . during the 1920s."[33] The Marxist geographer Richard Peet puts it more bluntly: "Environmental determinism became increasingly socially dysfunctional in the 1920s after the main issues of imperialist domination of the world had been

[28] Visher, "Memoir to Ellsworth Huntington, 1876–1947," *Ann. Assoc. Amer. Geogr.* 38 (1948): 38–50, on 43.
[29] Ellsworth W. Huntington, *Civilization and Climate* (1915; repr., Honolulu, 2001).
[30] Sydney F. Markham, *Climate and the Energy of Nations* (London, 1942).
[31] Castree, *Nature* (London, 2005).
[32] McGregor, "Huntington and Lovelock: Climatic Determinism in the 20th Century," *Physical Geography* 25 (2004): 237–50, on 238.
[33] Skaggs, "Climatology in American Geography," *Ann. Assoc. Amer. Geogr.* 94 (2004): 446–57, on 447.

settled by World War I."[34] And from a cultural and political ecology standpoint, Judkins claims that the "historical moment" when determinism handed over to possibilism was around 1920.[35]

The strong form of climate determinism was therefore largely discredited and marginalized as the ideological wars of the twentieth century reshaped the political and moral worlds that had allowed it to flourish. Academic geography embraced more descriptive and reflexive conceptions of the relationships between nature and society. In the 1920s and 1930s the possibilism of Vidal de la Blache and Carl Sauer offered satisfying ways of keeping the role of climate and the environment at more comfortable distances from theories of social organization and cultural history. The consequence was, according to Sluyter, that "geographers abandoned any concerted attempt at nature-society explanations and most of them re-aligned with either the natural or the social sciences."[36]

Vestiges of Huntington's strong determinism nevertheless still lingered among those engaged in talking about and analyzing climatic data in the context of society and behavior. Meyer discusses the persistence of climate determinism in American thought and culture through the middle decades of the twentieth century in *Americans and Their Weather*.[37] For example, Huntington's final book—*Mainsprings of Civilization*—was published in America in 1945 and was criticized at the time by Oskar Spate for offering a "pattern to history too much determined by physical factors."[38]

Elsewhere, too, climatic determinism remained ingrained in the way some climatologists and other scholars wrote about climate and its role in the world. Sociologist Nico Stehr has deconstructed the 1938 essay "Kultur und Klima" by German social psychologist Willy Hellpach, thereby offering an insight into the relationship between Nazi ideology and climatic determinism.[39] Determinism in fact offered a softening of the strident Nazi racism, by claiming that people could be "improved" if they were put in the right environment; it was not all down to Aryan genetic ancestry.

In England, Austin Miller's classic textbook *Climatology*, which went through nine editions between 1931 and 1961, was still claiming in its ninth edition in 1961 that "the enervating monotonous climates of much of the tropical zone . . . produce a lazy and indolent people,"[40] while in the 1950s the prolific English climatologist Charles Brooks was taken to task for the determinist outlook pervading his bestselling book *Climate in Everyday Life*.[41] One reviewer of the book complained, "The author has apparently not realised that the fumbling, prejudice-ridden speculations on human climatology which marked the earlier years of this century must now be replaced by . . . more adequate enquiries and emancipated from the restrictions of a race-dominant culture."[42] And in 1958, also in England, Gordon Manley was writing

[34] Peet, "The Social Origins of Environmental Determinism," *Ann. Assoc. Amer. Geogr.* 75 (1985): 309–33, on 327.
[35] Judkins, Smith, and Keys, "Determinism" (cit. n. 6).
[36] Sluyter, "Neo-environmental Determinism" (cit. n. 22), 816.
[37] Meyer, *Americans and Their Weather* (cit. n. 4), 168–72, 206–14.
[38] Spate, "Toynbee and Huntington" (cit. n. 7), 414.
[39] See, respectively, Stehr, "The Ubiquity of Nature: Climate and Culture," *J. Hist. Behav. Sci.* 32 (1996): 151–9; Hellpach, "Kultur und Klima," in *Klima-Wetter-Mensch*, ed. Heinz Wolterek (Leipzig, 1938), 428–9.
[40] Miller, *Climatology*, 9th ed. (London, 1961), 2.
[41] Brooks, *Climate in Everyday Life* (New York, 1951).
[42] Douglas H. K. Lee, "Book Review," *Quart. Rev. Biol.* 27 (1952): 75–6, on 76.

about the revival of climate determinism,[43] even if a weaker variant, with a poorly disguised ambivalence about the adequacy of earlier deterministic theories: "It is an opportune moment to be reminded that man is still subject to a variety of constraints that may yet be imposed by Nature."[44]

THE RISE OF CLIMATE REDUCTIONISM

Notwithstanding these examples, the fortunes of strong determinism, both as an ideology and as an explanatory framework for climate-society relationships, waned over the twentieth century. Yet with the emergence over the last twenty-five years of anthropogenic climate change as a physical and social phenomenon of worldwide importance, the question of how the challenging relationship between climate and society is conceived has taken on fresh importance. Geographer William Riebsame has offered four ways of viewing physical climate in relation to human society: climate as setting, as determinant, as hazard, and as resource.[45] As Riebsame explains, seeing climate as a determinant requires the identification of "causal chains that link climate to specific elements or behaviours of biophysical and socioeconomic systems,"[46] whether these elements be crop yield, malaria risk, economic performance, or violent conflict. The burgeoning climate change impacts literature of the 1990s and 2000s has been dominated by research "identifying" such causal chains, as witnessed by some of the examples cited earlier in the article. Such claims have been driven by a methodological reductionism.

Reductionism is an approach to understanding the nature of complex entities or relationships by reducing them either to the interactions of their parts or else to simpler or more fundamental entities or relationships. In the case of climate change studies, this means isolating climate as the (primary) determinant of past, present, and future system behavior and response. If crop yield, economic performance, or violent conflict can be related to some combination of climate variables, then knowing the future behavior of these variables offers a way of knowing how future crop yield, economic performance, or violent conflict will unfold. Other factors that influence these future environmental, economic, or social variables—factors that may be more important than climate or perhaps just less predictable—are ignored or marginalized in the analysis. To illustrate such reductionism at work, I offer two instances selected from among many possible examples.

