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august 2003

Critical Political Ecology

The politics of environmental science

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Routledge
Taylor & Francis Group
LONDON AND NEW YORK

The chapter argued that the universalizing, propositional statements about environmental explanation associated with the frameworks of orthodox science, relying on the correspondence theory of truth, are inadequate to acknowledge the institutional nature of many environmental problems as experienced by different people in a variety of locations and circumstances. As an alternative, the chapter reviewed debates within semantic and Critical Realism that allow some means of integrating social contextualization of environmental change with biophysical accuracy and the possibility of refuting existing, orthodox explanations.

The chapter presented some examples of different methodologies for more realist and socially relevant forms of explanation. These methodologies – such as events ecology and hybrid science – consider local framings of external ecological reality from both the scientist and local citizens' perspectives, with the intention of increasing both our awareness of these framings, and greater relevance of biophysical explanations to different social needs. It was argued that using such techniques allow a greater democratization of scientific practice – because they increase the transparency of explanations, and allow a local approach to explanations on terms determined by people experiencing problems, rather than according to meta-narratives of explanation or fixed spatial scales. The chapter made it clear that democratizing science in this way does not mean rejecting "global" environmental explanations or concerns in principle, but instead the need to understand better how, and by whom, such explanations are claimed to be global or local.

The next chapter now builds on this discussion by examining the political factors underlying the evolution of scientific networks and public access to scientific debate.

9 Democratizing environmental science and networks

This chapter now examines the political institutions and procedures that can increase transparency and public participation in environmental science. If environmental science reflects social and political framings, then how can political debate be reformed to make these framings more visible and relevant to more people? How can people not represented in the framings of environmental explanations be empowered to influence environmental science?

The chapter will:

- discuss the dilemmas of enhancing public participation in environmental science. Some observers have suggested that increasing participation may democratize scientific debates by acknowledging diverse forms of expertise, and by building trust in science. Against this, critics have suggested that scientific consensus and certainty are based upon the enforcement of networks and boundaries that are, by definition, exclusionary.
- examine how environmental assessments and scientific organizations may increase transparency and accountability. Such actions may form new ways of regulating the production of scientific knowledge, and may improve the communication of scientific findings from scientific networks to other groups.
- consider how alternative scientific networks or institutions may be empowered, especially from marginalized social groups or in developing countries. Such networks may often not seek to impose predefined "laws" or explanations of environmental degradation, but build local capacity to achieve inclusive political debate about the management of resources and environmental risks.

In common with Chapter 8, this chapter therefore presents practical means to address some of the problems of environmental science discussed in earlier chapters. The aim of a "critical" political ecology is to conduct environmental politics without using a priori definitions and explanations of environmental degradation. This chapter helps achieve this objective by describing political arenas that allow the discussion of

environmental objectives at the same time as acknowledging the political embedding of environmental science.

Scientific expertise and public participation

The earlier chapters of this book listed a variety of problems in using environmental science as a politically neutral basis for environmental policy. The aim of this chapter is to examine how far these problems can be addressed by democratizing the networks and institutions that produce science.

Chapter 8 started the analysis of democratizing environmental science by looking at ways to reform scientific methods themselves. In that chapter, "democratization" was defined as revealing the tacit politics within scientific statements, and in diversifying and localizing universalistic scientific explanations or "laws" of nature. How can similar reforms be made to public debate about the purpose of environmental science, and to scientific networks and institutions?

This objective raises a number of associated questions. First, it is necessary to consider the definition of networks. As discussed in Chapters 4 and 6, networks may refer to the people, actors, and organizations that uphold scientific practices or beliefs. Yet networks may be interpreted formally in the sense of clearly identifiable scientists and institutions, or more complexly in the sense of Actor Network Theory, or the extended translation model of science (Callon, 1995) that refers to the epistemological impacts of different networks on the definition and hybridization of physical objects as part of networks. Democratizing networks may therefore imply not simply changing the participants, but reconsidering the knowledge claims and approaches to biophysical objects in general.

Second, is it more effective to seek to reform existing networks, or to establish alternative, co-existing networks? Many scientific networks depend on the claim to represent expertise. Yet much research in cultural ecology and science studies has illustrated alternative forms of expertise within "lay" people such as farmers (e.g. Batterbury, 1996; Wynne, 1996a). Third, how far does the discussion of "science," as commonly portrayed in popular debates, itself foreclose what is considered to be expertise or legitimate knowledge?

These questions are addressed throughout this chapter. This initial section outlines some general dilemmas in discussing democratization of scientific networks. One crucial problem is in blending public participation with scientific certainty. Will science be considered effective if it includes dissenting voices and diverse opinions? Does environmental science seek to restrict public criticism in order to make its work seem more successful?

This section considers the political barriers to public participation in environmental science, and then examines some dilemmas of using orthodox concepts in environmental politics for analyzing the democratization of science. The following sections then assess means of reforming scientific institutions, and building alternative scientific networks.

Scientific networks and consensus

This book has discussed many of the problems of believing that environmental science can be separated from politics, or that existing explanations of environmental problems can be used as a neutral backcloth for political debate. The most extreme position of this belief can be expressed as a belief that science provides the "facts" for policymakers to use. This belief has been described as science "speaking truth to power" (Price, 1965), or the model of "synoptic rationality" in which decisions are made based on collating "all the facts" (Collingridge and Reeve, 1986: 63).

This book has argued that such approaches are clearly inappropriate for describing the evolution of scientific knowledge and its interface with policy. As discussed in previous chapters, scientific knowledge is clearly coproduced with political activism; the boundaries of scientific networks can be exclusive and related to political interests; and the very construction of scientific explanations of complex biophysical changes rely on social framings often rooted in history and language. How can the interface between science and policy be more effectively explained?

One of the first approaches to complicating the rigid separation of science and politics was the concept of "transcience" (Weinberg, 1972). Transcience can be described as the zone between pure science and pure politics that consist of topics where scientific experiments cannot reduce uncertainty to known levels. "Uncertainty" is commonly defined as the situation where we don't know what we don't know, whereas "risk" is used to define probabilities that can be calculated (e.g. Douglas, 1985). Under "transcience," science cannot provide answers sought by policymakers, and so policy criteria are used to direct the research and models chosen. For example, policy criteria such as protection of public health may dictate the inquiries into nuclear physics in order to identify the risks posed by nuclear power plants (Jasanoff and Wynne, 1998: 9).

The concept of transcience highlighted that certain topics of public policy based on scientific knowledge would remain uncertain, and shaped by topical political concerns, or the actions of influential politicians or scientists (see also Cobb and Elder, 1972; Kingdon, 1984). During the Second World War, for example, the British writer, C.P. Snow expressed concern about the "court politics" between Churchill and his leading scientists, which gave them "more direct power than any scientist in history" (Snow, 1961: 57–63; in Weingart, 1999: 153). The speech of James Hansen of the National Aeronautical and Space Administration to the US Congress in 1988 on the topic of global warming is a further case of a prominent scientist shaping political action regarding a scientifically uncertain topic.

Blurring lines between scientific expertise and political advocacy like this clearly raises questions concerning the alleged separation of science and politics (Jasanoff, 1990). When science advisers become integrated into policy debates, their status within the frameworks of orthodox science as neutral observers may change:

> What transforms scientific knowledge into an expert appraisal is its inscription within the dynamics of decision-making. Yet this inscription, at least in the case of scientifically and politically complex questions, immediately leads the scientist to express opinions or convictions which (however scientifically founded) cannot in any way be identified with knowledge in the strict sense which science generally affords this term.
>
> (Roquelpo, 1995: 170; also in Weingart, 1999: 157)

It is also worth asking how certain topics become seen as "uncertain," because these indicate where and how existing expertise is considered insufficient. Funtowicz and Ravetz (1985, 1992, 1993) proposed one model that advanced on the concept of "transcience" by proposing three levels of scientific certainty (see Figure 9.1). The model suggested that most uncertain and intractable policy dilemmas come when high decision stakes coincide with high systems uncertainty.

As shown in Figure 9.1, at the lowest level of uncertainty and decision stakes, the activities of "normal" science (in the terms of Kuhn's paradigms, see Chapter 3) are usually sufficient to provide legitimate information. Beyond this level, new participants and skills need to be consulted in order to resolve policy dilemmas (Funtowicz and Ravetz called this "professional consultancy"). At the highest levels of uncertainty and decision stakes, scientific experts may need to share inquiries with amateurs, stakeholders, or professions quite dissimilar to their own. Such "post-normal science" is seen, optimistically, to generate sufficient reframings in order to reduce uncertainty to a level where professional consultancy or "normal" (or applied) science can operate again.

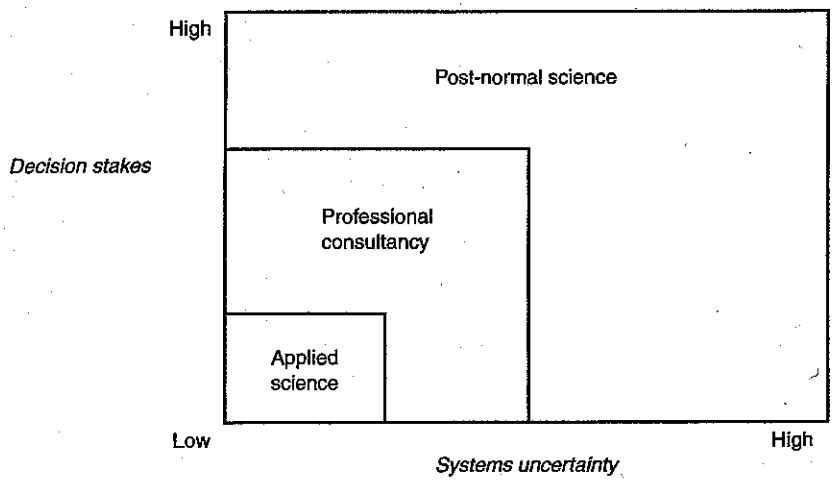

Figure 9.1 Three kinds of science
Source: Funtowicz and Ravetz, 1985, 1992.

The model of "post-normal science" is attractive for explaining political barriers to scientific participation because it shows ways in which divisions may be made between scientific progress and public consultation. But it also may be criticized for a number of reasons. As Jasanoff and Wynne (1998: 12) note, this model may be questioned because it assumed that uncertainty and decision stakes might be independent of each other; or because it implies that reducing uncertainty in post-normal science may simultaneously decrease decision stakes. Furthermore, MacKenzie (1990) and others have claimed, reductions in uncertainty occur if decision stakes are reduced for unrelated reasons. MacKenzie's model of the "certainty trough" (see Figure 9.2) indicates that "uncertainty" is also dependent on access to, and communication with, expert institutions, and that such factors may vary between different social groups.

A more political discussion of scientific uncertainty therefore highlights the political barriers to reaching public consensus about the veracity of specific explanations or scientific findings. "Uncertainty" is not just the statistical probability of successful explanation achieved via science, but also the degree of public access to, and participation in, the production of knowledge. Such factors also account in part for the emergence of institutionalized environmental explanations (or environmental orthodoxies). By definition, such explanations are seen to be unchallengeable "truth," yet in practice contain many aspects of uncertainty or irrelevance to people where they are applied (see Chapter 2).

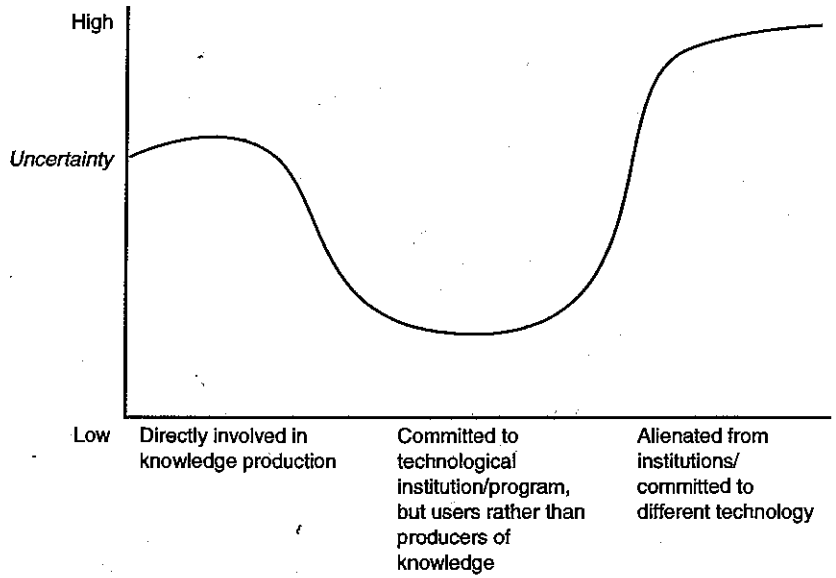

Figure 9.2 The certainty trough
Source: MacKenzie, 1990; Jasanoff and Wynne, 1998: 13.

