

Ellul and the Weather

John Byrne

Leigh Glover

Center for Energy and Environmental Policy
University of Delaware

Global climate change may result in a wide array of social and environmental harms, and this prospect has given rise to an international treaty, the 1992 UN Framework Convention on Climate Change. Scientific uncertainties, nation state politics, and economic resistance had to be addressed before this landmark environmental agreement could be realized. However, questions remain about the foundations and core commitments of this agreement. Ellul's characterology of technique is applied to the task of building a critique of the current international response to climate change and is allied to the proposition that ecological justice should guide the social response to climate change. It is argued that contemporary international efforts are directed at producing a "rational climate," rather than a climate for ecological justice

Keywords: *climate change; ecological justice; global environmental commons*

[I]n order to avoid famine, resulting from the systematic destruction of the topsoil, we must apply the latest technical methods . . . What measures are to be recommended? The various soils must be classified as to possible ways to cultivate them without destroying them. Authoritarian methods must be applied in order (a) to evacuate population[s] and to prevent [them] from working the imperiled soil; and (b) to grow only certain products on certain types of soil. The peasant can no longer be allowed freedom in these respects. . . . In Latin America there are today from 20 to 40 million ecologically displaced per-

sons, persons occupying lands which ought not to be under cultivation. They are living on hill-sides from which it is absolutely necessary to drive them if the means of existence of their countries are to be saved from destruction. It will be difficult and costly to relocate these people, but Latin America has no choice. If she does not solve this problem, she will be reduced to the most miserable standard of living. . . . The technical phenomenon cannot be broken down in such a way as to retain the good and reject the bad. It has a "mass" which renders it monistic. . . . The problem is the same in a capitalist state (where the Communist is the saboteur) and in a Communist state (where the saboteur is the internationalist in the pay of capitalism).

Jacques Ellul (1964)

Jacques Ellul's working life largely preceded the rise of contemporary environmentalism, and Ellul is seldom included in the pantheon of environmental writers.¹ However, as the above quote demonstrates, Ellul was acutely aware of the character of modern ecological problems and warned throughout his prodigious body of work of the deepening conflict between artificiality and nature (human and every other form). With this article, we hope to bring greater awareness of Ellul's approach to modernity in environmental inquiry. There is much, we argue, in Ellul's thought that can and needs to be brought to bear on modernist environmental problems in general, and that of climate change, in particular.

AUTHORS' NOTE: This article is partly drawn from a presentation titled "Climate Change and the Policy Commons" at the 19th Annual Conference of the National Association of Science, Technology and Society, February 19-21, 2004, in Baltimore, Maryland. We thank Willem Vanderburg for his assistance in its preparation.

Bulletin of Science, Technology & Society, Vol. 25, No. 1, February 2005, 4-16

DOI: 10.1177/0270467604273366

Copyright © 2005 Sage Publications

Technique and Nature

An Ellulian critique could be employed readily in assessing proposed responses to climate change that almost uniformly rely on a healthy dose of positive science and innovative technology. These “techno fixes” involve spectacular so-called big science suggestions for geo-engineering, such as capturing and pumping carbon dioxide to the deep ocean or to subterranean fissures, continental-scale forestation programs to increase biological carbon sequestration, fertilizing the oceans with iron to boost carbon dioxide uptake, placing mirrored arrays in space to intercept earth-bound solar radiation, and reducing greenhouse gas (GHG) emissions through an escalated program of nuclear energy. None of these technological solutions have been able to pass the conventional tests of technical and economic feasibility; however, as Ellul’s detailed analysis in *The Technological Society* (1964) observed, in the modernist order, feasibility tests mark only a point on the trajectory of technological compulsion; never a verdict, feasibility in our time is merely an indication of rational incompleteness with a massive effort always in motion to overcome the partiality of the known. Modernity’s goal is to cure the problem of technical and economic infeasibility.

However, Ellul’s work can also be used to understand the considerably more complex, subtle, and comprehensive effort at global environmental governance of climate change that is now under way internationally. In this regard, there are fundamental linkages between technological society and contemporary climate change.

First, the climate change problem is the outcome of the technological milieu of advanced industrialization, especially its extensive use of fossil fuels. As a consequence of human ingenuity, the level of carbon dioxide in the atmosphere is most likely to reach levels that are unprecedented in the last 420,000 years (Intergovernmental Panel on Climate Change [IPCC], 2001c, chap. 2). At the dawn of the Industrial Revolution in the late 18th century, the atmospheric concentration of carbon dioxide was approximately 280 parts per million by volume (ppmv); today it is estimated to be above 370 ppmv, and forecasted levels by year 2100 range from 490 to 1260 ppmv (IPCC, 2001c). To date, the bulk of the growth in concentrations is attributable to North America, Europe, Japan, Australia, and New Zealand, the locus of most of the coal, oil, and gas combustion. Since 1751, there have been 283 billion tons of carbon released to the atmosphere from fossil

fuel combustion, fully one half since the mid-1970s (Marland, Boden, & Andres, 2003). Annual global carbon emissions from human activity recently have averaged more than 6 billion tons (Marland et al., 2003). Best estimates of the yearly rate of natural absorption are in the range of 4 to 5 billion tons (IPCC, 2001c). The remainder is believed to be stored in the atmosphere.

Second, our conception of climate change is almost entirely constructed for us by scientific discourse. In 1988, at the urging of leading scientists, a consortium of United Nations agencies and nation states agreed to sponsor an Intergovernmental Panel on Climate Change (IPCC) that would continuously catalog research on possible human impacts on the climate system and advise the international community of the possible need for and types of international responses. In 1992, again under the auspices of the United Nations, and after the IPCC issued its first assessment report (1990), the global community of nations formed the *Framework Convention on Climate Change* (FCCC; United Nations [UN], 1992) and then created the 1997 Kyoto Protocol (UN, n.d.) that details a number of specific actions to avert further global warming under the FCCC. Together, the IPCC, FCCC, and Kyoto Protocol epitomize a modernist regime organized to understand and act on its own science-based construction of climate change as a problem. This regime expounds a scientific-rational strategy to articulate goals for societies and to fashion an objectively grounded policy architecture.