The way climate reductionism requires and seeks out simple chains of climatic cause-and-effect is perfectly illustrated in an empirical study of the relationship between climate change and economic growth published by the U.S. National Bureau of Economic Research.[47] The authors recognize that the question of whether climate change has a direct effect on economic development is contentious, but they claim nevertheless that their global analysis using data from over 180 nations reveals

[43] See Georgina Endfield in this volume.

[44] Manley, "The Revival of Climatic Determinism," *Geogr. Rev.* 48 (1958): 98–105, on 105.

[45] Riebsame, "Research in Climate-Society interaction," in *SCOPE 27—Climate Impact Assessment*, eds. Robert W. Kates, Jesse H. Ausubel, and Mimi Berberian (Chichester, 1985), 85–104.

[46] Ibid., 72.

[47] Melissa Dell, Benjamin F. Jones, and Benjamin A. Olken, "Climate Shocks and Economic Growth: Evidence from the Last Half Century" (working paper no. 14132, National Bureau of Economic Research, Cambridge, Mass., 2008).

a "substantial contemporary causal effect of temperature on aggregate [economic] output. . . . On average, a 1°C increase in average temperature predicts a fall in per-capita income by about 8 per cent."[48] Since they find this effect to be asymmetrical between richer and poorer countries, they are then able to extend their analysis to consider the impact of *future* climate change on economic performance. They conclude: "The negative impacts of climate change on poor countries may be larger than previously thought. Overall, the findings suggest that future climate change may substantially widen income gaps between rich and poor countries."[49] First the complex relationships that exist between climate and economic performance are reduced to a dependent relationship between temperature and GDP per capita, and then, using projections of future climate warming, future economic performance is predicted for the twenty-first century. The many subtleties and contingencies of national and regional economic performance are ignored or suppressed. Climate reductionism opens up the prospect of developing a narrative about future economic growth in which climate change becomes the primary driver of performance.

A second example of climate reductionism at work is Peter Halden's analysis of the geopolitics of climate change from an international relations perspective.[50] Halden, a social and political scientist working for the Department of Defense Analysis at the Swedish Defense Research Agency, takes as given the climate predictions from the Intergovernmental Panel on Climate Change (IPCC) for the year 2050. But he makes no attempt to envisage the possible social or political worlds of 2050, "a venture," he claims from his position as a political scientist, "that would be flawed at best and approaching hubris at worst."[51] He rejects the attempt to combine natural science forecasts with "speculative" social science in favor of a presumption of the social and political status quo. This reasoning hands the future over to Earth system models and their claims of revealing the impacts of climate change unfolding on a passive, unimaginative, and static humanity. Climate reductionism results in a narrative about future geopolitical movements in which, again, climate change becomes the primary driver.

Both these examples offer a one-eyed view of the future, yet it is one that pervades many recent academic analyses of climate change and social impact;[52] and consequently it is an account of the future that enters easily into public perception and discourse.[53] Inadvertently or not, such reductionist reasoning opens these analyses of climate impact to the charge of operating within neodeterminist explanatory frameworks. The two examples above are offered as archetypical illustrations of a widespread pattern of methodological climate reductionism as it is applied to many different dimensions of the imagined future: health, food production, biodiversity, tourism and recreation, human migration, violent conflict, and so on. The precise

[48] Ibid., 4, 6.

[49] Ibid., 27–8.

[50] Halden, *The Geopolitics of Climate Change: Challenges to the International System* (Stockholm, 2008).

[51] Ibid., 22–3.

[52] E.g., see the two recent studies cited earlier: Burke et al., "Civil War" (cit. n. 14), and Feng, Krueger, and Oppenheimer, "Cross-Border Migration" (cit. n. 17).

[53] Two examples among many references to the Burke et al. and Feng et al. studies are Tom Chivers, "Climate Change Will Lead to Civil Wars in Africa, Says Research," *Daily Telegraph*, November 25, 2009, and Nacha Cattan, "Climate Change Set to Boost Mexican Immigration to the US, Says Study," *Christian Science Monitor*, July 27, 2010.

numbers and fearful tones cited in the introduction to this article are the result of such reductionist reasoning and analysis. But given the demise of climate determinism described above, at least within large parts of the academy, how is it possible to have arrived back at an understanding of climate-society relationships that, I am suggesting, distorts and overemphasizes the causative role of climate in shaping the future prospects of society and the well-being of individuals?

THE HEGEMONY OF MODEL PREDICTIONS OF THE FUTURE

Sluyter offers one explanation for this resurgence of neoenvironmental determinism, or climate reductionism, in the cases I am looking at. He suggests that the Enlightenment dichotomy between nature and culture, so pervasive in Western thought and practice, began increasingly to be challenged in the 1980s and 1990s—for example, as described through Ulrich Beck's manufactured global risks and through Bruno Latour's entanglements of nature and culture.[54] In response to this move, Sluyter argues that environmental determinism offered one means for a "quick and dirty integration of the natural and social sciences."[55] As if the inadvisability of the dualistic thinking pervading Western thought were being belatedly realized, there was a rush to forge a new rapprochement between nature and culture. Determinist thinking was the simplest and most available ideology to hand. Sluyter is scathingly dismissive of such opportunism, however, and of the intellectual credulity exhibited by what he calls the "neodeterminists," authors such as Diamond and Sachs.

While I think there is some merit in his argument in the more general field of environment-society interactions, I wish to suggest a different line of reasoning that applies very specifically to the case of climate reductionism I have illustrated above. It is a line of reasoning that emerges from the way in which the understanding of climate change developed over the last decades of the twentieth century.