These political approaches to scientific uncertainty indicate the important role of scientific networks in constructing where uncertainty is seen and not seen. Yet, as discussed in earlier chapters, the emergence of scientific networks and expertise is in part directed by the political attention to different problems, and who participates in the analysis and regulation of findings. Consequently, some sociologists of science have argued that risk analysis is often far less reliable than alleged because regulatory scientists and government officials tend to depict risk assessments as if they are fully determinate, and understate both the complexity of biophysical factors and their own ignorance about them (Wynne, 1992; van Zwanenberg and Millstone, 2000: 262). Such problems have also been associated with monopolistic science or expert institutions – such as state science bodies – where such criticisms are resisted (de Jong, 1999). Accordingly, the optimistic "post-normal science" of Funtowicz and Ravetz may not occur because practitioners working within "normal science" often exclude dissenting or worried voices. As Collingridge and Reeve noted, the enforcement of consensus in this way may have severe implications on the ability for science to challenge the status quo:

> When research is directed from outside on problems where disciplinary distinctions are blurred, and where any proposed solution will have a high error cost, consensus is quite impossible. The price of a super-efficient normal science is the impossibility of scientific research exerting any significant influence on policy directions.
>
> (1986: 147)

Such statements have important implications for the inclusivity of science when "uncertainty" is perceived to be a topic of political concern. The search for a clearly agreed solution, within certain networks, may dissuade transdisciplinary research (or "hybrid science," see Chapter 8). Furthermore, the boundaries between what is considered science, or acceptable science, may be further enforced, with the further implication that expert institutions working on reducing uncertainty become important boundary organizations (see Chapter 6). As Jasanoff, in her study of US science advisers as policymakers, noted:

> By drawing seemingly sharp boundaries between science and policy, scientists in effect post "keep out" signs to prevent nonscientists from challenging or reinterpreting claims labeled as "science." The creation of such boundaries seems crucial to the political acceptability of advice... Curiously, however, the most politically successful examples of boundary work are those that leave some room for agencies and their advisers to negotiate the location and meaning of the boundaries.
>
> (1990: 236)

Scientific uncertainty, therefore, is not simply a matter of calculated risk, but is also a function of public participation in the generation and dissemination of knowledge. Yet, the desire to reduce apparent uncertainty by asserting the role of professional (or applied) science may paradoxically increase that uncertainty by reinforcing barriers between scientists and lay people. Furthermore, such reassertion of barriers may also result in privileging forms of knowledge produced by scientists relating to universal properties and inference, rather than local contextualization and meaning of such general biophysical changes gathered by consulting with local people. Ironically, such reassertion of the boundaries of orthodox science contributes to the production of universal "laws" – or environmental orthodoxies – that do not acknowledge local contexts or vulnerabilities to biophysical changes.

So, how can social concerns about environmental risk and uncertainty be communicated to scientific networks in ways that do not reiterate the boundaries of orthodox science? Also, how can such communication take place in ways that acknowledge the coproduction of environmental science and politics? These questions are addressed throughout this chapter. The next section, however, considers some further dilemmas for democratizing environmental science based on challenging some conventional approaches to ecological "community" and "rationality" that have significant implications for the production of more democratic environmental science.

Challenging orthodox concepts of environmental democratization

Democratizing environmental science networks may therefore face a number of political barriers. Yet there is also a need to reconsider some orthodox concepts through which environmental democratization may be achieved. This section briefly summarizes some problems with these concepts when seeking to democratize environmental science.

Much discussion of environmental democratization has focused on the adoption of predefined notions of ecological rationality. For example, Mason wrote:

> Environmental democracy is defined as a participatory and ecologically rational form of collective decision-making: it prioritizes judgments based on long-term generalizable interests, facilitated by communicative political procedures and a radicalization of existing liberal rights.
>
> (1999: 1)

This statement correctly draws attention to the tacit political models of democratization contained within environmentalism, yet does not draw equal attention to the tacit assumptions about ecology (a point Mason acknowledges). As discussed in Chapter 5, much discussion of ecological rationality as a liberatory force against the instrumental rationality of

oppressive industrial and state regimes (e.g. Eckersley, 1992) may be associated with a coproduced form of ecology that essentializes economic growth with environmental degradation and lost wilderness. This approach to ecological rationality may avoid alternative approaches from groups not represented in the construction of this rationality. Furthermore, such an approach may even restrict the livelihoods of unrepresented groups if it considers their actions to be environmentally damaging.

Second, the concept of "community" has also been used to indicate a sense of belonging and locality associated with democratic governance. Ecologists have used the concept to also refer to collections of biological species, or for groupings that lie between the individuals and entire populations. As reported in Chapter 1, such "community"-based models of ecology encouraged some of the early political ecologists to urge the limitation of individual human actions because of the impact on the community. Eugene Odum (1964: 15), for example, wrote: "[ecology] deals with the structure and function of levels of organization beyond that of the individual and species." Similarly, Paul Sears, writing in the same volume, commented that "by its very nature, ecology affords a continuing critique of man's [sic] operations within the ecosystem" (1964: 12).

These uses of the concept of "community," however, contain a variety of assumptions about togetherness that can be challenged (see Leach *et al.*, 1997; Agrawal and Gibson, 1999). Such statements suggest that human activities may be assessed in the aggregate and within ecological limits. But they do not acknowledge the ways "communities" can contain various subcategories, or how such limits are defined. The concept of "community" can be differentiated biophysically in relation to the institutional scales within which explanatory statements can be made (such scales refer to the semantic or epistemic boundaries that control the production of apparently true statements, see Chapters 3 and 8). "Community" can also be differentiated socially in reference to divisions such as gender, age, race, or class that make shared values less easy to predict (see Chapter 4). Indeed, as discussed in Chapter 7, the notion of "global" ecology that was enhanced by the first photographs of the Earth from space does not necessarily indicate a unified environmental perception, or the existence of global limits that are equally present or meaningful to all people (Yearly, 1996; Jasanoff, 2001). As discussed in Chapter 6, the words "institution" or "network" may be more useful as means to describe unified norms or experiences than "community," as these words indicate the contingent nature of what is shared by individuals rather than the automatic assumption that a community may really exist (Berry, 1989; O'Riordan and Jordan, 1999).

Third, notions of environmental "expertise" may also be questioned on a number of grounds. Clearly, as discussed above (pp. 233–237), the frameworks of orthodox science portrayed a distinction between "expert" and "lay" knowledge that can be challenged when inquiry concerns topics of local practice or perceptions of risk not shared by people formally classified by experts (see Wynne, 1996a; Fischer, 2000; Tesh, 2000). Indeed, much research in developing countries has highlighted how many farmers in supposedly threatened locations have adopted practices that maintain environmental protection despite rising population and affluence (Batterbury and Forsyth, 1999). There is a need to acknowledge a greater role of expertise among people historically identified as "lay." Such acknowledgment of expertise does not, of course, imply that all individuals have equal knowledge or training about specific risks, but that the experience and framing of risks by "lay" people is crucial for the understanding of risk (see debate between Daly, 1991 and Turnbull, 1991; Irwin, 1995).

These challenges to orthodox concepts of environmental expertise may also be directed at some attempts to redress the balance between "experts" and "lay" people. Some authors – and particularly the eco-anarchists such as Murray Bookchin – have argued that bureaucratic politics and instrumental industrial growth has caused a rationalization of expertise within the state apparatus, and a disturbing distance between experts and lay people. (Such arguments are clearly influenced by the sociologist Max Weber.) As a response, some observers have suggested that environmental decision-making should be diversified to the local level in order to reverse such rationalization, and to integrate environmental management with local experiences (see Eckersley, 1992; Murphy, 1994; Smith, 1996).

There is a need, however, to question how far such calls for devolution are also based on a perception of ecology as a response to instrumental rationality rather than a more contextualized assessment of different knowledge claims about complex biophysical processes and risks. It may be reasonable, for example, to see entrenched scientific expertise as characteristic of liberal democratic government (e.g. Ezrahi, 1990). But to see such entrenched government as itself the cause of ecological degradation (e.g. Beck, 1995) may be to essentialize instrumental rationality with environmental degradation in ways that overlook the complexity of biophysical change and our experiences of it (see Chapter 5).

Fourth, a common approach to environmental democratization has discussed the need to reform the "public sphere" by communicating new ecological discourses. This generally Habermasian approach defines the public sphere as a formal or informal arena in which environmental norms and policies may be discussed and agreement reached (see Habermas, 1987; Dryzek, 1990; Calhoun, 1992). In particular, some authors have pointed to the role of environmental social movements and activism as means of revising environmental policy in favor of groups seeking to regulate dominating state or industrial interests (e.g. Eder, 1996; Mol, 1996; Blowers, 1997; Brulle, 2000).

Such generally optimistic statements about the effects of public debate have been criticized by more constructivist writers who suggest these approaches overlook the role of communicative institutions such as courts, regulatory agencies, expert bodies, and news media in creating, and shaping multiple "public" spheres (Jasanoff and Wynne, 1998: 27;

Edwards, 1999). Indeed, theorists influenced more by Foucault have pointed out how the language adopted in such so-called public spheres – such as cost–benefit analysis by economists, or legal arguments in courts – may present further barriers to participation, even in inquiries that are claimed to be "public" (Tewdyr-Jones and Allmendinger, 1998). Indeed, under such circumstances, expert power and state power may be inseparable (Turner, 2001). The well-known Habermasian task of rationalizing the public sphere to enable greater public participation may therefore overlook the numerous barriers to participation, and the deliberate creation of co-existing public spheres by various organizations to establish different forms of legitimization and support for various objectives.

The general implication of these challenges to orthodox approaches to environmental democratization is to move debate away from "one" predefined notion of ecological rationality for a supposed unified "community," toward the acknowledgment that environment may be perceived and valued in various forms, from different people, in diverse political arenas. Such plurality of perspectives does not imply that all perceptions are equally powerful, or that each perspective may co-exist without contradictions. As discussed in Chapter 8, the recognition of diverse perspectives does not imply cultural relativism (or the belief that all are equally valid). Indeed, the cross-comparison of some perspectives may allow a form of scientific progress (see also de Jong, 1999: 198; van Zwanenberg and Millstone, 2000). Plural institutions and networks may exist at a variety of scales, and may exist in formal or informal political settings such as within state bureaucracy or *de facto* adopted by farmers or citizens regardless of official recognition. Yet, as argued by sociologists such as Giddens (1990), Beck (1995), and Seligman (1997), for example, the perception and experience of risks may be increasingly individuated because of the growing multiplicity of roles and tasks performed by individuals rather than groups.

A further implication is – as discussed in Chapter 7 – environmental risk cannot be explained simply in terms of linear causality or biophysical change alone. Instead, it is necessary to acknowledge the institutional shaping, communication, and response to perceived environmental threats, of which addressing perceived biophysical events is important, but not exclusive. As Jasanoff wrote:

> The social sciences have deeply altered our understanding of what "risk" means – from something real and physical if hard to measure, and accessible only to experts, to something constructed out of history and experience by experts and laypeople alike ... Trying to assess risk is therefore necessarily a social and political exercise, even when the methods employed are the seemingly technical routines of quantitative risk assessment ... it makes very little sense to regulate risk on the basis of centralized institutional authority, insulation from public demands, and claims to superior expertise.
>
> (1999: 150)

Table 9.1 Models of risk perception for public policy

Model	*Epistemology*	*Location of authority*	*Policy prescription*	
			Style	*Mechanism*
Realist	*realist*	*expert communities*	*managerial*	*expert advice*
Constructivist	*constructivist*	*social/interest groups*	*pluralist*	*public participation*
Discursive	*constructivist*	*professional discourses*	*critical*	*social movement*

Source: Jasanoff, 1998.

Indeed, Jasanoff (1998) has proposed that risk perception may be classified into three basic models which draw attention to different modes of analysis and expertise (see also Fischer, 2000). The Realist (or positivist) model lends most emphasis to identifying the underlying biophysical cause of risk, communicated via expert advice from expert communities. The constructivist model acknowledges the constructed and plural nature of risks, but seeks to achieve understanding via social inclusion and public participation. The discursive model is also constructivist in epistemology, but acknowledges the political barriers to participation posed by the "vernacular" or language of risk assessment permissible within specified (public) arenas (see Table 9.1).

The objectives of a "critical" political ecology are to assess how far political practices may lead to alternative explanations of environmental reality. According to these objectives, the constructivist and discursive models of risk analysis are most applicable for understanding the evolution of environmental science. Yet these models also imply adopting critical stances toward orthodox concepts of community, rationality, and expertise to see how far such concepts contribute to the coproduction of environmental science and politics.

The following sections of this chapter now assess the challenges in building more locally relevant alternatives to the universalizing "laws" adopted under the Realist model, by either reforming powerful scientific institutions, or by empowering the emergence of alternative institutions from less powerful sectors of society.

Regulating scientific institutions

The preceding discussion listed a number of challenges to the democratization of environmental science, and to orthodox approaches in environmental politics to achieving "environmental democratization." How can environmental politics acknowledge these concerns in order to achieve an effective reform of environmental science and networks?

Perhaps the most obvious means of reforming environmental science is to seek change within the institutions and networks of orthodox

environmental science. Changes might include seeking greater reflexivity or transparency within scientific and expert organizations, in order to acknowledge underlying social and political values, or to show the decision-making process through which advocacy statements are made. As discussed in Chapters 3 and 6, Mertonian norms of regulating scientific knowledge (based on principles such as sharing knowledge, or inviting and responding to criticism) may be considered neither accurate nor sufficient in terms of describing the evolution of scientific statements. Acknowledging public concerns about environmental science – or enhancing public participation in the framing of inquiry – may improve both the perceived relevance of science, and public trust in scientific institutions.