The regime has much to recommend it. It is notable to point out, that science and scientists are engaged, in this instance, in a process of research and analysis that forces advanced societies, specifically, and all of humanity, generally, to question core premises of modern ideals of progress. In particular, the goal of endless economic growth achieved by heightened technical and economic efficiency is potentially jeopardized by the climate change thesis, which traces the quantitative success of industrial economies to a carbon-intensive mode of production that could harm ecosystems everywhere. Arguably, if the climate change problem had not originated in science, its potent challenge to modernism might not now be considered. Although the science of climate change itself is on trial in many quarters (Demeritt, 2001; Jasanoff & Wynne, 1998; Shackley, 1995) because it opens the possibility of doubting the viability of advanced industrial society, one would be hard pressed to identify, in our era, an actor with sufficient credibility to

encourage the pursuit by humanity of this difficult question.

At the same time, although one can applaud science's effort, climate change also raises core problems for institutions of justice and democracy in the modern order. The phenomenon is not simply a matter of altered atmospheric chemistry but derives from a set of economic practices and uses of political power that have privileged the benefits of advanced industrialization to a few and now portends a distribution of consequent costs to socially and ecologically vulnerable populations that have had little to do with creating the problem (Agarwal & Narain, 1991; Byrne & Glover, 2000; Byrne & Inniss, 2002). Climate change is, in fact, constituted as a reality at the intersection of its physical and social history. Yet the modern response has found the justice and democracy dimensions of the problem difficult to conceive and, even more important, difficult to act on.

Herein lies the relevance of Jacques Ellul's work. His characterology (1964) offers a rarely found comprehensive explanation of the tendency of modernity to regard its conflicts and crises as technical problems and, at the same time, to doubt the credibility and usefulness of characterizations of these same conflicts and crises as problems of justice and democracy. In a sobering description of the modern mind and its ethical outlook, Ellul (1964) remarked that ours is the civilization that understands "efficiency is a fact and justice a slogan" (p. 282). We argue below that climate change is an instructive case of this tendency. Following Ellul's theory of technique and its evolving milieu as a means of investigating this nature-society conflict, we depict human-induced climate change as a process of modernizing the weather; that is, a poignant example of how modern society is escalating its imperative to manage and, finally, engineer nature, overriding long-standing moral and political hesitations in human cultures to assume such a role.

Climate Change and Ecological Justice

Climate change politics are intimately connected with issues of justice (see, e.g., Agarwal & Narain, 1991; Byrne, 1997; Byrne & Glover, 2000; Byrne, Glover, Inniss, et al., 2004; Byrne, Hadjilambrinos, & Wagle, 1993; Byrne, Wang, Lee, & Kim, 1998; Grubb, 1995; Shue 1992, 1993, 1995, 1999). Two broad and interlinked aspects to "climate justice" can be identified: One concerns the uneven impacts of climate change; and a second involves the burden of change

that accompanies a decision to reverse course by lowering GHG emissions. As to the first, environmental changes wrought by human impact on atmospheric chemistry will produce widespread effects to social systems that range from coastal and island inundation and the forced migration of human communities from these land surfaces, to rising heat-related deaths in inner cities and starvation in areas where subsistence farming is threatened (IPCC, 2001a). Although diffused spatially, the impacts of climate change are unlikely to result in common social or ecological risks. Natural systems and human communities will be subject to great changes; however, some will be more vulnerable than others. For example, coastal ecosystems are likely to experience disproportionate changes, as will the human communities that depend on them. In addition, the social impacts of climate change will not be confined to those who cause exceptionally high rates of GHG emissions. Consider for example, that current GHG emissions can exert an effect on climate for centuries, that the impacts of global climate change will be disassociated from the distribution of emissions, and that preexisting conditions of injustice will often amplify vulnerabilities of the relatively powerless segments of humanity.

Yet building an interest in justice to address unequal risks and impacts is only part of the challenge. Simultaneously, a regime of responses to mitigate GHG emissions² must be organized that likewise sustains an interest in justice. This involves allocating the obligation to reduce emissions in a way that recognizes disproportionate responsibility while also scaling the reduction effort to a level that can forestall future adverse, and uneven, social and ecological impacts.

A conception of climate justice built on the recognition of ecological and social values embedded in the idea of "ecological justice" (Byrne, Glover, & Martinez, 2002; Low & Gleeson, 1998) is emerging to tackle the twin dimensions of climate impacts and their mitigation. Under ecological justice, the ambit of claims to justice is extended from concerns with those able to participate in formal state and legal procedures and other processes to include the broader interests of future generations, ecological processes, and nonhuman species.

Although ecological justice may appear to be a radical departure from conventional legal concepts of justice, its importance is being acknowledged in many international (and national) policy debates (Hempel, 1996; Porter & Brown, 1996; Susskind, 1994). In the case of the *FCCC*, however, the underlying conception

of justice appears to be essentially anthropocentric. Article 2 of the *FCCC*, for example, sets the ultimate goal of the Framework Convention (UN, 1992) as avoiding adverse effects on the “physical environment or biota resulting from climate change which have significant deleterious effects on the consumption, resilience or productivity of natural and managed ecosystems or on the operation of socio-economic systems or on human health and welfare.” A number of articles in the *FCCC* directly address questions of social equity and fairness (see Articles 3.1, 4.2a, and 11.2). However, even these articles have contributed little to a justice agenda. Ecological justice requires adopting a perspective that goes beyond the anthropocentric and frames climate change impacts and the task of reducing GHG emissions in a novel way.

Climate Change Impacts and Ecological Justice

Climate change impacts are, by any measure, staggering in their potential reach, extent, and scale. Few realms of future social life will be untouched. Hydrology, coastal ecosystems, forests and soils; the range, distribution, and abundance of species; human health; infrastructure; and development are among the fields affected. The human imprint on the natural world from climate change has led some researchers to suggest naming the modern era the “anthropocene” (Crutzen & Stoermer, 2000). For illustrative purposes, we have selected human health, biodiversity, and small island developing states (SIDS) to describe some of the ecological justice issues of climate change.

Human health will be affected by climate change because of climate-related health variables: thermal extremes, food- and water-borne diseases, and vector-borne diseases will threaten populations; and the effects of natural disasters, such as storm surge and flooding, will likewise harm human health (World Health Organization [WHO], 2003).³ Estimates of the effects of climate change on the future of extreme climatic events are elusive; however, the IPCC (2001c) considers an increase of heavy rainfall, heat waves, and monsoonal variability to be probable. Densely populated deltaic areas and small island states are prominent in their vulnerability to sea-level rise and the effects of storm surge, notably in China, Bangladesh, and India along the mouths of the Ganges River, and the Nile River Delta in Egypt, where the welfare of millions will be at increased risk (IPCC, 2001a).