In summary, my argument concerns the hegemony held by the predictive natural and biological sciences over visions of the future. In the case of climate change, this hegemony is rooted in the knowledge claims of climate or Earth system models. In the absence of comparable epistemological reach emerging from the social sciences or humanities, these claims lend disproportionate discursive power to model-based descriptions of putative future climates. It thus becomes tempting to adopt a reductionist methodology when examining possible social futures: "Lots of things will change in the future, but since we have credible and quantitative knowledge about future climate let us examine, also quantitatively, what the consequences of these climates for society might be." The subsequent and derived climate impact modeling then boldly calculates, for example, the billions of people who because of climate change will become starving or thirsty, or the millions who because of climate change will be made destitute or homeless.[56] Climate reductionism is the means by

[54] Beck, *Risk Society: Towards a New Modernity* (London, 1992); Latour, *We Have Never Been Modern*, trans. C. Porter (New York, 1993).

[55] Sluyter, "Neo-environmental Determinism" (cit. n. 22), 817.

[56] Nigel W. Arnell, Melvin G. R. Cannell, Mike Hulme, R. Sari Kovats, John F. B. Mitchell, Robert J. Nicholls, Martin L. Parry, Matt T. J. Livermore, and Andrew White, "The Consequences of CO_2 Stabilisation for the Impacts of Climate Change," *Climatic Change* 53 (2002): 413–46; Norman Myers, "Environmental Refugees: Our Latest Understanding," *Phil. Trans. Royal Soc.* B 356 (2001): 16.1–16.5; Mabey, *Delivering Climate Security* (cit. n. 16).

which the knowledge claims of the climate modelers are transferred, by proximity as it were, to the putative knowledge claims of the social, economic, and political analysts.

This transfer of predictive authority, an almost accidental transfer, one might suggest, rather than one necessarily driven by any theoretical or ideological stance, is what I earlier defined as "epistemological slippage." If not quite the inexorable geometric calculus of Malthus, it nevertheless offers a future written in the unyielding language of mathematics and computer code. These models and calculations allow for little human agency, little recognition of evolving, adapting, and innovating societies, and little endeavor to consider the changing values, cultures, and practices of humanity. The contingencies of the future are whitewashed *out* of the future. Humans are depicted as "dumb farmers," passively awaiting their climate fate. The possibilities of human agency are relegated to footnotes, the changing cultural norms and practices made invisible, the creative potential of the human imagination ignored.

To give some substance to this argument I need to explore some of the historical contexts that have allowed climate models to claim such hegemony over the future and that have allowed climate reductionism to thrive. This requires an examination of the emergence of anthropogenic climate change as a matter of scientific concern in the 1970s and 1980s and as a matter of public policy debate in the 1980s and 1990s. There are three developments that are important for my argument: the retreat of the social sciences, and geography in particular, from working at the nature-culture interface; the emergence of a new epistemic community of global climate modelers; and the asymmetrical incorporation of climate change and social change into envisaged futures. Each of these three developments will be examined in turn.

The Absence of Theory about Climate-Society Interactions

The previous sections have shown how the academic discipline that had thought the longest and hardest about relationships between climate and society—geography—had by the 1960s become suspicious about grand theories of climate-society interaction, particularly those tinged with any trace of the old determinist ideology.[57] This reaction against the worst excesses of determinism "left geographers without a coherent conception of causality that would 'bridge' the social and natural sciences."[58] It also meant that the study of environment-society relationships "became a subject without an academic home, a stateless person in the world of sovereign disciplines."[59] It was in fact a small number of historians and atmospheric scientists, rather than geographers, who were the most willing to reengage substantively with questions about climate change and human society. Historians such as Emmanuel Le Roy Ladurie, atmospheric scientists such as Reid Bryson, and historical climatologists such as Hubert Lamb produced the most significant investigations during the 1970s into the nature of past interactions between climate change and social organization.[60] But

[57] John F. Hart, "The Highest Form of the Geographer's Art," *Ann. Assoc. Amer. Geogr.* 72 (1982): 1–29.

[58] Castree, *Nature* (cit. n. 31), 63.

[59] Meyer, *Americans and Their Weather* (cit. n. 4), 209.

[60] See, respectively, Ladurie, *Times of Feast, Times of Famine: A History of Climate since the Year 1000*, trans. Barbara Bray (New York, 1971); Bryson and Thomas J. Murray, *Climates of Hunger:*

they did so in the absence of any coherent theoretical framework to explain such interactions and certainly without any basis for prediction.

Against this background of disciplinary maneuvers and intellectual hesitancy, there were an increasing number of important questions emerging in the 1970s about how climate change and social change were related. Accelerated by the cultural background of a new environmental consciousness,[61] concerns were mounting over global food and energy security and the social impacts of drought in Africa and weather modification in America.[62] "Climate change and human affairs" were becoming entangled in new ways, as masterfully narrated by Crispin Tickell in his 1977 book of that title.[63] To understand these interactions required some grasp of both the dynamics of climate and the nature of human agency, whether individual, collective, or institutional. And as the story moved from the 1970s to the 1980s, it became increasingly clear that climates worldwide *were* changing, at least in part because of human activities. New questions were being asked by researchers, environmentalists, and policy makers about what these emerging and prospective changes in climate might mean for society.[64] Geographers and social scientists, however, remained rather poorly positioned to answer such questions, lacking agreed (or else acceptable) theories and tools for investigating the interactions between climate and society. Judkins, for example, describes how for geographers and social scientists the period from the 1960s to the 1980s was characterized by competing and contradictory theoretical accounts of environment-society interactions.[65]

The Epistemic Community of Global Climate Modeling

It was against this background of theoretical and methodological uncertainty about how society and climate were related that the methods and claims of a new community of climate modelers and global change scientists were emerging. The 1960s and 1970s had witnessed the development of the first computer-based simulation models of a universal and globally connected climate system.[66] Originally an extension of numerical weather prediction models, these new climate-oriented models allowed experiments with global climate to be performed in virtual reality that were not possible in physical reality. These models were constructed initially by meteorologists and atmospheric scientists in a small number of research centers in the United States, the United Kingdom, and Germany. They were later joined by oceanographers, atmospheric chemists, and biologists as the models extended their representation from simply the climate system (initially the atmosphere) to the deeply coupled components of the Earth system. This move was encapsulated in NASA's 1988 report *Earth*

Mankind and the World's Changing Weather (Madison, Wis., 1977); Lamb, *Climate: Past, Present and Future*, vol. 2: *Climatic History and the Future* (London, 1977).