Part of the problem also lies in reconsidering the role of science itself. Historically, the word "science" was enough to denote the source of respectable "truth." For example, the future US President, Woodrow Wilson, spoke in 1896 of "calm Science seated there, recluse, ascetic, like a nun" (Wilson, 1896). Yet today, public trust in science as an institution is much less, caused in part by the increasing diversity and individualization in roles performed by people, and what this means for receiving knowledge that can assist with these roles (Giddens, 1990; Seligman, 1997). Indeed, according to Ulrich Beck, such individuated experiences of risks, and declining levels of public trust are key aspects of "Risk Society." As Beck wrote: "[science is] more and more necessary, but at the same time, less and less sufficient for the socially binding definition of truth" (1992: 156).

The challenge facing public organizations under such conditions is to ensure that decisions are made in the public interest, or with sufficient ability for worried citizens to voice concerns and feel they have been listened to (Reich, 1990; Fischer, 2000). Those seeking to reform scientific institutions in this optimistic way, however, may also encounter some significant obstacles. First, the desire to enhance participation in scientific inquiry often implies seeking to soften, or diversify the boundaries around scientific inquiry and networks of scientists. Yet, as discussed above, the achievement of consensus and meaningful causal statements can often depend on the existence and enforcement of epistemic boundaries, and the status of perceived "experts" within orthodox, "normal" science. Second, some challenges to the credibility of scientific practice run the risk of causing great offence to professional scientists, who see such criticisms as inaccurate and unfair, especially if made by people untrained in physical science. Third, the definition and adoption of "participation," "transparency," and "accountability" are themselves contested, and will reflect different models of democracy or justice that should themselves be worthy of analysis (Mason, 1999).

This section considers means of reforming existing (and often orthodox) scientific institutions. The discussion forms part of wider debates about public understanding of science, but there is no attempt to review all of these debates in this book (see Irwin, 1995; Irwin and Wynne, 1996; Dierkes and van Grote, 2000). Instead, this section focuses on institutional

structures through which expert organizations can become more reflexive about political framings of science, and more accountable to public concerns about how science has been conducted.

The "science wars" and direct challenges to science

Perhaps the most direct form of public criticism of orthodox scientific institutions in recent years was the number of intellectual exchanges during the 1990s known as the "science wars" (see also Chapter 1; Jasanoff, 2000; Segerstråle, 2000). The "science wars" went beyond the expected level of "conjecture and refutation" associated with orthodox science because it was a discussion about science in general, and its accountability, governance, and claims to represent truth. Indeed, the implications of the "wars" are still felt today in debates about large-scale environmental explanation (such as Global Climate Models, or Land-Use-Cover-Change measurements), and challenges from more localized and contextualized approaches such as in this book.

It is commonly reported that the "science wars" began after the decision to terminate public funding for a superconducting supercollider particle accelerator during the 1992–1993 session of the US Congress. This decision quickly led to wider debates about the purpose of public funding for science, especially after the end of the Cold War, and the ability for the public to influence such decisions. One memorable phrase from this time was coined by Daryl Chubin, a senior analyst at the US Office of Technology Assessment, who described the self-serving arguments used by physicists to justify public funding for equipment such as the supercollider as "quark barreling" (see Fuller, 2000: 134). The debate led onto wider questions of sociology and politics of scientific knowledge, and an angry backlash from orthodox scientists who considered such questions as irrational. These debates comprised a variety of viewpoints and levels of disagreement, ranging from the generally uncontroversial to the overtly confrontational. For example, Mary Midgley wrote: "Science education is now so narrowly defined that many scientists simply do not know that there is any systematic way of thinking besides their own" (1992; in Nader, 1996: 13).

Barnes *et al.* wrote:

> The scientific profession possesses considerable authority in modern societies, and indeed wherever "science" is identified and designated as such, the implication is that something especially trustworthy or reliable is being described. Such authority is of course of inestimable value to individual scientists, and they have a vested interest in its maintenance. They can be expected to police the existing boundaries of science, to avoid the intrusion of whatever may detract from its reputation, and to seek to expel anything potentially disreputable which arises within.
>
> (1996: 140)

And Jasanoff:

> Like the strict constructionists of the Constitution, the critics of science studies ascribe an almost mystical primacy to the original intent of scientific authors, from Bacon to Einstein to figures of our own day – an intent, moreover, that only other scientists are licensed to decipher safely. The critics' constant fear is that science studies misrepresents the words and works of scientists, citing them out of context or distorting them through unnatural juxtapositions. Not for a moment do they share the humanist's sense of the fluidity and ambiguity of language – even scientific language – let alone of texts, artifacts, and agents being connected in complex webs of meaning. It is no wonder that, from this standpoint, humanistic readings of science are so readily construed as assaults on the truth.
>
> (1999: 498)

A common response of some ardent defenders of orthodox science was to reiterate the boundaries of scientific networks, and to question the motives of the critics. Most famously, Gross and Levitt wrote:

> To put it bluntly, the academic left dislikes science ... Within the academic left, hostility extends to the social structures through which science is institutionalized, to the system of education by which professional scientists are produced, and to a mentality that is taken, rightly or wrongly, as characteristic of scientists. Most surprisingly, there is open hostility toward the *actual content* of scientific knowledge and toward the assumption, which one might have supposed universal among educated people, that scientific knowledge is reasonably reliable and rests on a sound methodology.
>
> (1994: 2, emphasis in original)

This defense of scientific knowledge and methodology also led to criticisms of many other political concerns that the science defenders saw to be based on ideology rather than on science. Environmental concern reflecting deep-green (or ecocentric) beliefs, for example, was criticized because: "in part it [environmentalism] is an act of ritual abasement before a personified "nature" rather than a program of practicable measures for dealing with concrete environmental dangers" (Levitt, 1999: 132).

Environmentalism is therefore criticized because it may lead to the knee-jerk rejection of technologies such as nuclear power that could potentially reduce the causes of anthropogenic climate change. Furthermore, Levitt noted:

> Environmentalism has no credentializing process. Scientific acumen is not a requisite for participation or even leadership, and considerable prominence has been given to figures whose scientific competence is nearly non-existent ... in this atmosphere it is difficult to weigh choices in the light of the facts that scrupulous science provides.
>
> (ibid.: 133)

This book, of course, might concur with the need to question the use of scientific statements by different environmentalists in order to legitimize environmental policy on highly contested themes (see Chapters 2 and 5). Yet, unlike Levitt and other science warriors, this book would still question the ability for environmental science to produce socially neutral facts.

These criticisms of environmentalism, however, have been easily associated with "brownlash," or the attempts to discredit environmental concern by businesses unwilling to adopt environmental regulation, and has led to further responses from pro-environmentalists. Paul and Jane Ehrlich, for example, published the pro-environmentalist book, *Betrayal of Science and Reason: How Anti-Environmental Rhetoric Threatens our Future* (1996) partly as a way to demonstrate that environmentalism may also adopt the frameworks of orthodox science that mathematicians such as Levitt sought to protect. Other authors have similarly written to protect the concept of "nature" as a scientifically legitimate basis from which to formulate environmental policy (Soulé and Lease, 1995; see Chapter 1).

As discussed throughout this book such approaches to science and nature overlook diverse problems in how far these concepts can represent politically neutral representations of biophysical reality. Furthermore, under such discussions of environmentalism, much debate from science studies has been inappropriately cast as attempts to legitimize bodies that seek to avoid environmental regulation. The objectives of science studies, instead, are to highlight how tacit framings and institutions shape, and are shaped by, the practice of science. This statement can be made about the so-called "facts that scrupulous science provides" or the alleged "science and reason" claimed by both critics and defenders of (deep-green, or ecocentric) environmentalism.

The debates of the "science wars" helped to publicize some of the concerns of science studies about entrenched orthodox scientific networks. Yet these debates have also encouraged stereotypical images of "pro" and "anti" science, such as the mistaken belief that all professional scientists are uncritical of scientific procedures, or that science critics are opposed to science in any form. Alternative approaches have sought to reform procedures within specific organizations or assessments.

Reforming national and international organizations

Further attempts to reform environmental science have focused on increasing the transparency and participation within existing scientific or policy organizations. Such organizations may be at national or international levels, and include power over research funding, or dissemination of environmental expertise.

Fuller (2000) lists three ways to govern science at the stage where public funding is allocated to competing research proposals. The first model, of "finalization" (Schaefer, 1983), assumes that mature science will be governed through a combination of inertia within science's own networks and the overseeing directions imposed by the state. The second model, "cross-disciplinary relevance," was proposed by Alvin Weinberg (1963) (of transcience fame), which optimistically urged that public funding be prioritized for research providing maximum benefit for the widest selection of disciplines. The third model is "epistemic fungibility" (Fuller, 1993), which acknowledges that cross-disciplinary relevance often does not influence research funding because grant applications are often made to each discipline's own peer group (see also Collingridge and Reeve, 1986).

The model of epistemic fungibility also points out – in common with some debates in science studies – that scientific disciplines are also networks of people who are experts within their discipline, but are lay people outside disciplines. Achieving epistemic fungibility therefore implies acknowledging the different constituencies who control decisions affecting the allocation of research funding. Yet this objective may be challenged by the vested interests of closed networks. Fuller wrote:

> Were disciplinary communities made to be routinely accessible to each other, then much of the aura of expertise and esoteric knowledge that continues to keep the public at a respectful distance from scientists would be removed.
>
> (2000: 142)

Environmental organizations may also be examined for transparency and accountability in the formulation of environmental expertise. Chapter 6 began some discussion of the role of "boundary organizations" as institutions that control the coproduction of science by being accountable to different networks in science and policy. This discussion may be extended to organizations' responses to criticism from environmental groups.

One study by Landy *et al.* (1994), for example, focused on the United States Environmental Protection Agency (EPA). Landy *et al.* argued that the EPA was characterized by a system of "interest group liberalism," or "policy entrepreneurship" that effectively turned administrators into advocates of competing policy proposals (in Fischer, 2000: 228; also Landy, 1995). Under this system, Landy argued that policymakers had to engage in a variety of strategies to portray policies in positive ways to different constituencies such as journalists, legislators, judges, and the public, in ways that can easily be seen by the public to be manipulative and untrustworthy.

The solution to this problem, they argued, lies in increasing transparency and inclusivity of policy decision-making processes within the EPA. Furthermore, the EPA's role in decision-making should be shifted

from a position of policy entrepreneurship to providing public information about technological, legal, or financial feasibility of different options. The implication of this kind of study is not to suggest that administrators within the EPA may be corruptly promoting selected policy options, but to indicate the influences of hitherto unacknowledged organizational culture on how policy debate is conducted.

Similar analyses have been conducted on international organization. For example, the World Bank has commonly been criticized for avoiding environmental concerns by supporting large-scale infrastructure projects such as dams and highways; and for being apparently unaccountable in decision-making (e.g. Rich, 1994; Mehta, 2001). The Bank has responded to concerns with a variety of measures: in 1987, it upgraded its environmental office to full departmental level, and in 1989 introduced Environmental Impact Assessments (EIA) for projects. But most attention has been given to the decision to suspend funding for the Narmada dam in India in 1991, and then the decision of the incoming president, James Wolfensohn, to cancel the Arun 3 dam in Nepal in 1995 because of potential environmental and social impacts. Both dams were the subject of much public controversy and activism. As Bank staff are instructed in training sessions: "Don't get zapped by the Narmada effect, do your EIAs!" (in Goldman, 2001: 200).

Yet critics have suggested such responses by the Bank may still be problematic because they have emerged to avoid the most overt criticism rather than assessing environmental principles in general. Furthermore, new environmental codes adopted by the Bank still hide a variety of simplifications in environmental practice, and the simultaneous actions ensure new codes are seen as legitimate.

Goldman (2001) discussed these concerns in relation to the World Bank assessment of the proposed Nam Theun 2 dam in Laos. In particular, Goldman noted that the Bank had contracted research to the International Union for the Conservation of Nature (IUCN), but that the IUCN suppressed anthropological work that highlighted the impacts of the dam on diverse indigenous peoples in the region, and therefore problematized the IUCN's intention to develop parts of Laos into a National Biodiversity Conservation Area. The dam investors' consortium then hired a consultant from Norway who concluded that all peoples in the location of the dam could be resettled without harm, and who also argued that such groups could be described as one ethnic group, with few differences from other peoples in Laos. All such claims are contested by Goldman, who argued that the dam project framed environmental management in the eyes of the lowland state, international trade, and outsiders' visions of nature. Such criticisms echo comments made in Chapter 7 concerning the projection of risk onto regions and remote people. He wrote:

> The new authoritative logic of eco-zone management that is carving up Laos is designed to ensure that there will be "sustainable" hardwood supplies for export, watersheds for dams, and biodiversity

> preservation for pharmaceutical firms and eco-tourists. This worldview represents most small producers as ecologically destructive and backward.
>
> (2001: 207)

In addition, the production of environmental knowledge and assessments about the dam were accompanied by actions by the World Bank and IUCN to represent such information as legitimate and credible. In particular, the Bank sought to demonstrate the need for outside environmental guidance by claiming, for example, that the government of Laos showed no environmental awareness. The IUCN even went so far as to say that *no* conservation practices existed in Laos, and by once suggesting that the word does not exist in the Lao language. Such statements are demonstrably wrong when faced with the diversity of words (in various languages within Laos) that can mean "conservation," and by the abundance of information about conservation practices adopted by shifting cultivators (e.g. Fox *et al.*, 2000). Yet the purposes of such statements are to legitimize the intervention by these organizations, and to suggest that the framings and approaches adopted by them are the only options.