Many of the most important vector-borne tropical diseases are sensitive to climate, such as malaria,

schistosomiasis, dengue, and lymphatic filariasis (WHO 2003). Distribution and seasonality of these diseases are likely to alter with climate change, extending the period of possible transmission in affected areas and exposing new areas to the epidemics. Malaria has been identified as a disease likely to be highly affected by climate change (IPCC, 2001b). Models of the effect of climate change indicate an additional several hundred million people would be at risk of malaria in the 2080s (see, e.g., Martens et al., 1999).⁴ Editors of *The Lancet* (2001) considered these risks a “new bioterrorism.”

Biological changes are evident from the warming climate and other global factors in the contemporary era, and biodiversity losses will accelerate under climate change. A recent study of six biodiversity-rich regions (representing 20% of the earth’s surface) highlights the extent of these changes by 2050. Thomas et al. (2004) studied 1,103 land species and concluded that between 15% and 37% would become extinct. IPCC (2001a) reported that 25% of the world’s mammals and 12% of its birds are at “significant risk” (p. 271) of extinction. Of particular concern are the world’s biodiversity hot spots that shelter diverse populations of already threatened and endangered species (IPCC, 2002).

Small island developing nations are particularly vulnerable to climate change; indeed, a good deal of some countries will be obliterated by rising sea level and the devastation of storm surge. Sea-level rise is forecasted to be between 0.1 and 0.9m by 2100 (about 5 mm/year within a range of 2mm to 9 mm; IPCC, 2001c). Natural resources, such as beaches, reefs, atolls, freshwater supplies, and flora and fauna that supply valuable food, fiber, and materials will suffer the effects of inundation and erosion (IPCC, 2001a). Infrastructure is similarly vulnerable, especially roads, bridges, marine structures, communications, and buildings with coastal locations. Damage to these resources will produce disproportionate economic and social harm, given the concentration of settlements and economic activities in low-elevation coastal locations. Furthermore, such destruction sets back development for many modest-income communities and makes the prospects for sustainable livelihoods more difficult to secure (Byrne & Inniss, 2002).

GHG Emissions and Ecological Justice

There is considerable national differentiation in the global emissions of carbon dioxide released from fossil fuel combustion (Marland et al., 2003). In 2000, the

United States was the largest emitter and accounted for 23% of global emissions. China was second, followed by the Russian Federation, Japan, India, Germany, United Kingdom, Canada, Italy, and South Korea (Marland et al., 2003).⁵ Indicative of how uneven national emissions are, all of Africa's emissions (excluding South Africa) amount to less than those of the United Kingdom (Marland et al., 2003). Although global emission profiles are generally dominated by wealthy nations, many developing countries have high total emissions (notably Brazil, China, India, Indonesia, Mexico, Saudi Arabia, and South Africa), and this group tends to have high rates of emissions growth, as well. Forecasts of emissions growth have the developing world increasing as a source of emissions.

Because of the considerable inertia in the global climate system, there are lags between changes in GHG emissions and global climate. Reducing the future extent of global warming and sea-level rise depends on how quickly emissions can be reduced and by what extent; greater cuts earlier result in a lower rate and extent of warming and sea-level rise. Stabilizing atmospheric concentrations of carbon dioxide at 450 ppmv, for example, requires emissions to fall below the 1990 levels within the next 2 decades, and then continue to decline (IPCC, 2001c). Reducing GHGs by this magnitude involves a transformation of the conventional energy system away from reliance on fossil fuel combustion to one that supplies the majority of energy services from renewable sources. In effect, the basic model of industrialization that began with the age of steam will have to be overturned in a period of decades.

Significant economic consequences are feared if decarbonization of the global economy is attempted. Yet, studies on the economic implications for developed nations have not uniformly concluded that costs would be steep. In fact, some suggested that significant emissions reductions could be realized in the next decade without calamity (e.g., Interlaboratory Working Group, 1997, 2000). Developing nations face a different set of economic problems. Within the top 20 emitters, there are a number of developing nations (including Brazil, China, and India), several of which have low per capita GDP. Because the historical path of economic development entails growth in fossil fuel consumption, the challenge for developing countries is to improve quality of life without reproducing the industrialized world's high per capita GHG emissions (IPCC, 2001b, chap. 1).

Therefore, any proposals to reduce emissions globally face complex questions regarding the distribution of costs between nations, especially when the prospects for future development and historical emissions from the developed world are taken into account. Questions of ecological justice need to consider the challenge of reconciling inequalities embedded in the global economy and allocation of the burden of reducing emissions in an equitable manner that takes into account national circumstances (Agarwal & Narain, 1991; Byrne, Wang, Lee, et al., 1998; Meyer, 2000). Ecological justice brings forward the claims of developing nations and ecological protection into this equation.

Despite well-known inequities of responsibility for climate change, and although international negotiations recognize that adverse impacts from climate change are likely to be disproportionately borne by the poor (among nations and among classes in nations), the guiding principle of global governance has and continues to be efficiency. As discussed below, the preference of efficiency over justice in climate change policy emanates from the ideals and ideology of technological society that Ellul examined at length in his work. The problem is not that a justice agenda is impractical. Instead, a justice agenda is found by moderns to be inappropriate because it would be inefficient.

Response of the International Community to Climate Change

In one of the most ambitious efforts at global environmental governance yet attempted, the *FCCC* (UN, 1992) created a policy negotiation process and an international institutional apparatus to manage global carbon emissions (Oberthur & Ott, 1999; a more critical view is found in Byrne & Glover, 2002). This agreement identifies the anthropogenic GHGs at issue, sets a general goal for the agreement, and states that developed nations are to undertake the first round of emissions reductions. Under the *FCCC*'s 1997 operating agreement, known as the Kyoto Protocol, specific national emission reduction targets and a timetable for reductions are delineated for a group of wealthy nations and economies in transition. Against the benchmark of 1990, the group of nations referred to as Annex I countries (i.e., those of North America and Europe, along with Japan, Australia, and New Zealand)) is to collectively reduce their GHG emissions

5% below 1990 levels during the 2008 to 2012 budget period.

Under the principle of common but differentiated responsibilities, the *FCCC* requires initial actions to reduce emissions by Annex I nations. Because historical and current national emissions are mainly from this group, and because Annex I countries have the greatest capacity to reduce emissions by virtue of their economic development and technology research and development infrastructures, the *FCCC* designates these nations to bear the burden of action through 2012. Only two wealthy nations that signed the *FCCC* have refused to ratify the Kyoto Protocol, Australia and the United States.⁶

It is important to note that the Kyoto Protocol also established a set of policy instruments (the “Kyoto mechanisms”) to be used in efforts to reduce emissions that, taken together, create a comprehensive international GHG trading system. After several years of negotiation and development, the largest pollutant trading scheme ever attempted has now begun to operate. This system is complicated and involves considerably more than trading emission credits. Several forms of a new currency exist under the Protocol, including certified emission credits, assigned amount units, emission reductions units, and removal units. Composed of three separate mechanisms (emissions trading, the clean development mechanism, and joint implementation), the overall goal is to revise the global economy so that it can find least-cost emission reductions around the world.