[61] Sheila Jasanoff, "Image and Imagination: The Formation of Global Environmental Consciousness," in *Changing the Atmosphere: Expert Knowledge and Environmental Governance*, eds. Clark Miller and Paul N. Edwards (Cambridge, Mass., 2001), 309–37.

[62] Central Intelligence Agency, *Potential Implications of Trends in World Population, Food Production and Climate*, report no. OPR-401 (Washington, D.C., 1974).

[63] Tickell, *Climate Change and World Affairs* (Cambridge, Mass., 1977).

[64] E.g., Jill Williams, ed., *Carbon Dioxide, Climate and Society* (Oxford, 1978); Council of Environmental Quality, *Global Energy Futures and the Carbon Dioxide Problem* (Washington, D.C., 1981).

[65] Judkins, Smith, and Keys, "Determinism" (cit. n. 6).

[66] Paul N. Edwards, *A Vast Machine: Computer Models, Climate Data and the Politics of Global Warming* (Cambridge, Mass., 2010).

System Science: A Closer View, the so-called Bretherton report.[67] The report's lead author was Francis Bretherton, an applied mathematician and atmospheric scientist, and the goal of this new scientific mission was "to obtain a scientific understanding of the entire Earth system on a global scale"; predictions were to be secured by using "quantitative models of the Earth system to identify and simulate global trends."[68]

In barely twenty-five years—from the early 1960s to the late 1980s—scientific accounts of the causes and properties of climate had become progressively more complex. Climate was now viewed as the outcome of the functioning of an interconnected biogeophysical global system whose past, present, and future behavior could be modeled—and hence "predicted"—using mathematical equations and advanced computing technology. This marked a distinct break from the more varied conceptions of climate used by geographers, climatologists, and synoptic meteorologists earlier in the twentieth century. Clark Miller makes the interesting observation that the "First Annual Conference on Statistical Climatology" was held in 1979, and prior to this time there was no reason to refer to *statistical* climatology because there was no other form of climatology to distinguish it from.[69]

The more systemic concept of climate as Earth system science, together with the representation of this concept in simulation models, formed the twin bases around which a new epistemic community of global climate modelers coalesced. An epistemic community is a community of experts who share sets of beliefs about factual and causal understandings of particular phenomena.[70] Furthermore, these shared beliefs and values guide the community in drawing policy conclusions from its knowledge. By the 1990s "computer modelling had become *the* central practice for evaluating truth claims" for this community of global climate change scientists.[71] Yet as Miller has argued, epistemic communities and the knowledge they produce do not form in isolation from wider social, institutional, and political settings.[72] And the knowledge thus produced has a very distinctive geography of production. For example, the role of the cold war was crucial in the development of American climate science,[73] and by the 1970s and 1980s it was the growing political interest in human-induced climate change and the globalization of environmental politics that drove forward this new intellectual program.[74] The development of global climate and Earth system models and their application to examining questions about the future performance of a now "global climate," one being subjected to human-induced changes in atmospheric composition, occurred against the backdrop of the new environmental geopolitics of the post-Stockholm era.[75] June 1972 had witnessed the first

[67] NASA, *Earth System Science: A Closer View* (Washington, D.C., 1988).

[68] Ibid., 11.

[69] Miller, "Climate Science and the Making of a Global Political Order," in *States of Knowledge: The Co-production of Science and the Social Order*, ed. Sheila Jasanoff (London, 2004), 46–66.

[70] Peter M. Haas, "Epistemic Communities and International Policy Coordination," *International Organization* 46 (1992): 1–35.

[71] Paul N. Edwards, "Representing the Global Atmosphere: Computer Models, Data and Knowledge about Climate Change," in Miller and Edwards, *Changing the Atmosphere* (cit. n. 61), 31–65, on 53.

[72] Clark A. Miller, "Challenges in the Application of Science to Global Affairs: Contingency, Trust and Moral Order," in Miller and Edwards, *Changing the Atmosphere* (cit. n. 61), 247–86.

[73] David M. Hart and David G. Victor, "Scientific Elites and the Making of US Policy for Climate Change Research," *Soc. Stud. Sci.* 23 (1993): 643–80.

[74] Paul K. Wapner, *Environmental Activism and World Civic Politics* (New York, 1996).

[75] Clark A. Miller, "The Dynamics of Framing Environmental Values and Policy: Four Models of Societal Processes," *Environmental Values* 9 (2000): 211–33.

United Nations Conference on the Human Environment held in Stockholm, and this presaged a new era of international environmental diplomacy. The World Meteorological Organization's First World Climate Conference, held in 1979, and the 1983 report by the Carbon Dioxide Assessment Committee of the U.S. National Academy of Sciences were also evidence of the growing political saliency of climate change.[76]

The consequence of this coproduction of knowledge between what Miller has called "climate science and the global political order" was the foregrounding of model-based predictions of future climate change in academic and policy discourses.[77] Models came to be seen as "the only practical way to discern the effects of policy choices about climate change," and all important knowledge and choice about climate change seemed to revolve around such models.[78] The early battles about the credibility of anthropogenic climate change in the 1990s were therefore fought largely around the credibility of these models,[79] because both sides recognized the political significance of their knowledge claims about the future.

Yet to answer the demanding questions being asked about the significance of anthropogenic climate change for human society required more than mere knowledge of future climate. It demanded some translation of future changes in climate into future impacts for society. The *First Assessment Report* of the IPCC in 1990, for example, was organized into three separate volumes: one on climate science, one on climate impacts, and one on climate policy options. If climate modelers were by now offering credible predictions of future climate change, then before policies could be developed and evaluated, it was argued (implicitly, perhaps) that plausible accounts of the impacts of these changes on human society were needed. It was here that the asymmetry between the knowledge claims of the predictive natural scientists and those of geographers and other environmental social scientists emerged most acutely. Given the poorly developed and atheoretical understandings of climate-society relationships in the social sciences, how were these demanding questions going to be answered? How did the first IPCC assessments address these relationships?