There are many ways to assess international organizations such as the World Bank for environmental policy and transparency, including awareness of gender, local participation, and the influence of internal management cultures (see Wade, 1997; Kurian, 2000). There is insufficient space in this chapter to review all of these concerns, but the implications of the example from Laos is that environmental reforms need not necessarily lead to more democratic approaches to environmental expertise and science. Superficially, the Bank adopted environmental expertise from organizations – such as the IUCN – that have important reputations for offering environmental expertise. But this expertise was framed according to predefined, and highly contested, development objectives, and did not seek to challenge the underlying assumptions about environmental causality, or seek to include significant participation at the sub-state level.

The lesson of this discussion is that successful democratization of environmental science and networks needs to assess the process by which expertise is formulated and legitimized, rather than simply accepting "environmental" practices in principle. Simply claiming to be "environmental" need not democratize environmental science and networks if the environmental principles and assumptions are constructed in selective and predefined ways. This conundrum indicates the need to consider the constructivist and discursive models of risk (discussed above, p.241) in order to indicate how far discourses of environmental reform may actually democratize or reinforce existing networks. The examples of the EPA and approaches to research funding discussed earlier suggest that procedures can be reformed to increase transparency. But the example of the Nam Theun 2 dam suggests that the World Bank and IUCN have opportunistically used apparent environmental reform as a further arena in which to

conduct predefined, and highly contested, development objectives. Critics must be diligent to identify when such "reforms" are being used to reinforce, rather than democratize, environmental networks. If discussion seems to be resisted by the networks, then outright opposition or the empowerment of alternative networks may be more effective.

Reforming environmental assessments

Finally, the practice of environmental assessments may also be reformed. Assessments are the means by which scientific networks may communicate findings to policymakers (see Social Learning Group, 2000a, b; Farrell *et al.*, 2001). Commonly, however, assessors have adopted the classic "science speaks to power" model, discussed above (p.233), which has resulted in some important failings.

For example, the Global Biodiversity Assessment (GBA) was undertaken by the United Nations Environment Program (UNEP) at the second conference of the parties to the Convention on Biological Diversity (CBD) in 1995. The report aimed to provide a comprehensive survey of scientific and policy dilemmas concerning biodiversity, and aimed to revolutionize thinking on biodiversity in the same way as the IPCC had done for anthropogenic climate change (Cash and Clark, 2001). The assessment was more than 1,000 pages long, and had included the participation of more than 1,500 scientists from more than 80 countries. The survey was also designed to be free from political criticism by being conducted independently of the CBD. Indeed, the GBA drew upon the expertise and organization skills of UNEP, the World Conservation Union (WCU), and the World Resources Institute (WRI); by including a wide variety of scientists from both developed and developing countries; and by adopting a comprehensive peer review process of its findings. Yet despite these actions, and initial positive reviews of the assessment, parties to the CBD largely ignored the GBA; it did not shape the political agenda for biodiversity conservation; nor was it used as a source book by individual nations for furthering domestic biodiversity policies. Indeed, the GBA was viewed with suspicion by some countries, particularly in the developing world (see Raustilia and Victor, 1996; Reid, 1997). In the words of one participating scientist: "it [the GBA] sank like a lead balloon" (Kaiser, 2000: 1677; in Cash and Clark, 2001: 2).

Cash and Clark (2001) have suggested the failure of the GBA resulted from four errors specifically associated with that assessment. First, the GBA did not acknowledge the political context of the negotiations on biodiversity conservation. The assessment was initiated between the first and second conference of the parties to the CBD, and accordingly was produced at a time when different parties were lobbying for different policy outcomes. The assessment was easy to portray, or delegitimize, as partial to different political viewpoints rather than as a basis from which to establish policy. Indeed, the comparatively more authoritative assessments of

ozone depletion in 1985, and the IPCC initial reports in the late 1980s, preceded the establishment of conventions on these topics. Second, the GBA failed to address the needs of its users by focusing too much on technical, "state of the art" scientific measurement, rather than on how biodiversity is perceived and experienced in many countries. Third, the GBA failed to treat assessment as a communication process between assessors and users. Part of the reason for this lack of communication was the desire to demonstrate impartiality in its findings, but the result was perceived irrelevance. Fourth, the GBA failed to connect global and local levels of assessment, by overlooking means to acknowledge local concerns and exposure to risks, or local capacity to deal with them.

These failings in a high profile and expensive environmental assessment indicate both the attractions and contradictions of portraying science to be independent of politics. In order to make the GBA seem legitimate in the eyes of users, the assessors sought to put distance between the assessment and users. Yet by not communicating with users, the assessment lost credibility and relevance, and could not help being criticized by some developing country representatives as reflecting only the framings and practices of the Convention's more powerful parties.

Because of these kinds of experiences with environmental assessments, Farrell *et al.* (2001) suggested reforms to four under-appreciated elements of assessment design. First, it is important to acknowledge the assessment initiation and context, or the hidden framings that make an assessment appear necessary. Who called for the assessment and why? In the case of the GBA, one critic was quoted as saying, "the scientific community just decided we needed this and did it" (in Kaiser, 2000: 1677; Cash and Clark, 2001: 3). As discussed widely in this book, such framings have important epistemological implications on the research findings and causal statements. Second, what are the science–policy interactions of the assessment? How far are scientists isolated from policymakers? Third, who participates in assessments, and under what conditions? And fourth, what are the different assessment capacities available to ensure effective assessments in different contexts? Assessment capacity refers to the ability of relevant organizations, actors, and political arenas to ensure participation in assessments, and successful communication between different parties.

The purpose of reconsidering these four elements of assessment design is to increase the appreciation of environmental assessments as dynamic and social processes. Yet there are still important questions about how these suggestions can result in the democratization of the scientific networks adopted by assessments. First, many assessments still enforce boundaries between the formulation of scientific advice, and then its application to policy. This is perhaps shown most in the case of the IPCC, where scientists involved in the research of climate change are excluded from writing the associated summaries for policymakers, which are written by political representatives. Similarly, the Ozone Transport Assessment Group of 1995–1997 separated "technical" and "political" issues. Such separation in these cases still indicates a belief that scientific practice itself may not reflect social and political framings, or that "science" can be conducted in political neutrality, and then be communicated to "power."

Second, a further question concerns the extent of public participation within environmental assessments. As discussed at the beginning of this chapter, it is not clear if achieving scientific certainty about environmental problems may simply mean obtaining consensus among a controlled network of participants. Some commentaries about environmental assessments have approached participation warily because it might prevent the achievement of consensus. For example, Farrell *et al.* wrote:

> Expanding participation does not necessarily benefit the assessment process – particularly in the short term. It can reduce the assessment's quality, make the assessment logistically unmanageable and/or increase the difficulty of reaching consensus.
>
> (2001: 330)

Participation may therefore be controlled in order to reduce the potentially disruptive influence on apparently successful assessments. Farrell *et al.* claim that increasing participation from developing countries in the IPCC was a source of potential disruption, but resulted in the positive outcomes of providing more attention to development-oriented aspects of climate change. Against this, however, critics have suggested such participation has not democratized the IPCC enough. Increased participation has been mostly at the level of inter-state negotiation, rather than at the substate level. Furthermore, the IPCC still holds on to the emphasis on atmospheric greenhouse gas concentrations as a guide to environmental risk, rather than understanding more contextual analyses of vulnerability (e.g. Dowlatabadi, 1997; Kates, 2000b; Demeritt, 2001; see Chapter 7). In this sense, increased participation may have reinforced the existing Realist and linear model of risk adopted within the IPCC, and not have resulted in a more diversified reframing of how risk is presented.

Increased participation in some environmental assessments may therefore have limited impacts on the democratization of science and networks. As Farrell *et al.* note, it is important to ensure that participation includes aspects of culture and perception of environmental problems, rather than be restricted to the nominal inclusion of "token" representatives of unrepresented groups. It should also be noted that there are many types of assessment, with different contexts and possibilities for change. Despite such statements, however, it is not clear how far some environmental assessments, predicated on the belief that science itself can be separated from political framings, can actually adopt such greater participation in meaningful terms. According to this belief, participation cannot, by definition, democratize science. Yet as this book has sought to demonstrate, the very identification of environmental problems and causal links are indeed determined by social and political factors.

This section has discussed a variety of means by which existing scientific networks may be democratized or reformed in order to increase transparency, and increase the possibility for people outside the network to influence them. But have these measures successfully challenged the boundaries of networks, or increased widespread participation? One alternative is to empower alternative networks as a way to challenge the authority of existing, more powerful systems of expertise. The next section now considers these alternative networks.

Empowering alternative networks

So, if attempting to reform existing scientific institutions may prove problematic, is it possible to develop alternative networks that may address the needs of less represented groups more successfully?

This next section now examines the emergence of alternative institutions or networks of science that may exist in parallel to, or outside of, the formal boundaries of orthodox scientific institutions. Such alternative networks may be considered a form of democratization because they allow greater localization and diversification of environmental explanation. They may also increase transparency and public participation in local environmental science.

The alternative networks discussed in this chapter are not simply those associated with social movements. As discussed in Chapter 5, many discussions of ecology associated with "new" social movements have adopted ecological discourses that essentialize environmental degradation with social oppression and instrumental rationality in modern societies. Indeed, Richard Harvey Brown (1998) has discussed the possibility for a "democratic science" based on improved social communication to a public sphere in order to avoid such instrumentalism. This book has argued that such discourses themselves need to be democratized in order to understand how – and with whose participation – such assumptions were made. Similarly, as discussed in Chapter 6, other social movements may often harness or replicate existing environmental discourses in order to achieve political success.

Instead, this section considers institutions that acknowledge the coproduction of political activism and environmental science, and which seek to acknowledge the political boundaries associated with public participation. Such institutions need not reject interfaces with formal scientific knowledge from expertise from other institutions. But they may seek to advance the constructivist and discursive models of risk discussed above, rather than simply provide capacity for the implementation of science constructed under the Realist model.

The discussions in this section are all related in various ways to wider debates concerning so-called Deliberative and Inclusionary Processes in Environmental Policymaking (DIPS) and participatory approaches to environmental policy (see Dryzek, 1990; Button and Madson, 1999; Holmes and Scoones, 2000). This chapter cannot summarize all of these debates, but focuses mostly on the ways in which debates within political ecology can engage with diversifying the local negotiation of environmental science.

Environmental adaptations in developing countries

The concept of environmental adaptations was introduced in Chapter 2 to refer to environmental practices and livelihood strategies that allow the protection of resources despite the existence of poverty or increasing populations (see Netting, 1993; Batterbury and Forsyth, 1999). Examples of adaptations include soil conservation measures such as *diguettes* (or lines of stone) to prevent erosion, or soil mounds to enhance agricultural fertility (e.g. Tiffen and Mortimore, 1994; Batterbury, 1996; Sillitoe, 1998), or gradual transformation of forest–savanna landscapes to enhance the production of specific tree species valuable for local livelihoods (e.g. Fairhead and Leach, 1996; Schmidt-Vogt, 1998). Environmental adaptations are often considered forms of so-called community-based natural resource management (CBNRM) (e.g. Leach *et al.*, 1997).

Environmental adaptations indicate two important lessons for empowering alternative scientific networks. First, adaptations may be considered to be a form of alternative network because they offer exceptions to generalized predictions of environmental degradation such as the I = PAT equation (see Chapter 2). Second, adaptations also indicate the importance of local, and often unpredictable, factors of culture and social organization that are not always included in rational choice, or positivist approaches to common-property resource theory (e.g. Ostrom, 1990). As a result, some authors have argued that studying the institutional bases of environmental adaptations, and transferring these to new locations, may be effective ways of diversifying and localizing environmental management (see Mehta *et al.*, 1999, 2001).

Empowering and transferring adaptations, however, imply a number of difficulties. First, there are problems in identifying how far practices are "local." As discussed in Chapter 7, there is a need to assess how far conceptions of local practices may reflect outside constructions of locality or indigenous people that may hinder locally determined development. It is also increasingly difficult to identify groups of people or environmental practices that are not in some way connected to regional or global networks of trade, investment, or migration (Bebbington and Batterbury, 2001). Such increasing global integration both affects the institutional basis of environmental adaptations, and the causes of environmental degradation. Murton (1999), for example, found that Tiffen and Mortimore's (1994) originally positive findings that "more people" may mean "less erosion" in Machakos, were increasingly less apparent because local farmers were spending time away from soil conservation, and instead were engaging in sporadic migration to cities for waged employment.

Second, there is also a need to consider the role of "global" environmental risks alongside "local" environmental problems. Some environmental adaptations may be effective against locally defined problems, but may be insufficient to mitigate risks that may occur more globally, or practices that have environmental impacts outside localities. For example, Chapter 6 described the example of the International Center for Research in Agroforestry (ICRAF) framing research on shifting cultivation in Southeast Asia in terms of regional impacts on declining biodiversity or regional haze from fires. Such concerns also have to be matched with local framings of problems, and how far policies suggested from a regional perspective (such as restricting shifting cultivation) might actually impact negatively on local livelihoods.