In seeking to revise the global economy, the Protocol’s designers understood that emission reduction often would be provided by societies who had little responsibility for the problem. Indeed, American analysts advised national leadership in 1998 (while the United States was still a negotiating party) that a prudent strategy to comply with the Kyoto Protocol would be to trade for more than one half of its compliance obligation (Kopp & Anderson, 1998). When challenges to the fairness of this outcome were raised, a common response was that trading restrictions would result in inefficient burdens that could harm the global economy in the long run, to the disadvantage of all societies (IPCC, 2001b).

Science and the Problem of Climate Change

Ecological problems in the modern era are indivisible from science, and especially so in the

case of climate change. Action by the international community on climate change has its immediate origins in concerns first expressed by scientists (see, e.g., Christianson 1999; Hecht & Tirpak, 1995; Weart, 2003). An early decision by nation states was to create the IPCC to provide science information for policy makers. The IPCC’s assessment reports and special studies review available research and literature, covering the physical science, climate change impacts, and mitigation (see Footnote 2). The aim of the international community in forming this organization of some 2,500 scientists was to build a rational policy model for using scientific knowledge to inform the *FCCC*’s agreement details and subsequent negotiations process.

Climate change is a difficult issue for scientific advisors to address in serving the needs of policy makers. There continues to be uncertainty about important aspects of the problem, even for such questions as the extent of future warming (IPCC, 2001c). Likely impacts at the regional and local levels remain speculative.⁷ Technological cures for climate change are unavailable; the primary response is to reduce GHG emissions and to prepare for eventual impacts. Predominantly, the impacts of climate change lie in the future and are often diffuse and remote from those responsible for GHG emissions. Furthermore, there is the distinct possibility of future climate surprises, a likelihood that has increased with further discoveries of rapid climate changes in the palaeoclimate record (Schneider, 2004). In addition, even by the standards of an environmental problem, climate change sprawls across the disciplinary boundaries.

It is not surprising that research has concentrated on the physical climate system, working to improve the predictive capacities of the global climate models and the problems of quantifying GHG sources and sinks. As commentators have noted, the IPCC has been circumspect in this task by dealing largely with the problem of climate change as it is manifested in the physical world (Shackley, 1997). In this realm, the IPCC has provided surprisingly little assistance to policy makers, who (at least in part), because of uncertainties about the rate and extent of global warming, have been reluctant to act. The IPCC has been caught up by its own scientific standards, which has led it to doubt the usefulness of research on social dimensions of the climate problem. Social, economic, and political phenomena are not seen as having the same scientific standing as physical phenomena and technical responses. One exception is that the IPCC has recog-

nized econometric modeling in its reports to international negotiators. Indeed, IPCC reporting about the global carbon trading system and the general estimations of costs of taking action to limit emissions hinges on acceptance of the outputs of econometric models as approximating real facts.

Climate change science has had its share of controversy, for although the IPCC followed its mandate and expressed the consensus view of scientists, it was subject to attack by politically motivated groups supported by the so-called carbon club.⁸ As a result, the public aspects of climate change science have involved a contest for legitimacy, a struggle that the IPCC is destined to win, but not easily. What has emerged after the efforts of the IPCC is a distinct understanding of the climate change problem as shaped by the demands of international negotiations. Science has moved toward the goal of providing the information required by a global system to manage the international carbon economy. In this sense, it constitutes an essential component of a rational system based on the functioning of the global economy.

Missing from this body of official knowledge are the wider research needs that would address issues raised by the demands of ecological justice.⁹ Almost any pathway to stabilizing GHG concentrations in the future implies largely abandoning the fossil fuel energy system, yet despite the enormity of this challenge, the official arbiters of reason have yet to address a post-fossil fuel future. Similarly, the challenge of meeting the needs of the developing world through climate-friendly sustainable development has also been beyond the ambit of the IPCC. One defense of this neglect takes classic form: Science, it is said, addresses objective issues and leaves questions of values to political processes. However, climate change science (at least its social science-dominated Working Group III—see IPCC, 2001b) has proved not to be neutral regarding equity concerns, supporting the quest for “efficient global warming” (Byrne & Yun, 1999) in which economically less advantaged social groups and nations offer up emission cuts (and carbon sinks) at prices below the costs of the wealthy to avoid or mitigate GHG releases.

A Weather Forecast for Technological Society

In the face of evident and extensive problems of injustice embedded in the climate change problem,

what can explain the alliance of science and international policy in the pursuit of efficiency?

As with nearly all complex social problems, many factors have contributed to the emergence of anthropocentric climate change, and many are now shaping the policy responses under consideration. Among these is undeniably the interest of economic elites and their political partners in, on one hand, protecting their capital, assets, and market control from costly disruptions of the status quo and, on the other, the sometimes conflicting desires among elite members to profit from this social and environmental problem.¹⁰ As O’Connor (1994) noted, global capitalism’s unending search for surplus value leads to environmental contradictions (especially an innate tendency to “foul the nest” in which it operates) that preclude a sustainable relation with the natural order. In this regard, a potent explanation of the climate change problem could build on Marx’s critique of modern political economy in which *efficiency* is seen as a code word for economic exploitation. Whether the concern is with labor or the atmosphere, the diagnosis would be the same—injustice is to be rationalized by the objective laws of supply and demand that Marx sought to show were purely exploitive. Science’s participation in the identification of the problem might then be seen as a capitalist effort to lend credibility to such a rationale.

Although helpful to an extent, this explanation also presents problems. In one respect, the critique of capitalism is wide ranging and, as a result, finds nothing special in the problem of climate change. Issues of justice, from this perspective, are unified around a theme of exploitation that does not seek to differentiate among them. However, how do we then account for the distinctly scientific character of climate change? Without modern science, as shown above, the phenomenon of a human-caused warming of the world is inconceivable. Shall one then conclude that science invented global warming to enable a new profit center for capitalism?