The Asymmetrical Incorporation of Climate and Social Change into Envisaged Futures

The first studies assessing the consequences of future anthropogenic climate change for society were undertaken in the late 1970s and early 1980s; some of this work is summarized by Jill Williams and by William Kellogg and Robert Schware.[80] But to investigate the methodological challenges these new policy-driven questions were posing for academic environmental social science researchers in the 1980s and 1990s, I examine two seminal books published in this era. Both books were methodologically oriented, and, taken together, they illuminate how methodological space was created within which climate reductionism could emerge.

[76] National Academy of Science, *Changing Climate—Report of the Carbon Dioxide Assessment Committee*, ed. William A. Nierenberg (Washington, D.C., 1983).

[77] Miller, "Climate Science" (cit. n. 69).

[78] Edwards, "Representing the Global Atmosphere" (cit. n. 71), 63.

[79] Fred Pearce, "Greenhouse Wars," *New Scientist*, July 19, 1997, 38–43.

[80] See, respectively, Williams, *Carbon Dioxide, Climate and Society* (cit. n. 64); Kellogg and Schware, *Climate Change and Society: Consequences of Increasing Atmospheric Carbon Dioxide* (Boulder, Colo., 1981).

The first is the volume commissioned and published by the International Council of Scientific Unions' Scientific Committee on Problems of the Environment (SCOPE) on climate impact assessment.[81] This report, known as *SCOPE 27*, was a response to the new World Climate Impact Program (WCIP)—whose aim was "to advance our understanding of the relation between climate and human activities"—that had been agreed at the 1979 First World Climate Conference. This volume was one of the first outputs from WCIP and became a standard text in the field. I have already quoted from Riebsame's chapter in this volume, which offered four ways in which climate may be viewed. But the crucial methodological chapter was written by the respected geographer Robert Kates. The WCIP, *SCOPE 27*, and Kates's specific chapter are all therefore a direct response to the growing policy demand for credible and salient knowledge about what anthropogenic global climate change might mean for future society.

Kates laid out the methodological challenges of performing climate impact assessments, three of which are particularly relevant for the argument presented here. First, he acknowledged an explicit knowledge hierarchy between the "hard" sciences and the "soft" sciences. As one moves from understanding global heat balances to the impacts of climate change on nutrition, for example, there is "less predictability, more speculation and greater uncertainty."[82] Complexity increases, precision decreases, and uncertainties are compounded. The second challenge identified by Kates and of particular interest in the present context is that of linking very different methodologies: for example, modeling of global climate with analysis of energy trends or assessment of population dynamics. The poverty of theoretical and methodological development in this area was recognized by Kates: "As yet there has been no comprehensive study of the problems of integrating such scientific apples and oranges."[83] (This is the field that today is more commonly known as integrated assessment modeling [IAM] and that is still deficient in its ability to represent processes of societal adaptation.[84])

The third challenge therefore was how to develop even the most basic of analytical frameworks for performing such "linked studies" of climate impact assessment. Kates offered two schematic diagrams, one of which he called the "impact model" and the other the "interaction model" (both reproduced here in fig. 1). In the former, climate change determines the impact directly, while in the latter the impact is the joint product of the interaction between climate and social change. And it is the former model that Kates claimed was predominant in nearly all attempts at climate impact assessment, which went "directly from climate events to inferences of higher-order consequences."[85] Reflecting on the reasons for this paucity of studies that sought to embrace a more interactive framework of climate-society relationships, as opposed to the instinct to revert to a cruder deterministic or reductionist account, Kates remarked that it was due "partly to disciplinary isolation and partly to

[81] Kates, Ausubel, and Berberian, *SCOPE 27* (cit. n. 45).

[82] Robert Kates, "The Interaction of Climate and Society," in Kates, Ausubel, and Berberian, *SCOPE 27* (cit. n. 45), 3–36, on 4.

[83] Ibid., 5.

[84] See Hans-Martin Füssel, "Modelling Impacts and Adaptation in Global IAMs," *WIREs Climate Change* 1 (2010): 288–303.

[85] Kates, "Interaction of Climate and Society" (cit. n. 82), 31. Füssel states, "Adaptation has received only limited attention in global IAMs so far"; "Modelling Impacts" (cit. n. 84), 288.