Third, it is sometimes difficult to separate the concept of environmental adaptations from the underlying securities – such as land tenure, health, education, or access to resources – that allow adaptations to succeed. Clearly, some adaptations – such as building terraces, installing *diguettes*, or shaping forest islands – are only attractive to farmers if they are confident they can reap the rewards in the future. Enforced resettlement, or appropriation of land by state or investors, or during times of political unrest, may therefore undermine the adoption of environmental adaptations. Similarly, all members of the locality are unlikely to benefit from adaptations in the same way. As discussed above (p.238), the concept of "community" frequently hides a variety of social divisions along lines of gender, caste, age, etc. that may differ in access to underlying securities such as land tenure or education. (Indeed, this criticism may also be applied to the concept of "social capital," which has also been used in generally positive terms about local development.)

Because of these problems, some observers have argued that more attention should be given to the means by which local environmental governance may be achieved, rather than the imposition of predefined "laws" about environmental degradation. Box 9.1 describes some potential institutional forms that may allow the successful transfer of experience of environmental adaptations to new locations. These approaches differ to orthodox approaches to environmental management or environmental politics by allowing the local framing of environmental problems, and by acknowledging that concepts of "community" include a variety of conflicts and social divisions that may be constantly experienced and negotiated. Together, they form suggestions for how local environmental governance may be achieved, which may also include constructive engagement with expert knowledge from outside localities.

The concepts of sustainable livelihoods and environmental entitlements focus on building environmental adaptations at the micro level. Sustainable livelihoods is a more general term referring to the means of establishing capabilities and assets that may enable social groupings (such as individuals, households, or localities) to maintain reliable sources of income despite resource scarcities (see Chambers and Conway, 1992;

Box 9.1 Some possible institutional forms for integrating environmental governance and learning

Sustainable livelihoods

The concept of sustainable livelihoods is a framework for integrating environmental management with local livelihood strategies. In simple terms, a "livelihood" may be defined as the capabilities, resources, and other assets and activities required for making a living. A "sustainable livelihood" may be defined as one that

> can cope with and recover from stress and shocks, maintain and enhance its capabilities and assets and provide sustainable livelihood opportunities for the next generation; and which contributes net benefits to other livelihoods at the local and global level and in the short and long term.
>
> (Chambers and Conway, 1992: 1)

Sustainable livelihoods differ from orthodox approaches to environmental management in two key ways. First, they reject the assumption that there is an inescapable link between poverty and environmental degradation, and instead seek to empower local strategies to conserve resources. Second, they allow local people to frame environmental problems and resource conservation in terms that are necessary for their livelihoods.

Environmental entitlements

The environmental entitlements debate seeks to apply the "entitlements" approach of Amartya Sen (see Chapter 7) to the means by which individuals or social groups can gain access to, and protect, environmental resources. The approach seeks to highlight the "endowments" or "entitlements" that may allow different people to use resources, and the varied way in which social institutions – or shared norms of behavior or environmental perception – may influence this access (Leach *et al.*, 1999). Institutions may exist at micro, meso, or macro scales, involving negotiations within households, villages, or regions, and between different actors. Environmental entitlements also help avoid a simplistic approach to "community"-based natural resource management by highlighting the social divisions that exist within so-called communities.

Adaptive management

Adaptive management is a form of resource management that allows local people to negotiate and reframe official advice on environmental management from orthodox science. It aims to understand the potential for different management techniques by looking at the responses to management itself from local people who use scientific information (Berkes *et al.*, 1998). Adaptive management has been used in contexts where resources are subject to a variety of local and regional demands on land use, such as in areas of protected forest, or in the evolution of community forestry (Robbins, 2000; Klooster, 2002). It provides a means by which management techniques may be adapted dynamically in order to reflect the demands

made by a wide group of users as the result of regular communication between resource managers from different user groups.

Islands of sustainability

The concept of islands of sustainability refers to a region or locality that has adopted forms of economic cooperation and environmental protection that allow it to integrate economic success with environmental conservation (Wallner *et al.*, 1996; Bebbington, 1997). Similar to sustainable livelihoods, "islands of sustainability" commonly exist in zones considered to be subject to widespread environmental degradation and poverty. "Islands" allow local livelihoods to continue through the co-creation of political unity between different villages or farms, common economic strategies, and the establishment of trading links with other localities. The establishment of common links between different parties in each "island" is crucial to successful integration.

Sources: Chambers and Conway, 1992; Wallner *et al.*, 1996; Bebbington, 1997, 1999; Berkes *et al.*, 1998; Carney, 1998; Scoones, 1998; Batterbury and Forsyth, 1999; Leach *et al.*, 1999; Robbins, 2000; Klooster, 2002.

Scoones, 1998). Some authors have referred to this as *bricolage*, or the ability to adopt a flexible and interconnecting range of income sources and environmental activities to reduce vulnerability to changes (e.g. Batterbury, 2001; Cleaver, 2001). Often, sustainable livelihoods are based on a combination of three key actions: agricultural intensification, income diversification, or short- or long-term migration by some or all members of a household. For example, in the Sahel of West Africa, Mossi farmers from Burkina Faso may seek to overcome long-term problems of drought and declining agricultural productivity by seeking short-term employment in cities. In Papua New Guinea, Wola shifting cultivators have maintained soil fertility despite growing populations by innovating with soil mounds and the adoption of sweet potato that thrives on such mounds (Sillitoe, 1998).

The concept of environmental entitlements is a similar approach but focuses more on the institutional controls of access to resources. The approach reflects Amartya Sen's entitlements approach to food security discussed in Chapter 7, and seeks to indicate the different institutions – or shared behavior and expectations – through which individuals or social groupings may gain access to resources, often in variable or short supply (Leach *et al.*, 1999). For example, in the semi-arid Indian province of Rajasthan, water management is crucial for irrigation and for urban sanitation. The underlying biophysical variation in groundwater leads to variable supplies of water for either boreholes or local surface water supplies. According to the approach of environmental entitlements, *endowments* for water may be defined as the private arable and pasturelands occupied by farmers, and the water rights that enable access to communal water supplies. *Entitlements* for water supply, on the other hand, include irrigation

water, crops, and income from marketed products, and these are influenced by collective action among owners of contiguous plots, or communal repair work on gullies and canals. A variety of institutional controls influence endowments and entitlements. Access to water endowments are influenced by micro institutions such as inheritance of land, labor contributions to agriculture, and macro-scale institutions such as interactions between the governments of India and Rajasthan concerning watershed development policy, and land laws. At the meso scale, entitlements are influenced by market forces and credit institutions. The result of these interactions is a supply of water to large farmers, marginal farmers, and livestock rearers (Ahluwalia, 1997).

Local strategies may also allow more overt resistance to environmental changes or controls that are imposed from outside. In the Dominican Republic, for example, Rocheleau *et al.* (2001) noted how local *bricolage* by different farmers allowed resistance to the introduction of *Acacia* trees as both cash crops and carbon-offset forestry. Such local resistance has also been noted against state-led soil or forest conservation policies often dating back to colonial science and management objectives in South Africa (Driver, 1999); India (Jewitt, 1995; Srivaramakrishnan, 2000); West Africa (Fairhead and Leach, 1996; Batterbury, 2001); and in Thailand (Johnson and Forsyth, 2002). A less confrontational approach may be adaptive management (Berkes *et al.*, 1998), or the mutual shaping of external environmental management plans by formal scientists and local people. This approach has been praised for developing models of community forestry in Mexico, for example, because it allows the integration of different framings and experiences of forests from different users (Klooster, 2002). Yet such negotiations may still be controversial. In India, for example, Robbins (2000) noted that the resulting consensus within such negotiations still reflected powerful groups, and that the consequent environmental assumptions about the impacts of forest use could still be questioned from other perspectives.

The concept of "islands of sustainability" (Wallner *et al.*, 1996) also proposes a large-scale application of sustainable livelihoods for integrating economic competitiveness and environmental sustainability, often in regions where orthodox thinking would assume widespread environmental degradation and poverty. In the rural Andes, for example, a combination of action by NGOs, agricultural producers, and local governments have succeeded in intensifying agriculture, and in increasing investment in new, high-value products such as horticultural crops (Bebbington, 1997). In such cases, the establishment of local trade associations, with coordinated agricultural and environmental practices (including both indigenous and imported techniques) may increase prosperity and agricultural production, despite orthodox expectations that such regions may experience downward cycles of poverty and environmental degradation.

The formation of localized zones of environmental governance that can resist wider forces of economic and political control is, of course, one of

the key objectives of all cultural and political ecology that focuses on social justice and environment in the developing world. The attention to how far local governance can also influence the scientific assumptions underlying environmental management, and the means to achieve such governance, are crucial elements in ensuring that environmental science is included in such decentralized political control.

Marginalized social groups and environmental science

The formation of alternative scientific networks for environmental explanation may also be conducted in locations that are not necessarily associated with developing countries. Many social groups around the world may be considered marginalized or under-represented in hegemonic science. As discussed in Chapter 4, it is common to assume that women, ethnic minorities, and people in lower economic classes may be less represented in common scientific discourse. Indeed, feminist analysts of science have observed that some women have considered "science" to exist outside of their day-to-day experiences, and consequently see science to be both irrelevant and unapproachable (Harding, 1986; Schiebinger, 1993; Lederman and Bartsch, 2001).

Empowering alternative scientific networks for marginalized groups, however, raises important dilemmas. First, it is important to identify under-represented groups in a critical and comprehensive manner. Simply assuming that, for instance, "women" or "ethnic minorities" or "children" are necessarily under-represented may overlook how such groups have succeeded in gaining recognition, and may also essentialize marginalization with these categories. Second, it is important to appreciate that the objective is not to get groups such as women into science (as it currently exists), but to reframe science itself in order to better reflect the needs and concerns of unrepresented people. These two problems exist simultaneously:

> The gendered character of scientific knowledge means that women's location always begins from outside science ... It is difficult indeed for any woman to become "inside" the practices and authority of orthodox science. It is even more difficult if she is not white or middle class.
>
> (Barr and Birke, 1998: 78)

A third problem is whether seeking to empower alternative networks may imply having to adopt the language of dominant networks in order to gain credibility. If they do adopt similar language, how far does this make them lose their alternative status? Indeed, the need for environmentalists to use orthodox science in order to gain credibility, when some have argued against the principles of science and technology, has been well recorded by critics of environmentalism (Yearley, 1992). Similarly, as discussed in Chapter 6, the problem of attempting to reform environmental policy

through local social movements – or the "Liberation Ecologies" approach of Peet and Watts (1996) – may also experience the problem of needing to use existing environmental discourses rather than introduce new themes.

The empowerment of alternative scientific networks may therefore undertake both the reframing of scientific inquiry to reflect the concerns of marginalized groups (under the constructivist model of risk), and the development of new, and more inclusive forms of measuring and discussing risk (under the discursive model). Empowering networks themselves may include activism on behalf of marginalized groups, and the establishment of new arenas for scientific debate and dissemination of scientific knowledge.

Chapter 6 already reported one apparently successful example of reframing AIDS research in the USA through an alliance of scientists and people with AIDS (Epstein, 1996). Epstein's work indicated that the alliance of patients and scientists with links to medical research establishments succeeded in creating a change of emphasis toward the treatment of symptoms of AIDS, and a more sensitive approach to patients in general. This activism was helped in part by campaign objectives that sought to modify, rather than overthrow existing science networks, by seeking other ways to address the risk posed by AIDS rather than seeking ways to avoid transmission of the virus alone.

Yet such reframing of scientific research groups may also be done by formal intervention in processes of research funding and dissemination. In the USA in 1992, for example, the Carnegie Commission deliberately changed its support for research in order to link science and technology to societal goals, and particularly to less wealthy people (Carnegie Commission, 1992). The concept of "science shops" has also been used to promote scientific needs and findings within urban neighborhoods. Science shops act as brokers between community groups and university researchers on themes of concern defined by the lay groups rather than researchers (for instance, concerning the origin of local pollution). In the Netherlands, for example, individuals can approach science shops for information, and if this is not available, they are then put in contact with interested researchers (Barr and Birke, 1998: 16, 138).

Another well-known example is the Kerala Sastra Sahitya Parishad (KSSP) organization of India. The KSSP was established in 1962 as the result of a number of scientists and social activists who feared that scientific information was inaccessible to most people. After some years of translating scientific books from English into the local language of Malayalam, in 1972, the organization adopted the motto "Science for Social Revolution," and sought to make local development more oriented to local concerns. The organization in particular opposed the construction of the "Silent Valley" dam in 1984, and then used local volunteers to assist the central government campaign to increase local literacy in the area. The KSSP was awarded the "Alternative Nobel Prize" in 1996 (see Fischer, 2000: 162).

Yet, in some cases, environmental problems may also be experienced in ways that are not commonly discussed, or where there are no overt causal links between environmental causes and the problems experienced. One particularly emotive example is the case of lost pregnancies, which, as Linda Layne (1990: 69) suggests is associated with a "veil of silence," indeed, so silent that it is one common bereavement for which there are no Hallmark cards available. Disturbingly, it is estimated that some 31–43 percent of all pregnancies in the USA end in miscarriage (Layne, 2001: 25). Yet the links of lost pregnancies and environmental factors – such as chemical toxins – is poorly researched.