Or one might hypothesize that science exists in a contradictory relation with capitalism. In one direction, its materialist philosophy leads practitioners to search for understandings of nature that expose capitalism’s contradictions. Although in another direction, its operational existence in a capitalist world leads to scientific agendas that advance an elite ability to control and manipulate nature for capitalist use (see Foster, 2000, for a discussion of the issue). Such a bipolar portrait might be used to explain science’s discovery of climate change and its interest in serving capitalist

aims to manage the atmosphere. Yet this rendering requires a level of capitalist prescience: The global economy's owner-managers needed climate change to be explained with a knowing confidence that the explanation would reinforce, rather than threaten, their control. At least to date, the highly contentious positions of corporate regimes and lobbies toward climate change policy do not suggest that such prescience in the capitalist class exists (or will emerge).

Of course, additional explanations for the emergence of an efficient climate change ideal can be proffered besides those rooted in the criticism of capitalism. A prominent contender might be the supposition that a global system of political power caused our present climate policy regime. In this approach, nation states, multinational corporations, and other powerful actors are thought to manage policy making as a political process (typically highlighted by the theoretical constructs of "neorealism" and "historical materialism," see, e.g., Rowlands, 2001). Several researchers have constructed variations of this model to demonstrate the influence of nations and economic interests on climate change policy (e.g., Grimes & Kentor, 2003; Newell & Paterson, 1999; Paterson, 1996). Here, science has relative autonomy in the creation of knowledge and, in the case of climate change, constructed ideas suited to its institutional interests in research (e.g., Boehmer-Christiansen, 1997). The politics of climate change, by contrast, emerges as an effort to protect entrenched and powerful nation-state and corporate interests in light of the new discovery.

Again, there are empirical reasons for explaining the problem in these terms. Without denying these, though, there is a similar problem of undifferentiated explanation. Society-atmosphere relations have no distinctive importance, other than as an instance of environmental politics. Indeed, for this framework it is easiest to treat climate change as a pollution problem in which economic, political, and environmental interests collide, and politics is the messy, not very pretty, process of finding compromises that can alleviate or divert conflicts for the time being.

However, an ecological justice interest would reject this proposal because it fails to recognize the distinctness of a global, long-lived ecological threat; that is, climate change is not like pollution; and it cannot, at least for those asserting a justice interest in climate change, be resolved by reworked so-called clean air or clean energy policies.

Although the climate change debate has and will continue to attract insightful analysis from the tradi-

tions of political economy and global environmental politics, the concerns briefly noted above suggest that additional frameworks are needed. In this spirit, Ellul's research on technique and technological society can be introduced as a means of understanding the spread of ideals of rationality, artificiality and order in modernity's interaction with nature.

Engels's Law

Ellul welcomed Engels's argument that the quantitative presence of social practices, values, and ideas can, with time, alter the qualitative experience of society. Of particular interest for Ellul were several centuries of promotion of rationality, artificiality and order into every facet of society from philosophy to law, economic production, state administration, and military organization—and from the realm of ideas and ideologies to operating principles of institutions.

One result of their pervasiveness is an altered sense of social reality, in which nature becomes incidental to the human drama (Byrne, Glover, et al., 2002). Social existence outside nature's constraints and, eventually, its rules, is a defining feature of technological society for Ellul. What Ellul (1964) referred to as modern technique's "monism" (pp. 94-111) insulates the ideas of rationality, artificiality, and order, and their ideal status in modernity, from external assessment—each is justified in its own terms. Social or ecological effect is measured by these self-same criteria, leaving no context for social reality (or the experience of social reality) that is apart from the rational, artificial order automatically being built by self-augmenting technological progress (Ellul, 1964, pp. 79-94).

The cognition of climate change occurs in this monist social reality. Of course, even moderns understand the social vulnerabilities that might accompany storm surges and sea-level rise, increased climatic extremes, and ecological catastrophe. Still, climate change, in technological society, is not a problem *per se*. Having abandoned nature as the arbiter of social reality in favor of rationality, artificiality, and order, modern thinking confines the phenomenon to a series of scientific and technical concerns: Can it be proved? What are its physical consequences? Its social consequences? What are the economic benefits and costs of addressing these consequences? Is adaptation to climate change, or mitigation of the problem the superior response? The IPCC and *FCCC* machinery are filled with such questions, and the two processes manage

legions of researchers, modelers, and economists in the quest for answers.

In this regard, Ellul's analysis of our era points to the distinctness of climate change. Through this phenomenon, we discover how social reality has overcome past fears of natural constraints and has even overcome the need to respect nature's rules. A global threat from nature can now, confidently, be assigned for study. Modernity is experiencing climate change as a research question.

Science as Narrator

In fact, the contest about climate change is instructive for what is not raised. The blue canopy that has inspired poets throughout the ages and has been conceived by cultures across time and geography to shelter the gods now fascinates humanity with its chemistry, physics, and mechanics. Our canopy is literally filled with science; our reverence is for the rational artifice that will divulge its secrets. No good poems will follow from the IPCC or *FCCC*,¹¹ no romance of nature will ensue, no god will be beckoned to save us.

In its new being, the sky is virtual; it exists inside climate models operating inside computers instructed by algorithms that live on mathematical topographies. Moderns discover the sky in the laboratory, not in nature (a noun that, for moderns, betrays its user's distinctly quaint, irrational outlook). Laboratory work has brought to our attention that we lack the ability currently to control the weather and other events of the climate system. This is the alarm bell of climate change, as it sets in motion the challenge to know the atmosphere and carbon cycle in a manner that will enable their management. We will decide its chemistry, physics, and mechanics when the sky has been scientifically rendered.

As science narrates the story, economic and political institutions have jockeyed, and will continue to jockey, for control of climate policy. Ellul's propositions need not be construed as denying the existence and importance of other narrators. However, the narratives of class and power cannot address a key issue here. Management of the blue canopy cannot be realized by a calculus of its so-called commodity versus capital value; nor can the principles of its management be unearthed by the logic of asymmetric power. Although management of the sky will surely reflect the political and economic agendas of the powerful (see Byrne & Glover, 2000), the contours and organization of climate administration must also derive from

technical acumen. As Habermas (1974) noted, the "disinfected reason" that governs modernity is far from apolitical; however, it cannot be reduced to a trick of class hegemony or *realpolitik*.

Autonomy of Technique

This leads to perhaps the most critical (and controversial) argument advanced by Ellul (1964), namely, that human judgment, valuation, and choice have been sublimated by the rule of technique—"the totality of methods rationally arrived at and having absolute efficiency . . . in every field of human activity" (p. xxv). In the modern era of "the one best way," of the optimally efficient, members of technological society live in awe of the rational, artificial, and orderly. We are like spectators attending to the "spectacle" of technological society (Debord, 1994).