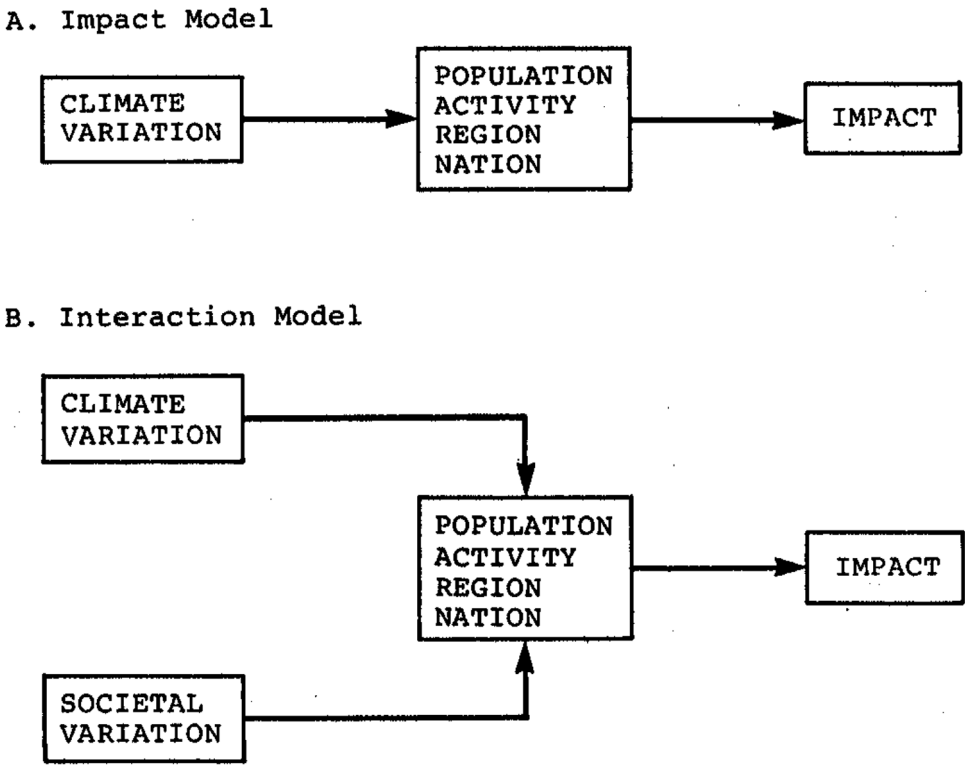

Figure 1. *Schematics of impact and interactive models are highly simplified graphic depictions of types of study methodologies. It was the more reductionist "impact model" that predominated in most impacts studies. Reproduced by permission from Kates, "Interaction of Climate and Society" (cit. n. 82), 31.*

the limited effort expended to date on the study of the interaction of climate and society as compared to the study of the dynamics of climate itself."[86]

SCOPE 27 therefore reveals, I suggest, how the idea of an explicit knowledge hierarchy, the lack of any theoretical frameworks for integrated analysis, and the preferred linear model of climate response contributed to a climate reductionism at work in impact assessments. At this crucial moment in the 1980s, when climate predictions were asserting their knowledge claims about the future and when policy was demanding knowledge about future consequences of climate change for society, it was easy for simple reductionist accounts of future climate change impacts to emerge.

Kates did not explicitly address the development of climate predictions or scenarios, which have become the pivotal component of so many climate impact studies. The second book I wish to examine, however, does so. Published in 1998 under the title *Climate Impact and Adaptation Assessment*,[87] this was a widely read guide to the IPCC approach to assessing climate change impacts and adaptations. This book offered "a readable guide" to the *Technical Guidelines for Assessing Climate Change*

[86] Kates, "Interaction of Climate and Society" (cit. n. 82), 31.
[87] Martin L. Parry and Timothy R. Carter, *Climate Impact and Adaptation Assessment: The IPCC Method* (London, 1998).

Impacts and Adaptations published a few years earlier by the IPCC,[88] guidelines that became widely cited and used internationally in the field. In these IPCC assessment guidelines, as interpreted by Martin Parry and Tim Carter in their guide, the default methodological assumptions and practices revealed by Kates in the 1980s were reinforced. In this case it was done by privileging predictions of future climate over explorations of how the many other dimensions of cultural, social, and political life may change in the future. Climate reductionism through epistemological slippage was the result.

The IPCC method for impact and adaptation assessment had seven recommended steps (fig. 2), at the center of which—step 4—was the selection of future climate scenarios. With future climate(s) thus established, the method proceeded to estimate the consequences of climate change for both natural and social environments, before examining how such consequences might be adapted to. In their summary of step 4, Parry and Carter took care to emphasize the importance of recognizing social dynamics: "The environment, society and the economy are not static" in the absence of climate change.[89] But the subsequent practical guidance for how to incorporate such dynamism into scenarios of the future is limited. Out of twenty-three pages in this crucial scenario chapter, less than three are devoted to the representation of social change, whereas over fourteen pages offer guidance on how to develop future climate change scenarios. And most of this guidance refers to the use of data and results from global climate models.

The asymmetry evidenced in the Parry and Carter chapter between methods for depicting climate and social futures is merely representative of much wider practice in the field of climate impact assessment over the last twenty-five years. For the first twelve years of the IPCC process (1988–2000) there were no systematic attempts to develop methods or scenarios that represented future social, cultural, or political change, even though large amounts of effort were directed to advancing and distributing model-derived representations of future climate. Only with the publication of the IPCC *Special Report on Emissions Scenarios* in 2000 was significant visibility given to the representation of different social futures in climate impact studies.[90] This deficiency contributed to the widespread adoption of what I call climate reductionist methods in climate impact assessment, the consequences of which have been earlier illustrated. The IPCC *Third Assessment Report* in one of its chapters lamented this practice: "Future socioeconomic . . . changes have not been represented satisfactorily in many recent impact studies," and "many impact studies fail to consider adequately uncertainties embedded in the scenarios they adopt."[91] And at a national scale, a review of the U.K. Climate Impacts Programme in 2005 noted that climate impact studies have seldom been able to incorporate alternative social futures, "preferring instead to concentrate on exploring 'climate-only' impacts," a direct illustration of climate reductionism at work.[92]

[88] Timothy R. Carter, Martin L. Parry, Hideo Harasawa, and Shuzo Nishioka, *IPCC Technical Guidelines for Assessing Climate Change Impacts and Adaptations* (London/Tsukuba, 1994).

[89] Parry and Carter, *Climate Impact* (cit. n. 87), 72.

[90] IPCC, *Special Report on Emissions Scenarios* (Cambridge, 2000).

[91] Timothy R. Carter and Emelio La Rovere, "Developing and Applying Scenarios," in *Climate Change, 2001: Impacts, Adaptation and Vulnerability*, eds. Jim McCarthy, Osvaldo Canziani, Neil A. Leary, Dave J. Dokken, and K. S. White (Cambridge, 2001), 145–90, on 181.

[92] Chris West and Megan Gawith, eds., *Measuring Progress: Preparing for Climate Change through the UK Climate Impacts Programme* (Oxford, 2005), 61.