Layne (2001) studied three cities in locations close to high concentrations of chemical toxins in the USA (Woburn, Massachusetts; Love Canal, New York; and Alsea, Oregon). Layne found that few women who had lost pregnancies were also willing to link these to exposure to toxins. Indeed, many women sought to blame themselves for miscarriages. For example, one woman from Alsea believed she caused her own lost pregnancy by her "own stupidity" in taking a strenuous hike, rather than her documented exposure to dioxin-containing herbicides (ibid.: 42). In cases like these, the public taboo concerning the loss of pregnancy, and stereotypical social expectations that women need to succeed as mothers, have meant that women often seek explanations for miscarriages that focus on their own presumed role rather than on external factors. As Layne noted: "In our culture, we deal with events like unsuccessful pregnancies, which challenge our cherished narratives of linear progress and the cultural mandate to be always happy, primarily by pretending they don't happen" (2001: 25)

Layne's study has important implications for empowering alternative networks of scientific explanation. The tendency for women to blame themselves rather than toxins (or other external causes) for lost pregnancies suggests the existence of a "storyline" (see Chapter 4) about the role of individuals in causing miscarriages. Yet clearly, such an explanation is likely to be highly simplistic and unnecessarily blameworthy of women concerned. Challenging this trend requires creating a new public arena in which potential alternative causes for miscarriages may be discussed. Layne sought to achieve this by calling for "an agenda for a feminist discourse of pregnancy loss" (1997). Creating a new arena for discussing the problem may therefore increase the search for potential causes for miscarriages, and enhance support for men and especially women who have been affected by them.

Much political ecology, of course, has focused on addressing the environmental concerns of marginalized social groups or environmental problems that have been overlooked by official policies. Assessing the institutional forms or social solidarities that allow greater analysis and questioning of assumed scientific causes of risk might enhance this process. Indeed, seeking further political attention for the environmental risks experienced by less powerful groups is a key requirement of democratizing environmental concern in the years to come.

Participatory environmental assessments

Finally, it is worth considering the techniques by which environmental research itself may highlight alternative conceptualizations of environmental problems. This chapter has already discussed how the languages and techniques of risk assessment may themselves be a barrier to public participation (under the discursive model of risk). Diversifying the languages and arenas through which environmental risks are discussed or defined may further increase the democratization of environmental science and networks.

Participatory environmental assessment may be defined as forms of research that allow maximum opportunity for people under research to define and express their thoughts about environmental problems in terms of their own choosing. The aim of such research is to reduce as many influences from outside agendas, networks, or assumptions as possible (often such assumptions are held by researchers themselves). Ideally, such research avoids the problems of "speaking on behalf of others" or essentializing "local" knowledge discussed in Chapter 7. Participatory assessments also allow ways to reform formal environmental assessments fundamentally by allowing participants to frame the purpose of environmental research themselves, rather than by simply allowing participants to discuss the research findings alone (see above, pp. 249–251).

There are many forms of participatory environmental assessment, and a full discussion of all techniques is beyond the scope of this book (see Anderson and Jaeger, 1999; Fischer, 1999; Holmes and Scoones, 2000). Box 9.2 lists some possible methods for encouraging participation in policy discussions. These techniques may be divided into different categories. Legislative theatre and community video, for example, offer ways for local people to express different elements of support or concern for different policy options or perceived problems. Focus groups, citizen juries, and deliberative polling, for example, offer means for citizens themselves to engage in discussions about the nature of problems, and to express concerns both individually and collectively. Other techniques such as multi-criteria mapping or participatory scenario building aim to highlight the diversity of different evaluations and policy options available. In all cases, such participatory assessment techniques seek to demonstrate the complexity of local concerns about environmental problems or propositions. By so doing, they also move away from the uniformity of orthodox science and "laws" of nature that suggest a priori conceptualizations of causes and effects of environmental changes, or the black-box statements of cost–benefit analysis (CBA) and contingency valuation conducted by environmental economists (see Lohmann, 1998).

Political ecologists need not necessarily engage closely in the undertaking of participatory environmental assessments. But if political ecologists are to engage critically with contested notions of environmental problems and the potentially damaging political impacts of orthodox explanations and associated policies, then they have to be aware of how assessment

Box 9.2 Some possible methods for encouraging participation in policy processes

- Participatory appraisal and priority assessment.
- Multicriteria mapping.
- Citizen juries.
- Standing panels.
- Focus groups.
- Community issue groups.
- Community video.
- Legislative theatre.
- Participatory scenario building.
- Future search workshops.
- Citizen foresight panels.
- Visioning exercises.
- Deliberative polling.
- Consensus conferences.
- Stakeholder decision analysis.

Source: Holmes and Scoones, 2000: see also Anderson and Jaeger, 1999; Durant, 1999; Dürrenberger *et al.*, 1999; Fischer, 1999; Hörning, 1999.

methods may overlook the diversity and complexity of local environmental perceptions. Participatory methods allow some means to indicate such diversity. Ideally, such assessments have to be matched by the existence of political arenas that acknowledge their findings, and display transparency when discussing the different evaluations. Yet, as discussed above (pp.239–240), such optimistic notions of a public sphere may never exist, and it may be more realistic to expect to see different evaluations being counted or discounted in a variety of formal and informal arenas, including law courts, newspapers, street marches, or websites. Yet the degree of participation included in different environmental assessments may be grounds by which different knowledge claims may be themselves assessed.

This section has summarized some methods by which alternative scientific networks may be empowered in order to reduce the influence of hegemonic environmental assessments and assumptions. Yet before this chapter ends, it is necessary to discuss some important implications of democratizing environmental science and networks for debates concerning the political transparency and participation in environmental science.

Implications for integrating environmental governance and learning

This chapter has sought to identify ways to democratize environmental science and its networks by reforming existing science networks or empowering the emergence of alternative networks seeking to represent the perspectives of under-represented people.

However, it is important to acknowledge that democratizing environmental science does not imply the replacement of one set of explanations with another in a final way. Instead, as discussed throughout this book, different environmental explanations are contingent upon a number of framings, objectives, and their associated boundaries. Revising orthodox and unquestioned environmental science toward more locally accurate and relevant explanations consequently reflects an evolving debate about what science should achieve, and for whom. Such different approaches to science may therefore reflect different ideologies of social justice and democracy that may themselves constitute networks, and accordingly be acknowledged and discussed as such.

The awareness and criticism of one's own institutional assumptions – or "institutional reflexivity" – is therefore a key requirement in ensuring that challenges to hegemonic environmental science may also be called democratization. According to Cultural Theory (see Chapter 4), each institution may be located within one of the myths of nature, and as such, institutional reflexivity implies recognizing the limitations of world visions associated with just one myth (e.g. Thompson, 1993). More poststructuralist approaches such as narratives or storylines (see Chapter 4), are less rigidly linked to the different myths, and instead see reflexivity as a critical analysis of how such understandings or ideologies have emerged over time, and how different future framings and public participation may result in different epistemologies.

One concept that may allow greater integration of ideologies and resulting science is the so-called "virtuous circle of facts and norms" (Kearns, 1998). Adopting many insights of Critical Theory (and especially Habermas), the "virtuous circle" refers to the ability to integrate learning about environmental reality with the constant reshaping of ideologies and perspectives through which such inquiry is framed. Kearns argued that the influence of such reshaping of environmental history has been demonstrated in the case of research on the history of the western USA. Environmentalist writers such as William Cronon (1991) and Donald Worster (1977, 1979) can be compared with Richard White (1980) and Patricia Limerick (1991), who gave more attention to questions of social justice, and who also sought to understand environmental change from the perspectives of ethnic groups and classes not referred to in more ecologically minded histories. Kearns wrote:

> An understanding of the "other's" point of view entails recognizing both the specific differences that frame worldviews and the particular context in which those framings take place ... Only the *voice* of the other can adequately alert us to plurality and difference ... If historical and geographical writings can build on this work ... and continue to attend to the sets of agenda of those groups in subjugated positions, then the circle between facts and values will indeed have turned virtuous.
>
> (1998: 404; emphasis in original)

Such integrated environmental explanation and social learning has been reflected in various other discussions of democratizing environmental science in this book (e.g. Collier, 1989; Bhaskar, 1991; Kukla, 1993, in Chapter 8). It is also similar to the concept of discursive democracy (Dryzek, 1990), or Robert Chambers' (1997) question, "Whose reality counts?" Such views point to the need to seek democratic challenges to institutionalized ideological or scientific statements – but also to the need to constantly reassess the values and knowledge guiding them. This book has argued that environmental science and politics are coproduced. Democratizing environmental science also means making the democratizing process dynamic, transparent, and inclusive, but also self-critical.

Summary

This chapter has brought the book's substantive discussions to a close (prior to the Conclusion) by examining political means to increase transparency and public participation in the formulation of environmental science. The chapter builds upon the discussion of democratizing environmental scientific techniques in Chapter 8. Together, these chapters also suggest practical ways to carry out research and debate under a "critical" political ecology.

The chapter argued that scientific uncertainty cannot be understood without acknowledging the extent of public participation or observation of scientific inquiry. Yet increasing public participation may also mean challenging the status of established scientific organizations as sole providers of expertise. Similarly, reinforcing orthodox scientific networks may also mean reiterating linear models of risk, which emphasize projected biophysical changes as causes of risk, rather than contextual factors underlying the interpretation or vulnerability to such changes. Furthermore, the language or techniques through which environmental risk and science are discussed also form effective barriers to public participation.

The chapter discussed two main ways of revising orthodox or hegemonic scientific networks in favor of more decentralized, or less powerful viewpoints. The first way is to reform existing scientific institutions. The chapter discussed direct attacks on orthodox science (such as during the "science wars"); and different approaches to reforming scientific organizations such as the World Bank, and formal environmental assessments. These approaches have had limited success, but have sometimes led to the evolution of new approaches of making scientific expertise appear legitimate rather than including public participation in the early framings of environmental science.

Second, the chapter outlined various ways in which different scientific networks could be empowered as alternatives to orthodox scientific institutions. This section looked at environmental adaptations in developing countries, and particularly institutional approaches such as environmental entitlements or sustainable livelihoods as means to increase local governance over environmental management. This section also considered the emergence of environmental science relevant for marginalized people and subjects, such as the causes of lost pregnancies, and a variety of participatory environmental assessment techniques that can enhance local framings of environmental science.

But despite these optimistic proposals for reframing and governing science, the chapter noted two remaining problems. All scientific explanation relies in part on the establishment of communities or networks of explanation that require boundaries in order to be meaningful and credible. Democratizing environmental science and networks depends ultimately on a guiding ideology about the nature of social justice. Such ideologies need to be acknowledged and questioned for their potential impacts on learning about environmental change.

Finally, as discussed throughout this book, concepts of "science" are commonly used to support and legitimize different political strategies. It should not be surprising that certain networks or organizations do not wish to listen to criticism, or change strategies because of greater public participation. Learning to identify successful, rather than superficial, forms of scientific participation and governance may therefore become an important new theme of environmental democratization in the future.

Bibliography

Adams, W.M. (1997) "Rationalization and conservation: ecology and the management of nature in the United Kingdom," *Transactions of the Institute of British Geographers* NS 22: 277–291.

Adams, W.M. (2001) *Green Development: Environment and Sustainability in the Third World*, 2nd edn, London: Routledge.

Adger, W. (2000) "Social and ecological resilience: are they related?" *Progress in Human Geography* 24: 3, 347–364.

Adger, W., Benjaminsen, T., Brown, K., and Svarstad, H. (2001) "Advancing a political ecology of global environmental discourses," *Development and Change* 32: 4, 687–715.

Agarwal, A. and Narain, S. (1991) *Global Warming in an Unequal World*, New Delhi: Center for Science and Environment.

Agger, B. (1992) *The Discourse of Domination: from the Frankfurt School to Postmodernism*, Evanston, IL: Northwestern University Press.

Agrawal, A. (1995) "Dismantling the divide between indigenous and scientific knowledge," *Development and Change* 26: 3, 413–439.

Agrawal, A. and Gibson, C. (1999) "Enchantment and disenchantment: the role of community in natural resource conservation," *World Development* 27: 4, 629–649.

Ahluwalia, M. (1997) "Representing communities: the case of a community-based watershed management project in Rajasthan, India," *IDS Bulletin* 28: 4, 23–26.

Alford, C. (1985) *Science and the Revenge of Nature*, Gainesville, FL: University Presses of Florida.

Alford, D. (1992) "Streamflow and sediment transport from mountain watersheds of the Chao Phraya basin, northern Thailand: a reconnaissance study," *Mountain Research and Development* 12: 3, 257–268.

Allen, B. (1993) *Truth in Philosophy*, Cambridge, MA: Harvard University Press.

Andersen, I. and Jaeger, B. (1999) "Scenario and workshops and consensus conferences: towards more democratic decision-making," *Science and Public Policy* 26: 5, 331–340.

Anderson, D. (1984) "Depression, Dust Bowl, demography and drought: the colonial state and soil conservation in East Africa during the 1930s," *African Affairs* 83: 332.

Anderson, J. (1968) "Cultural adaptation to threatened disaster," *Human Organization* 27: 298–307.

Anderson, L. (1994) *The Political Ecology of the Modern Peasant: Calculation and Community*, Baltimore, MD: Johns Hopkins University Press.

Angelsen, A. (1995) "Shifting cultivation and deforestation: a study from Indonesia," *World Development* 23: 1713–1729.

Angelsen, A. and Kaimowitz, D. (1999) *Rethinking the Causes of Deforestation: Lessons from Economic Models*, Washington, DC: World Bank.

Archer, M., Bhaskar, R., Collier, A., Lawson, T., and Norrie, A. (eds) (1998) *Critical Realism: Essential Readings*, London: Routledge.