Ellul's clear intent was to record the technical determinism underlying modern life (Vanderburg, 2002). For obvious reasons, an argument that suggests human intention and choice have disappeared is unsettling. In response, critics challenge if the case has been, or can be, made. However, such criticism usually targets the notion that human beings have been reduced to robotic existence in the technical milieu, with the contrarian view being that this cannot be because human thought, intelligence, and action makes the robot.¹²

However, there is another reading of Ellul's technical determinism (in the spirit of Engels's law) in which the ubiquity of technique and the institutional commitment to its unrelenting advance is emphasized. In this interpretation, human beings may comply with or resist the compulsion of technique. Yet, such action (either way) resides in what one might call a personal reality that transpires within technical reality. In what Mills (1967) called a conflict between biography and history, the tension felt in personal reality toward technical reality is indicative of a determinist underpinning of modern life.

Read in this manner, Ellul's observations on the autonomy of technique may have some force. The argument is not that human beings are altogether without willful action or are incapable of rejecting technical advance. Rather, the determinism lies in the advance of technical intention and action as human beings exercise their will and choose their actions.

Applied to the issue of climate change, the autonomy of technique refers to what would appear to be an inevitable requirement to address its prospect in a manner that makes best use of the ensemble of tech-

nique. What exactly does this mean? In confronting the threat of increased human mortality and morbidity, economic loss, and declines in other species and habitats, it means we will enlist technical acumen to abate or moderate risks. More than that, these problems will trigger efforts to improve technical acumen. In turn, efforts at improvement will inspire more sophisticated measurement, analysis, and, eventually, conceptualization of the problems and their mechanics. Success in this arena will, then, enable society to know climate more systematically and experience the world in a technically more robust and complete way.

Concretely, modern efforts to grapple with climate change have already and will continue to lead to a more scientific approach to the sky. Econometric modeling of the value of the sky will increase. The complexity of the problem will demand more scientific and econometric knowledge; however, advances in these domains will surely change human experience of the blue canopy. Subjective knowledge will not disappear; however, its unreliability will be proved and such knowledge will not much longer advise society's interaction with climate. Similarly, politics and political economy will not disappear, but the inappropriateness of managing atmospheric chemistry, physics, and mechanics by their means will become obvious. Whatever else may happen, society can be predicted, under the sway of the autonomy of technique, to invest continually in an efficient response to the problem. Subjectivity, politics, and political economy may hinder the realization of efficient global warming; however, none is likely to halt the approach.

Improving the Sky

In this respect, a forecast of the future of climate change is possible, using Ellul's characterology. We will search for a sky that can be rational. We will endeavor to find a carbon cycle that is orderly or can be made to be so with appropriate scientific intervention. As we succeed in the quest for these, it will be possible to specify an atmospheric chemistry of social and ecological progress, and the costs and benefits of realizing such progress. Applying technical reasoning to the problem, we will be able to define plans, and implementation strategies for our plans, that move society steadily and efficiently forward. Climate change will not again threaten our way of life.

Notably, this forecast cannot promise that our repair of what, in the modern view, is a broken carbon cycle or our upgrading of the sky's rationality will, in fact,

stop climate change. From the modern point of view, that cannot be the goal. Instead, a rational and efficient climate is the proper objective. And here the modern dissatisfaction with an ecological justice strategy can be located. A justice perspective finds the fact of climate change itself to be a problem. The phenomenon, as discussed above, disproportionately burdens the poor in its impacts and its mitigation. Moreover, the long-lived character of the problem means that the futures of ecosystems and forms of life are ineluctably harmed. A solution that cannot promise an end to the risk of human-induced climate change is, therefore, on justice grounds, unacceptable. The efficiency of an unjust solution hardly matters in an ecological justice framework. In addition, rational climate management asserts a technical interest where ecologically it is problematic. The modern pursuit of the control of nature has been rejected on justice grounds by many because it breaches nature's autonomy in the service of technique's reasonableness (Byrne & Glover, 2000; Devall & Sessions, 1985; Naess, 1973; Rolston, 1988). In this regard, modernity's efficiency and ecological justice are locked in a contradiction that cannot be overcome.

In sum, a technological society can be forecasted to institutionally invest in the efficient solution; however, no equivalent interest in a just outcome (unless it is efficient) can be expected. Furthermore, climate change maps the modern conflict between the artificial and the natural, but technological society can only be expected to resolve the conflict by searching for the one best way—the rationalization of the blue canopy. Because efficiency is a fact and justice is merely a slogan for the technically minded, appeals to ecological justice are likely to fall on the deaf ears of modernity.

Notes

1. By *environmentalism* we refer to a political movement beginning sometime in the 1960s when environmental awareness took the form of mass political expression and action. Earlier concerns with nature and the rejection of modernity or industrialization on the grounds of its assault on social and environmental values are clearly foundations for the ideology of modern environmentalism, and we include Ellul as a seminal influence in this regard. However, in our view, environmentalists have often neglected to recognize the importance of Ellul's (and others') work in shaping the intellectual and political discourse on nature in our time.

2. A comprehensive account of the science of climate change, its impacts, and mitigation can be found in the Third Assessment Report of the Intergovernmental Panel on Climate Change report series (IPCC, 2001a, b, c).

3. Natural disasters exact a high toll on human life, with the vast majority of the victims living in developing countries (Center for Research on the Epidemiology of Disasters [CRED], 2004). In a small sample of natural disasters in recent years, for example, a 1998 flood in China claimed 3,600 lives and left almost 16 million homeless; a 1999 cyclone in Orissa, India, took 9,800 lives; and in the same year, flooding in Venezuela claimed 30,000 (CRED, 2004). In 2004, there were more than 1,000 deaths from monsoonal flooding in Bangladesh, India, and Nepal (National Climatic Data Center [NCDC], 2004).

4. This study found that under one climate model the global increase in people at risk from malaria in 2080 was 300 million for *P. falciparum* and 150m for *P. vivax* species of malaria; a second model produced a range of 260m to 320m for *P. falciparum* and 100m to 200m for *P. vivax*.

5. Marland et al.'s (2003) data refer to carbon emissions from fossil fuel sources, cement manufacture, and gas flaring. In 2000, global annual emissions (in million metric tons) were 6,611, and the top 10 nations were United States (1,529), China (762), Russian Federation (392), Japan (323), India (292), Germany (214), and United Kingdom (155), Canada (119), Italy (117), and South Korea (117).