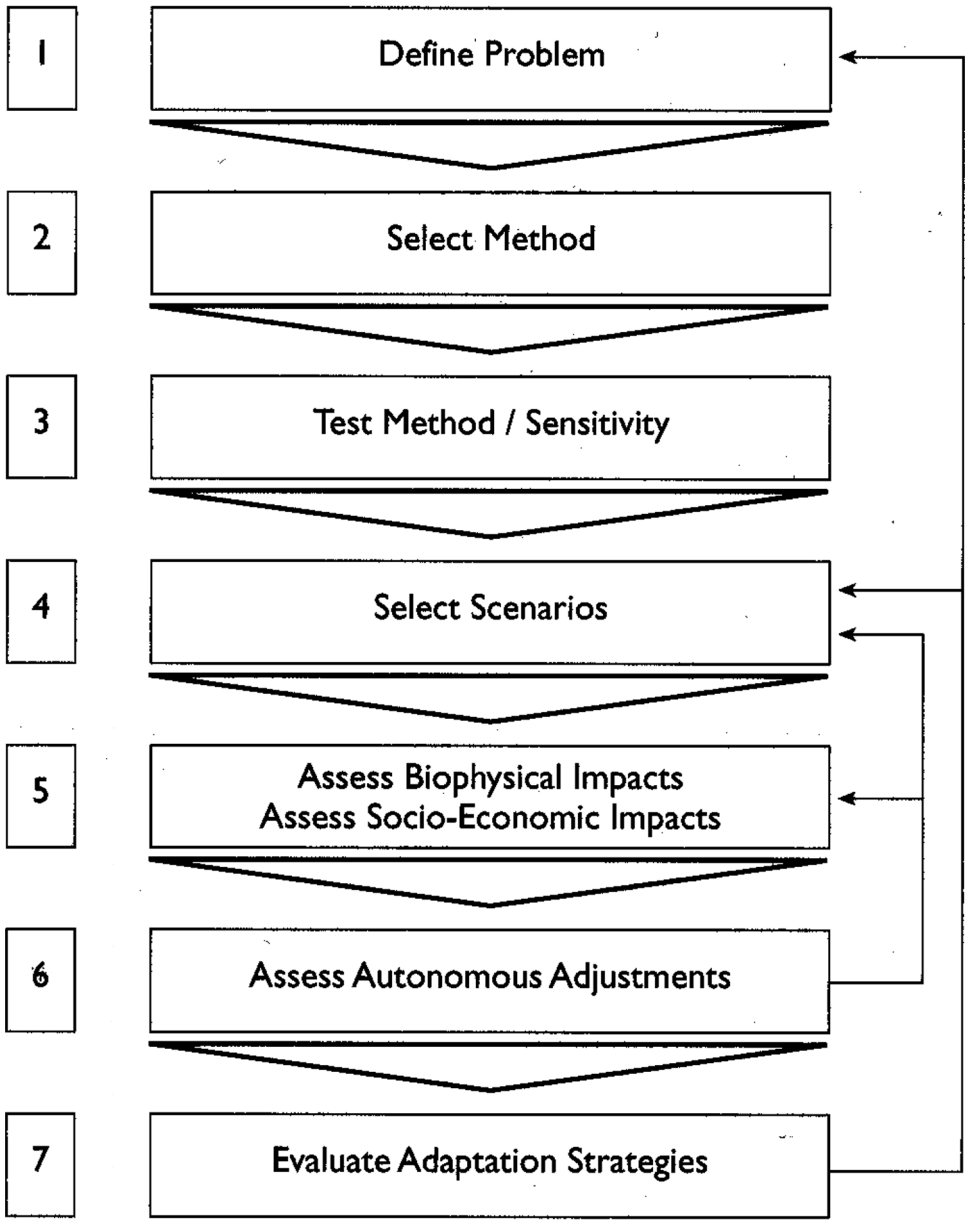

Figure 2. *Seven steps of climate impact assessment, adopted by the IPCC. Step 4 is the crucial stage of creating the future. Reproduced by permission from Parry and Carter,* Climate Impact and Adaptation Assessment *(cit. n. 87).*

Reactions against climate reductionism, notably the concepts of vulnerability and resilience, have emerged in the last decade or so from parts of the social science community.[93] The origins of these less reductionist conceptual and analytical paradigms are to be found in hazards research and ecology, respectively, and were introduced into climate change research in the late 1990s (vulnerability) and early 2000s (resilience). They offer ways of exploring sensitivities of socioecological systems to climate perturbations—and other environmental and social stresses—without being dependent upon the predictive claims of climate modeling. Although they have gained some visibility in recent climate change research, because vulnerability and resilience approaches to understanding climate-society relationships are less dependent on model-based climate projections, they have been slow to overturn the standard IPCC climate impact methodology.[94]

* * *

The combination of these historical developments—the rise of a powerful epistemic community of climate modelers, the asymmetrical incorporation of climate and social change into envisaged futures, and, confounding the whole enterprise, the lack of theory making around climate-society interactions—has allowed a form of climate reductionism to dominate contemporary analysis and thinking about the future. Although it is clear to many social scientists that "the impact of any climatic event depends on the local ecological setting and the organisational complexity, scale, ideology, technology and social values of the local population,"[95] current intellectual endeavors in this area unduly privilege climate as the chief determinant of humanity's putative social futures.

Quantitative climate predictions for the 2050s, 2080s, or even further ahead continue to be offered by a powerful community of climate modelers, most recently at very high spatial and temporal resolutions. For example, the latest climate projections from the U.K. government incorporate weather information at hourly intervals for regions as small as 25 square kilometers and for several decades into the future.[96] Yet the "complexity, scale, ideology, and social values" of future local populations and communities are for the most part ignored or assumed to be static. The study by Halden summarized earlier is a good example of this asymmetry in representations of the future. Quantified—and often unconditional—predictions of future climate change impacts therefore abound, such knowledge claims drawing power from the epistemic muscle of climate and Earth system models in a process of epistemological slippage.

And so the future is reduced to climate. By stripping the future of much of its so-

[93] Marco A. Janssen and Elinor Ostrom, "Resilience, Vulnerability and Adaptation: A Cross-Cutting Theme of the International Human Dimensions Programme on Global Environmental Change," *Global Environmental Change* 16 (2006): 237–9.

[94] For a discussion of some of the reasons why progress has been slow, see Karen L. O'Brien and Johanna Wolf, "A Values-Based Approach to Vulnerability and Adaptation to Climate Change," *WIREs Climate Change* 1 (2010): 232–42.