Arnold, D. (1996) *The Problem of Nature*, Oxford: Blackwell.

Aronowitz, S. (1988) *Science as Power: Discourse and Ideology in Modern Society*, Basingstoke: Macmillan Press.

Aronson, J., Harré, R., and Cornell Way, E. (1994) *Realism Rescued: How Scientific Progress is Possible*, London: Duckworth.

Atkinson, A. (1991) *Principles of Political Ecology*, London: Belhaven.

Baarschers, W. (1996) *Eco-facts and Eco-fiction: Understanding the Environmental Debate*, London: Routledge.

Baden, J. (ed.) (1994) *Environmental Gore: a Constructive Response to "Earth in the Balance,"* San Francisco, CA: Pacific Research Institute for Public Policy.

Bandyopadhyay, J. (1999) "Chipko movement: of floated myths and flouted realities," *Economic and Political Weekly* 34: 15, Apr, 10–16.

Bankoff, G. (1999) "A history of poverty: the politics of natural disasters in the Philippines, 1985–95," *Pacific Review* 12: 3, 381–420.

Bankoff, G. (2001) "Rendering the world unsafe: 'vulnerability' as western discourse," *Disasters* 25: 1, 19–35.

Banuri, T. (1990) "Development and the politics of knowledge: a critical interpretation of the social role of modernization theories in the development of the Third World," in Marglin, F. and Marglin, S. (eds) *Dominating Knowledge: Development Culture and Resistance*, Oxford: Clarendon.

Barnes, B., Bloor, D., and Henry, J. (eds) (1996) *Scientific Knowledge: a Sociological Analysis*, London: Athlone Press.

Barr, J. and Birke, L. (1998) *Common Science: Women, Science and Knowledge*, Bloomington and Indianapolis, IN: Indiana University Press.

Barraclough, S. and Ghimire, K. (1996) "Deforestation in Tanzania: beyond simplistic generalizations," *The Ecologist* 26: 3, 104–107.

Bass, T. (1990) *Camping with the Prince, and Other Tales of Science in Africa*, Cambridge: Latterworth Press.

Bassett, T. and Zuéli, K. (2000) "Environmental discourses and the Ivorian Savanna," *Annals of the Association of American Geographers* 90: 1, 67–95.

Batterbury, S. (1996) "Planners or performers? Reflections on indigenous dryland farming in northern Burkina Faso," *Agricultural and Human Values* 13: 3, 12–22.

Batterbury, S. (2001) "Landscapes of diversity: a local political ecology of livelihood diversification in south-western Niger," *Ecumene* 8: 4, 438–464.

Batterbury, S. and Bebbington, A. (eds) (1999) "Environmental histories, access to resources and landscape change: an introduction," Special edition of *Land Degradation and Development* 10: 4, 279–288.

Batterbury, S. and Forsyth, T. (1999) "Fighting back: human adaptations in marginal environments," *Environment* 41: 6, 6–11, 25–29.

Batterbury, S., Forsyth, T., and Thomson, K. (1997) "Environmental transformations in developing countries: hybrid research and democratic policy," *Geographical Journal* 163: 2, 126–132.

Batterbury, S. and Warren, A. (eds) (2001) "The African Sahel 25 years after the

great drought: assessing progress and moving towards new agendas and approaches," Special edition of *Global Environmental Change* 11: 1, 1–8.
Bebbington, A. (1997) "Social capital and rural intensification: local organizations and islands of sustainability in the rural Andes," *Geographical Journal* 163: 2.
Bebbington, A. (1999) "Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty," *World Development* 27: 12, 2021–2044.
Bebbington, A. and Batterbury, S. (2001) "Transnational livelihoods and landscapes: political ecologies of globalization," *Ecumene* 8: 4, 369–380.
Beck, U. (1992) *Risk Society: Towards a New Modernity*, Cambridge: Polity.
Beck, U. (1995) *Ecological Politics in an Age of Risk*, Cambridge: Polity.
Benedick, R. (1991) *Ozone Diplomacy: New Directions in Safeguarding the Planet*, Cambridge, MA: Harvard University Press.
Benhabib, S. (ed.) (1996) *Democracy and Difference: Contesting the Boundaries of the Political*, Princeton, NJ: Princeton University Press.
Benjaminsen, T. (2001) "The population–environment nexus in the Malian cotton zone," *Global Environmental Change* 11: 4, 283–295.
Benton, T. (1996) "Marxism and natural limits: an ecological critique and reconstruction," in Benton, T. (ed.) *The Greening of Marxism*, New York: Guilford Press, pp. 157–186.
Berger, P. (1987) *The Capitalist Revolution*, Aldershot: Wildwood House.
Berkes, F., Folke, C., and Colding, J. (eds) (1998) *Linking Social and Ecological Systems: Management Practices and Social Mechanisms for Building Resilience*, Cambridge: Cambridge University Press.
Bernstein, H. and Woodhouse, P. (2001) "Telling environmental change like it is? Reflections on a study in Sub-Saharan Africa," *Journal of Agrarian Change* 1: 2, 283–324.
Berry, S. (1989) "Social institutions and access to resources," *Africa* 59: 1, 41–55.
Bhaskar, R. (1975) *A Realist Theory of Science*, Leeds: Leeds Books.
Bhaskar, R. (1986) *Scientific Realism and Human Emancipation*, London: Macmillan.
Bhaskar, R. (1991) *Philosophy and the Idea of Freedom*, Oxford: Blackwell.
Biot, Y. (1995) *Rethinking Research on Land Degradation in Developing Countries*, Washington, DC: World Bank.
Blaikie, P. (1985) *The Political Economy of Soil Erosion in Developing Countries*, London: Longman Development Series.
Blaikie, P. (1995) "Understanding environmental issues," in Morse, S. and Stocking, M. (eds) *People and Environment*, London: University College London Press, pp. 1–30.
Blaikie, P. and Brookfield, H.C. (ed.) (1987) *Land Degradation and Society*, London: Methuen.
Blaikie, P., Cannon, T., Davis, I., and Wisner, B. (1994) *At Risk: Natural Hazards, People's Vulnerability and Disasters*, London: Routledge.
Blowers, A. (1997) "Environmental policy: ecological modernization or the risk society?" *Urban Studies* 34: 5/6.
Boehmer-Christiansen, S. (1994) "Global climate protection policy: the limits of scientific advice part II," *Global Environmental Change* 4: 3, 845–871.
Botkin, D. (1990) *Discordant Harmonies: A New Ecology for the Twenty-First Century*, New York: Oxford University Press.
Braun, B. and Castree, N. (eds) (1998) *Remaking Reality: Nature at the Millennium*, London: Routledge.

Brechin, S. (1997) *Planting Trees in the Developing World: A Sociology of International Organizations*, Baltimore, MD: Johns Hopkins University.
Brookfield, H., Potter, L., and Byron, Y. (1995) *In Place of the Forest: Environmental and Socio-Economic Transformation in Borneo and the Eastern Malay Peninsula*, Tokyo, Paris, New York: United Nations University Press.
Brown, L. (2001) *Eco-economy: Building an Economy for the Earth*, London and Washington, DC: Earthscan and Earth Policy Institute.
Brown, R. (1998) *Toward a Democratic Science: Scientific Narration and Civic Communication*, New Haven, CT: Yale University Press.
Brulle, R. (2000) *Agency, Democracy, and Nature: The US Environmental Movement from a Critical Theory Perspective*, Cambridge, MA: MIT Press.
Bryant, R. (1992) "Political ecology: an emerging research agenda in Third-World studies," *Political Geography* 11: 1, 12–36.
Bryant, R. (1997a) *The Political Ecology of Forestry in Burma 1824–1994*, London: Hurst.
Bryant, R. (1997b) "Beyond the impasse: the power of political ecology in Third World environmental research," *Area* 29: 1–15.
Bryant, R. (1998) "Power, knowledge and political ecology in the Third World: a review," *Progress in Physical Geography* 22: 1, 79–94.
Bryant, R. and Bailey, S. (1997) *Third-World Political Ecology*, London: Routledge.
Bunge, M. (1991) "What is science? Does it matter to distinguish from pseudoscience? A reply to my commentators," *New Ideas in Psychology* 9: 2, 245–283.
Bunker, S. (1985) *Underdeveloping the Amazon: Extraction, Unequal Exchange and the Failure of the Modern State*, Chicago, IL: University of Illinois Press.
Button, M. and Madson, K. (1999) "Deliberative democracy in practice: challenges and prospects for civic deliberation," *Polity* 31: 4, 609–637.
Calder, I. (1999) *The Blue Revolution: Land Use and Integrated Water Resources*, London: Earthscan.
Calder, I. and Aylward, B. (2002) *Forests and Floods: Perspectives on Watershed Management and Integrated Flood Management*, Rome: FAO, and Newcastle, University of Newcastle.
Calhoun, C. (ed.) (1992) *Habermas and the Public Sphere*, Cambridge, MA: MIT Press.
Callon, M. (1986) "Some elements of a sociology of translation: domestication of the scallops and the fishermen of Saint Brieuc Bay," in Law, J. (ed.) *Power, Action and Belief: A New Sociology of Knowledge? Sociological Review Monograph*, Volume 32, London: Routledge and Kegan Paul, pp. 196–233.
Callon, M. (1995) "Four models for the dynamics of science," in Jasanoff, S., Markle, G., Petersen, J., and Pinch, T. (eds) *Handbook of Science and Technology Studies*, Thousand Oaks, CA: Sage, pp. 29–63.
Carnegie Commissions on Science, Technology, and Government (1992) *Enabling the Future: Linking Science and Technology to Societal Goals*, New York: Carnegie Commission.
Carney, D. (1998) *Sustainable Rural Livelihoods: What Contribution Can We Make?* London: Department for International Development.
Carson, R. (1962) *Silent Spring*, Boston, MA: Houghton Mifflin.
Cartwright, N. (1983) *How the Laws of Physics Lie*, Oxford: Clarendon.
Cartwright, N. (1999) *The Dappled World: a Study of the Boundaries of Science*, Cambridge: Cambridge University Press.

Cash, D. and Clark, W. (2001) "From science to policy: assessing the assessment process," *John F. Kennedy School of Government, Harvard University, Faculty Research Working Paper Services, RWP01–045*, Cambridge, MA: Kennedy School of Government.

Casman, E. and Dowlatabadi, H. (eds) (2002) *Contextual Determinants of Malaria*, Washington, DC: RFF Press.

Castree, N. (1995) "The nature of produced nature: materiality and knowledge construction in Marxism," *Antipode* 27: 1, 12–48.

Castree, N. (ed.) (2001) *Social Nature*, Oxford: Blackwell.

Castree, N. and Braun, B. (1998) "The construction of nature and the nature of construction: analytical and political tools for building survivable futures," in Braun, B. and Castree, N. (eds) *Remaking Reality: Nature at the Millennium*, London: Routledge, pp. 3–42.

Chambers, R. (1997) *Whose Reality Counts? Putting the First Last*, London: IT Books.

Chambers, R. and Conway, G. (1992) *Sustainable Rural Livelihoods: Practical Concepts for the 21st Century*, IDS Discussion Paper 296: Brighton, UK: IDS.

Chapman, G. and Thompson, M. (eds) (1995) *Water and the Quest for Sustainable Development in the Ganges Valley*, London: Cassell.

Chomitz, K. and Kumari, K. (1996) "The domestic benefits of tropical forests: a critical review emphasizing hydrological functions," *World Bank Policy Research Working Paper 160,* World Bank, Policy Research Department, Washington, DC.

Clark, W. (1985) "Scales of climate impacts," *Climatic Change* 7: 5–27.

Cleaver, F. (2001) "Institutional bricolage, conflict and cooperation in Usangu, Tanzania," *IDS Bulletin* 32: 4, 26–35.

Cline-Cole, R. and Madge, C. (eds) (2000) *Contesting Forestry in West Africa*, Aldershot: Ashgate.

Cobb, R. and Elder, C. (1972) *Participation in American Politics: the Dynamics of Agenda Building*, Baltimore, MA: Johns Hopkins University Press.

Cockburn, A. and Ridgeway, J. (eds) (1979) *Political Ecology: an Activist's Reader on Energy, Land, Food, Technology, Health, and the Economics and Politics of Social Change*, New York: Times Books.

Cohen, E. (1989) "'Primitive and remote': hill tribe trekking in Thailand," *Annals of Tourism Research* 16: 1, 30–61.

Collier, A. (1989) *Scientific Realism and Socialist Thought*, Hemel Hempstead: Harvester Wheatsheaf.

Collier, A. (1994) *Critical Realism: The Work of Roy Bhaskar*, London: Verso.

Collingridge, D. and Reeve, C. (1986) *Science Speaks to Power: the Role of Experts in Policy Making*, London: Pinter.

Conklin, H. (1954) "An ethnoecological approach to shifting agriculture," *Transactions of the New York Academy of Sciences* 77: 133–142.

Conley, A. (1996) *Ecopolitics: the Environment in Poststructuralist Thought*, London: Routledge.

Corbridge, S. (1986) *Capitalist World Development: a Critique of Radical Development Geography*, Basingstoke: Macmillan.

Correll, E. (1999) *The Negotiable Desert: Expert Knowledge in the Negotiations of the Convention to Combat Desertification,* Linköping Studies in Arts and Science, no. 191, Department of Water and Environmental Studies, Sweden: Linköping University.