6. At the time of writing, Russia ratified the Kyoto Protocol (UN FCCCS, 2004). With Russia's approval, the Protocol is slated to come into force in February 2005.

7. Such is the difficulty of this task, that contemporary climatic events defy certain attribution to climate change.

8. This term was coined by environmentalists to describe the alliance of fossil fuel energy, automotive, and associated industries and conservative political groups, primarily based in the United States, and whose activities included political lobbying and supporting scientists with views differing from the IPCC (Leggett, 2000).

9. To be fair, the IPCC's last assessment report (IPCC, 2001c) did address some of the equity issues associated with GHGs and identified sustainable development as having a role in capacity building in developing nations, but clearly as relatively low priority areas.

10. Standing to gain are those who possess advantages (in technology, market position) that can be sold to fix the problem (e.g., vendors selling high efficiency power plants that are, expectably, more expensive); it also includes those who benefit from storm surges, higher clean energy prices, and other consequences of a warming world.

11. Perhaps in recognition of its triumph in this case over the literary arts, the scientific community has taken to describing its modeling efforts as attempts at constructing storylines for future relations with the atmosphere (IPCC, 2001c); a sort of consolation from science for its victory over literature.

12. Of course, there are those who point out that moderns are fascinated with cyber possibilities and may indeed eagerly embrace a posthuman existence (Harraway, 1991).

References

Agarwal, A., & Narain, S. (1991). *Global warming in an unequal world: A case of environmental colonialism*. New Delhi, India: Centre for Science and Environment.

- Boehmer-Christiansen, S. (1997). A winning coalition of advocacy: Climate research, bureaucracy and "alternative" fuels. *Energy Policy*, 25(4), 439-444.
- Byrne, J. (1997). *Equity and sustainability in the greenhouse: Reclaiming our atmospheric commons*. Pune, India: Parisar.
- Byrne, J., & Glover, L. (2000). *Climate shopping: Putting the atmosphere up for sale* (TELA Series No. 5). Melbourne: Australian Conservation Foundation.
- Byrne, J., Glover, L., Inniss, V., Kulkarni, J., Mun, Y.-M., Toly, N., et al. (2004). Reclaiming the atmospheric commons: Beyond Kyoto. In V. I. Grover (Ed.), *Climate change: Five years after Kyoto* (pp. 429-452). Enfield, NH, and Plymouth, UK: Science Publishers.
- Byrne, J., Glover, L., & Martinez, C. (2002). The production of unequal nature. In J. Byrne, L. Glover, & C. Martinez (Eds.), *Environmental justice: Discourses in international political economy* (pp. 261-291). New Brunswick, NJ, and London: Transaction Publishers.
- Byrne, J., Hadjilambrinos, C., & Wagle, S. (1993). Distributing costs of global climate change. *IEEE Technology and Society*, 13(1), 17-24.
- Byrne, J., & Inniss, V. (2002). Island sustainability and sustainable development in the context of climate change. In H.-H. M. Hsiao, C.-H. Liu, & H.-M. Tsai (Eds.), *Sustainable development for island societies: Taiwan and the world* (pp. 3-29). Taipei, Taiwan, and Chung-Li, Taiwan: Asia-Pacific Research Program, Academia Sinica and Southeast Asia Regional Committee for START Secretariat, National Central University.
- Byrne, J., Wang, Y.-D., Lee, H., & Kim, J.-D. (1998). An equity- and sustainability-based policy response to global climate change. *Energy Policy*, 26(4), 335-343.
- Byrne, J., & Yun, S.-J. (1999). Efficient global warming. *Bulletin of Science, Technology & Society*, 19(5), 493-500.
- Center for Research on the Epidemiology of Disasters. (2004). *The OFDA/CRED International Disasters Database*. Retrieved September 20, 2004, from www.em-dat.net/disasters/country.php
- Christianson, G. E. (1999). *Greenhouse: The 200-year story of global warming*. Harmondsworth, UK: Penguin.
- Crutzen, P. J., & Stoermer, E. F. (2000, May). The "anthropocene." *Global Change Newsletter*, 41, 17-18.
- Debord, G. (1994). *The society of the spectacle*. New York: Zone Books.
- Demeritt, D. (2001). The construction of global warming and the politics of science. *Annals of the Association of American Geographers*, 91(2), 307-337.
- Devall, B., & Sessions, G. (1985). *Deep ecology: Living as if nature mattered*. Salt Lake City, UT: Peregrine Smith.
- Ellul, J. (1964). *The technological society*. New York: Vintage Books.
- Foster, J. B. (2000). *Marx's ecology: Materialism and nature*. New York: Monthly Review Press.
- Grimes, P., & Kentor, J. (2003). Exporting the greenhouse: Foreign capital penetration and CO₂ emissions 1980-1996. *Journal of World Systems Research*, 9(2), 261-275.
- Grubb, M. (1995). Seeking fair weather: Ethics and the international debate on climate change. *International Affairs*, 71(3), 463-496.
- Habermas, J. (1974). *Theory and practice*. Boston: Beacon.