[95] Fakri A. Hassan, "Human Agency, Climate Change and Culture: An Archaeological Perspective," in *Anthropology and Climate Change: From Encounters to Action*, eds. Susan A. Crate and Mark Nuttall (Walnut Creek, Calif., 2008), 39–69, on 40.

[96] UK Climate Projections (UKCP09) Web site, http://ukclimateprojections.defra.gov.uk (accessed 20 January 2011).

cial, cultural, or political dynamism, climate reductionism renders the future free of visions, ideologies, and values. The future thus becomes overdetermined. Yet the future is of course very far from being an ideology-free zone. It is precisely the most important territory over which battles of beliefs, ideologies, and social values have to be fought. And it is these imagined and fought-over visions of the future that—in many indeterminate ways—will shape the impacts of anthropogenic climate change as much as will changes in physical climate alone.

PUTTING SOCIETY BACK INTO THE FUTURE

Climate reductionism—a form of neoenvironmental determinism—offers a methodology for providing simple answers to complex questions about the relationship between climate, society, and the future. In its crudest form it asserts that if social change is unpredictable and climate change predictable then the future can be made known by elevating climate as the primary driver of change. But such reductionism downgrades human agency and constrains the human imagination. So, looking back, Diamond claims that "history followed different courses for different peoples because of peoples' environments,"[97] while looking forward Lovelock fears that "despite all our efforts to retreat sustainably, we may be unable to prevent a global decline into a chaotic world ruled by brutal war lords on a devastated Earth."[98]

Although offering accounts of the past and the future that are more popular than academic, both Diamond and Lovelock adopt inadequate and impoverished reductionist frameworks for understanding the past and envisioning the future. Many of the statements concerning the impacts of future climate change emerging from the more analytical research community suffer from the same limitations. The consequence of such reductionism is expressed clearly in Karl Popper's attack from a generation ago on historicism and its deterministic roots: "Every vision of historicism expresses the feeling of being swept into the future by irresistible forces."[99] While Popper, writing in a different era, had historical materialism and the enemies of an open society in mind, his reasoning well applies to climate change today.

The allure of determinist thinking is that it offers the appearance of "naturalistic" explanations—even justifications—of cultural or economic dominance (as in past variants of determinism) or "naturalistic" accounts of the future that evacuate it of human agency (as I have contended is the case with climate change today). In contrast to earlier climate determinisms, which flowered in the ascendant and optimistic imperial cultures of classical Greece and of imperialist Europe and a youthful United States, I suggest that the climate reductionism I have described here is nurtured by elements of a Western cultural pessimism that promote the pathologies of vulnerability, fatalism, and fear.[100] It is these dimensions of the contemporary cultural mood that provide the milieu within which this particular form of environmental determinism has reemerged. By handing the future over to inexorable nonhuman powers,

[97] Jared Diamond, *Guns, Germs and Steel: The Fates of Human Societies* (New York, 1997), 25.
[98] Lovelock, *Revenge of Gaia* (cit. n. 21), 198.
[99] Popper, *The Poverty of Historicism* (London, 1957), 160.
[100] See Pat Devine, Andrew Pearman, and David Purdy, eds., *Feelbad Britain: How to Make It Better* (London, 2009); Rod Liddle, *Social Pessimism: The New Social Reality of Europe* (London, 2008).

climate reductionism offers a rationalization, even if a poor one, of the West's loss of confidence in the future.

These characteristics of Western culture have also been described by sociologist Frank Furedi in his book *Invitation to Terror*.[101] Furedi explains the confusion that has emerged in Western culture about the new international terrorism of this century and links it to a pessimism about the accomplishments of modernity and science and a fear of their legacy. Such pessimism evacuates the future of belief, vision, and promise. The knowledge claims of intelligence experts—or, in the case studied here, of climate modelers—are invited to fill the voids in the human imagination thus created. While Furedi's is a contested position—for many, the promises of new technologies remain as alluring as ever—Beck describes a similar phenomenon when he talks about the nonexistent and fictitious future replacing the legacies of the past as the basis for present-day action: "Expected risks are the whip to keep the present in line. The more threatening the shadows that fall on the present because a terrible future is impending, the more believed are the headlines provoked by the dramatisation of risk today."[102]

Climate reductionism is a limited and deficient methodology for accessing the future. In his poetic essay "The End of the World," environmental historian Stephen Pyne offers an insight into similar reductionist limitations with regard to the past:

> Reductionism is good for extracting resources and for creating instruments, medicines, gadgets; but it does not—cannot—tell us how to use them or when or why. It cannot convey meaning because meaning requires contrast, connections, context. . . . [Reductionism] cannot tell us what we need to know in order to write genuine history, even when that history involves nature.[103]

If reductionism is a limited form of reasoning for interpreting the past, then climate reductionism is even more inadequate with regard to telling the future. The epistemological pathways offered by climate models and their derived analyses are only one way of believing what the future may hold. They have validity, and they have relevance. But to compensate for the epistemological slippage I have described in this article it is necessary to balance these reductionist pathways to knowing the future with other ways of envisioning the future.

The "contrast, connections, and context" to which Pyne refers must be created by putting society back into the future. Since it is at least possible—if not indeed likely—that human creativity, imagination, and ingenuity will create radically different social, cultural, and political worlds in the future than exist today, greater effort should be made to represent these possibilities in any analysis about the significance of future climate change. Some of these futures may be better; some may be worse. But they will not be determined by climate, certainly not by climate alone, and these worlds will condition—perhaps remarkably, certainly unexpectedly—the consequences of climate change.

[101] Furedi, *Invitation to Terror: The Expanding Empire of the Unknown* (London, 2007).
[102] Ulrich Beck, "Global Risk Politics," in *Greening the Millennium: The New Politics of the Environment*, ed. Michael Jacobs (Oxford, 1997), 18–33, on 20.
[103] Pyne, "The End of the World," *Environmental History* 12 (2007): 649–53, on 650.