- Harraway, D. (1991). *Simians, cyborgs and women: The reinvention of nature*. New York: Routledge.
- Hecht, A. D., & Tirpak, D. (1995). Framework agreement on climate change: A scientific and policy history. *Climatic Change*, 29(4), 371-404.
- Hempel, L. C. (1996). *Environmental governance: The global challenge*. Washington, DC: Island Press.
- Intergovernmental Panel on Climate Change. (1990). *Climate change: The IPCC scientific assessment*. J. T. Houghton, G. J. Jenkins, & J. J. Ephraums (Eds.). Cambridge, UK: Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2001a). *Climate change 2001: Impacts, adaptation, and vulnerability* (Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change). J. J. McCarthy, O. F. Canziani, N. A. Leary, D. J. Dokken, & K. S. White (Eds.). New York: Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2001b). *Climate change 2001: Mitigation* (Contribution of Working Group III to the Third Assessment Report of the Intergovernmental Panel on Climate Change). B. Metz, O. Davidson, R. Swart, & J. Pan (Eds.). Cambridge, UK: Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2001c). *Climate change 2001: The scientific basis* (Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change). J. T. Houghton, Y. Ding, D. J. Griggs, M. Noguer, P. van der Linden, X. Dai, et al. (Eds.). New York: Cambridge University Press.
- Intergovernmental Panel on Climate Change. (2002). *Climate change and biodiversity* (IPCC Technical Paper V). H. Gitay, A. Suarez, D. J. Dokken, & R. Watson (Eds.). Geneva, Switzerland: Author.
- Interlaboratory Working Group. (1997). *Scenarios of US carbon reductions: Potential impacts of energy technologies by 2010 and beyond*. Washington, DC: U.S. Department of Energy.
- Interlaboratory Working Group. (2000). *Scenarios for a clean energy future*. Oak Ridge, TN, and Berkeley, CA: Oak Ridge National Laboratory, Lawrence Berkeley National Laboratory.
- Jasanoff, S., & Wynne, B. (1998). Science and decisionmaking. In S. Rayner & E. L. Malone (Series Eds.), *Human choice and climate change. Vol. 1: The societal framework* (pp. 1-87). Columbus, OH: Batelle Press.
- Kopp, R. J., & Anderson, J. W. (1998). *Estimating the costs of Kyoto: How plausible are the Clinton administration's figures?* Washington, DC: Resources for the Future.
- Lancet Editors. (2001, November 17). Climate change—The new bioterrorism. *Lancet*, 358, 1657.
- Leggett, J. (2000). *The carbon war: Global warming and the end of the oil era*. Harmondsworth, UK: Penguin.
- Low, N., & Gleeson, B. (1998). *Justice, society and nature: An exploration of political ecology*. London and New York: Routledge.
- Marland, G., Boden, T. A., & Andres, R. J. (2003). Global, regional, and national CO₂ emissions. In *Trends: A compendium of data on global change* (n.p.). Oak Ridge, TN: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory, U.S. Department of Energy. Available at <http://cdiac.esd.ornl.gov/trends>
- Martens, P., Kovats, R. S., Nijhof, S., de Vries, P., Livermore, M. T. J., Bradley, D. J., et al. (1999). Climate change and future populations at risk of malaria. *Global Environmental Change*, 9, S89-S107.
- Meyer, A. (2000). *Contraction and convergence: The global solution to climate change*. Foxhole, Dartington, Totnes, UK: Green Books for The Schumacher Society.
- Mills, C. W. (1967). *The sociological imagination*. London and New York: Oxford University Press.
- Naess, A. (1973). The shallow and the deep, long-range ecology movement: A summary. *Inquiry*, 16, 95-100.
- National Climatic Data Center. (2004). *Worldwide weather and climatic events* [Data set]. Retrieved September 20, 2004, from www.noaa.gov/oa/climate/research/2004/jul/hazards.html
- Newell, P., & Paterson, M. (1999). A climate for business: Global warming, the state, and capital. *Review of International Political Economy*, 5(4), 679-703.
- Oberthur, S., & Ott, H. E. (1999). *The Kyoto Protocol: International climate change policy for the 21st century*. Berlin and New York: Springer.
- O'Connor, M. (1994). On the misadventures of capitalist nature. In M. O'Connor (Ed.), *Is capitalism sustainable?: Political economy and the politics of ecology* (pp. 125-151). New York: Guilford.
- Paterson, M. (1996). *Global warming and global politics*. London and New York: Routledge.
- Porter, G., & Brown, J. W. (1996). *Global environmental politics* (2nd ed.). Boulder, CO: Westview.
- Rolston, H. (1988). *Environmental ethics: Duties to and values in the natural world*. Philadelphia: Temple University Press.
- Rowlands, I. H. (2001). Classical theories of international relations. In U. Luterbacher & D. F. Sprinz (Eds.), *International relations and global climate change* (pp. 43-65). Cambridge, MA, and London: MIT Press.
- Schneider, S. (2004). Abrupt, non-linear climate change, irreversibility and surprise. *Climatic Change*, 14, 245-258.
- Shackley, S. (1995). Global climate change: The natural construction of a science-policy domain. *Science and Public Policy*, 22, 218-230.
- Shackley, S. (1997). The Intergovernmental Panel on Climate Change: Consensual knowledge and global politics. *Global Environmental Change*, 7(1), 77-97.
- Shue, H. (1992). The unavoidability of justice. In A. Hurrell & B. Kingsbury (Eds.), *The international politics of the environment: Actors, interests, and institutions* (pp. 373-397). Oxford, UK: Oxford University Press.
- Shue, H. (1993). Subsistence emissions and luxury emissions. *Law and Policy*, 15(1), 39-59.
- Shue, H. (1995). Ethics, the environment and changing international order. *International Affairs*, 71(3), 453-461.
- Shue, H. (1999). Global environment and international inequality. *International Affairs*, 17(3), 531-545.
- Susskind, L. E. (1994). *Environmental diplomacy: Negotiating more effective environmental agreements*. New York: Oxford University Press.
- Thomas, C. D., Cameron, A., Green, R. E., Bakkenes, M., Beaumont, L. J., Collingham, Y. C., et al. (2004). Extinction risk from climate change. *Nature*, 427, 145-148.
- United Nations. (1992). *The Framework Convention on Climate Change*. Retrieved September 20, 2004 from http://unfccc.int/files/essential_background_publications_htmlpdf/application/pdf/conveng.pdf

- United Nations. (n.d.). *The Kyoto Protocol to the Convention on Climate Change*. Bonn, Germany: Climate Change Secretariat.
- United Nations Framework Convention on Climate Change Secretariat. (2004, October 7). *Russian decision on ratification: Major step towards entry into force of Kyoto Protocol* [Press Release]. Bonn, Germany: Climate Change Secretariat.
- Vanderburg, W. H. (2002). *The labyrinth of technology*. Toronto, Canada: University of Toronto Press.
- Weart, S. R. (2003). *The discovery of global warming*. Cambridge, MA: Harvard University Press.
- White, R. M., & White, W. (2004). Climate science, technology and politics: a tangled web. *Technology in Society*, 26, 375-384.
- World Health Organization. (2003). *Climate change and human health*. Geneva, Switzerland: Author.

John Byrne is director and professor of the Center for Energy and Environmental Policy at the University of Dela-

ware, Maryland. He is a contributing author to the Second and Third Assessment Reports (1996 and 2000) of the Intergovernmental Panel on Climate Change. He serves as co-executive director of the Joint Institute for Sustainable Energy and Environmental Future, headquartered in Seoul, Korea. He has published 12 books and more than 150 articles on energy and environmental policy. He can be reached at e-mail: jbyrne@udel.edu.

Leigh Glover is a policy fellow and assistant professor at the Center for Energy and Environmental Policy at the University of Delaware, Maryland. He has been involved in climate change research, administration, education, and advocacy for many years and has published on a number of aspects of climate change policy and politics. He can be reached at e-mail: lglover@udel.edu.