Costanza, R., Kemp, M., and Boynton, W. (1995) "Scale and biodiversity in estuarine ecosystems," in Perrings, C., Mäler, K., Holling, C., and Jansson, B. (eds) *Biodiversity Loss: Economic and Sociological Issues*, Cambridge: Cambridge University Press, pp. 84–125.

Covey, J. (1995) "Accountability and effectiveness in NGO policy alliances," in Edwards, M. and Hulme, D. (eds) *Non-Governmental Organisations – Performance and Accountability: Beyond the Magic Bullet*, London: Earthscan, pp. 167–182.

Crapper, P. (1962) *Land Requirements for the Papua New Guinea Population*, Internal Report, CSIRO Land Research Series no. 1, Melbourne.

Cronin, E. (1979) *The Arun: A Natural History of the World's Deepest Valley*, Boston, MA: Houghton Mifflin.

Cronon, W. (1991) *Nature's Metropolis: Chicago and the Great West*, New York: Norton.

Cronon, W. (1992) "A place for stories: nature, history and narrative," *Journal of American History* 78: 1347–1376.

Cronon, W. (1996) "The trouble with wilderness: a response," *Environmental History* 1: 1, 47–55.

Cullet, P. and Kameri-Mbote, P. (1998) "Joint implementation and forestry projects: conceptual and operational fallacies," *International Affairs* 74: 2, 393–408.

Custodio, E. (2000) *The Complex Concept of Overexploited Aquifer*, Papeles del Proyecto Aguas Subterráneas, Serie A: Uso intensiob del las agues subterráneas, aspectos ecológicos, tecnolólogicos y éticos, Madrid: Fundación Marcelino Botín.

Cutajar, M.Z. (2001) "Notes for closing session," *Global Change Open Science Conference* (IGBP–IHDP–WCRP), Amsterdam, 10–13 July 2001, Bonn: International Human Dimensions Program on Global Environmental Change.

Cutter, S. (1995) "The forgotten casualties: women, children and environmental change," *Global Environmental Change* 5: 3, 181–194.

Dahlberg, A. and Blaikie, P. (1999) "Changes in landscape or in interpretation? Reflections based on the environmental and socio-economic history of a village in northeast Botswana," *Environment and History* 5: 2, 127–174.

Daly, J. (1991) "Does a constructivist view require epistemological relativism? A response to Turnbull," *Social Studies of Science* 21: 3, 568–571.

Davies, B. and Harré, R. (1990) "Positioning: the discursive production of selves," *Journal for the Theory of Social Behavior* 20: 1, 43–63.

de Jong (1999) "Institutionalized criticism: the demonopolization of scientific advising," *Science and Public Policy* 26: 3, 193–199.

DeHart, J. and Soulé, P. (2000) "Does I = PAT work in local places?" *Professional Geographer* 52: 1, 1–10.

Demeritt, D. (1994) "The nature of metaphors in cultural geography and environmental history," *Progress in Human Geography* 18: 2, 163–185.

Demeritt, D. (1998) "Science, social constructivism and nature," in Braun, B. and Castree, N. (eds) *Remaking Reality: Nature at the Millennium*, London: Routledge, pp. 173–193.

Demeritt, D. (2001) "The construction of global warming and the politics of science," *Annals of the Association of American Geographers* 91: 2, 307–337.

Denevan, W. (1989) "The fragile lands of Latin America," in Browder, J. (ed.) *The Fragile Lands of Latin America: Strategies for Sustainable Development,* Boulder, CO: Westview Press, pp. 3–25.

DFID (Department for International Development, Great Britain) (2002) *Poverty and Environment*, information booklet, March, London: DFID.

Dickens, P. (1996) *Reconstructing Nature: Alienation, Emancipation and the Division of Labour*, London: Routledge.

Dierkes, M. and van Grote, C. (2000) (eds) *Between Understanding and Trust: the Public, Science and Technology*, Amsterdam: Harwood.

Dietz, T. and Rosa, E. (1994) "Rethinking the environmental impacts of population, affluence and technology," *Human Ecology Review* 1: 2, 277–300.

Donovan, D. (1981) "Fuelwood: how much do we need?' *Newsletter* (DGD 14), Hanover, NH: Institute of Current World Affairs.

Dougill, A., Thomas, D., and Heathwaite, A. (1999) "Environmental change in the Kalahari: integrated land degradation studies for nonequilibrium dryland environments," *Annals of the Association of American Geographers* 89: 3, 420–442.

Douglas, M. (1978) *Purity and Danger*, London and New York: Routledge.

Douglas, M. (1985) *Risk Acceptability According to the Social Sciences*, London: Routledge and Kegan Paul.

Douglas, M. (1987) *How Institutions Think*, London and New York: Routledge and Kegan Paul.

Douglas, M. (1993) "The depoliticization of risk," in Ellis, R. and Thompson, M. (eds) *Culture Matters: Essays in Honor of Aaron Wildavsky*, Boulder, CO: Westview Press, pp. 121–132.

Dove, M. (1992) "Foresters' belief about farmers: a priority for social science research in social forestry," *Agroforestry Systems* 17: 13–41.

Dowlatabadi, H. (1997) "Assessing the health impacts of climate change: an editorial essay," *Climatic Change* 35: 2, 137–144.

Dregne, H. (1985) "Aridity and land degradation," *Environment* 27: 8, 16–20, 28–33.

Drèze, J. and Sen, A. (1990) *The Political Economy of Hunger: Vol. 1, Entitlement and Well-Being*, Oxford: Clarendon.

Driver, T. (1999) "Anti-erosion policies in the mountain areas of Lesotho: The South African connection," *Environment and History* 5: 1, 1–25.

Dryzek, J. (1990) *Discursive Democracy: Politics, Policy and Political Science*, Cambridge: Cambridge University Press.

Dryzek, J. (1997) *The Politics of the Earth*, Oxford: Oxford University Press.

Dryzek, J. (1998 [1995]) "Political and ecological communication," in Dryzek, J. and Schlosberg, D. (eds) *Debating the Earth: The Environmental Politics Reader*, Oxford: Oxford University Press, pp. 584–598.

Dubos, R. (1964) "Environmental biology," *Bioscience* 14: 1, 11–14.

Dummett, M. (1978) *Truth and Other Enigmas*, London: Duckworth.

Dunne, T. and Black, R. (1970) "Partial area contributions to storm runoff in a small New England watershed," *Water Resources Research* 6: 5, 1296–1311.

Dunne, T. and Leopold, L. (1978) *Water in Environmental Planning*, San Francisco, CA: W.H. Freeman and Company.

Durant, J. (1999) "Participatory technology assessment and the democratic model of the public understanding of science," *Science and Public Policy* 25: 5, 313–319.

Dürrenberger, G., Kastenholz, H., and Behringer, J. (1999) "Integrated assessment focus groups: bridging the gap between science and policy?' *Science and Public Policy* 25: 5, 341–349.

Dye, C. and Reiter, P. (2000) "Temperatures without fevers?' *Science* 289: 1697–1698.

Eckersley, R. (1992) *Environmentalism and Political Theory: Towards an Ecocentric Approach*, London: University College London Press.

Eckholm, E. (1976) *Losing Ground: Environmental Stress and Food Problems*, New York: W.W. Norton.

Eckley, N. (2001) "Designing effective assessments: the role of participation, science and governance, and focus," *European Environment Agency Environmental Issue Report no. 26*, Copenhagen: Office for Official Publications for the European Communities.

Economist, The (1996) "Science and technology: the science of sexual discrimination," June, 22: 97–99.

Eder, K. (1996) "The institutionalization of environmentalism: ecological discourse and the second transformation of the public sphere," in Lash, S., Szersynski, B., and Wynne, B. (eds) *Risk, Environment and Modernity*, London: Sage, pp. 203–223.

Edwards, A. (1999) "Scientific expertise and policy-making: the intermediary role of the pubic sphere," *Science and Public Policy* 26: 3, 163–170.

Edwards, P. and Schneider, S. (2001) "Self governance and peer review in science for policy: the case of the IPCC Second Assessment Report," in Miller, C. and Edwards, P. (eds) *Changing the Atmosphere: Expert Knowledge and Environmental Governance*, Cambridge, MA: MIT Press, pp. 219–246.

Ehrlich, P. and Ehrlich, A. (1991) *Healing the Planet: Strategies for Resolving the Environmental Crisis*, Cambridge, MA: Perseus.

Ehrlich, P. and Ehrlich, A. (1996) *Betrayal of Science and Reason: How Anti-Environmental Rhetoric Threatens our Future*, Washington, DC and Covelo, CA: Island Books.

Ehrlich, P. and Holdren, J. (1974) "The impact of population growth," *Science* 171: 1212–1217.

Enzensberger, H. (1974) "A critique of political ecology," *New Left Review* 84: 3–31.

Epstein, S. (1996) *Impure Science: AIDS Activism and the Politics of Knowledge*, Los Angeles, CA: UCLA Press.

Escobar, A. (1996) "Constructing nature: elements for a poststructural political ecology," in Peet, R. and Watts, M. (eds) *Liberation Ecologies: Environment, Development, Social Movements*, London: Routledge, pp. 46–68.

Escobar, A. (1998) "Whose knowledge, whose nature? Biodiversity, conservation, and the political ecology of social movements," *Journal of Political Ecology* 5: 53–82.

Escobar, A. (1999) "Steps to an antiessentialist political ecology," *Current Anthropology* 40: 1, 1–30.

Escobar, E. (1995) *Encountering Development: the Making and Unmaking of the Third World*, Princeton, NJ: Princeton University Press.

Eyerman, R. and Jamison, A. (1991) *Social Movements: A Cognitive Approach*, Cambridge: Polity.

Ezrahi, Y. (1990) *The Descent of Icarus: Science and the Transformation of Contemporary Democracy*, Cambridge, MA: Harvard University Press.

Fairhead, J. and Leach, M. (1996) *Misreading the African Landscape: Society and Ecology in a Forest–Savanna Mosaic*, Cambridge: Cambridge University Press.

Fairhead, J. and Leach, M. (1998) *Reframing Deforestation: Global Analysis and Local Realities: Studies in West Africa*, London: Routledge.

Farrell, A., VanDeveer, S., and Jäger, J. (2001) "Environmental assessments: four

under-appreciated elements of design," *Global Environmental Change* 11: 4, 311–333.

Ferguson, J. (1990) *The Anti-Politics Machine: "Development," Depoliticization and Bureaucratic Power in Lesotho*, Minneapolis, MN and London: University of Minnesota Press.

Fetzer, J. and Almeder, R. (1993) *Glossary of Epistemology/Philosophy of Science*, New York: Paragon House.

Fischer, F. (1999) "Technological deliberation in a democratic society: the case for participatory inquiry," *Science and Public Policy* 25: 5, 294–302.

Fischer, F. (2000) *Citizens, Experts and the Environment: the Politics of Local Knowledge*, Durham and London: Duke University Press.

Fogel, C. (2001) "From invisibility to...? Indigenous peoples, traditional ecological knowledge, and the Kyoto Protocol," Paper presented at the workshop, *Localizing and Globalizing: Knowledge Cultures of Environment and Development*, Kennedy School of Government, Harvard University, April 5–7.

Fogel, C. (2002). "Perspectives on 'carbon sinks': the construction of knowledge and policy to abate global climate change, 1980–2001." Ph.D. Dissertation, University of California at Santa Cruz.

Forsyth, T. (1994) "Shut up or shut down: how a Thai health agency was forced to close when it challenged a major foreign investor," *Asia, Inc.* 3: 4, April, 30–37.

Forsyth, T. (1996) "Science, myth and knowledge: testing Himalayan environmental degradation in Thailand," *Geoforum* 27: 3, 375–392.

Forsyth, T. (1998a) "Mountain myths revisited: integrating natural and social environmental science," *Mountain Research and Development* 18: 2, 126–139.

Forsyth, T. (1998b) "The politics of environmental health: suspected industrial poisoning in Thailand," in Hirsch, P. and Warren, C. (eds) *The Politics of Environment in Southeast Asia: Resources and Resistance*, Routledge, London, pp. 210–226.

Forsyth, T. (1999a) *International Investment and Climate Change: Energy Technologies for Developing Countries*, London: Earthscan and the Royal Institute of International Affairs.

Forsyth, T. (1999b) "Flexible mechanisms of climate technology transfer," *Journal of Environment and Development* 8: 3, 238–257.

Forsyth, T. (1999c) "Environmental activism and the construction of risk: implications for NGO alliances," *Journal of International Development* 11: 5, 687–700.

Forsyth, T. (2001a) "Environmental social movements in Thailand: how important is class?" *Asian Journal of Social Sciences* 29: 1, 35–51.

Forsyth, T. (2001b) "Political ecology and critical realism," in Stainer, A. and Lopez, G. (eds) *After Postmodernism: Critical Realism?* London: Athlone Press, pp. 146–154.

Forsyth, T. (2002) "What happened on *The Beach*? Social movements and governance of tourism in Thailand," *International Journal of Sustainable Development* 5: 3, 325–336.

Forsyth, T., Leach, M., and Scoones, I. (1998) *Poverty and Environment: Research and Policy Priorities*, UNDP and European Commission.

Foster, J. Bellamy (2000) *Marx's Ecology: Materialism and Nature*, New York: Monthly Review Press.

Foucault, M. (1980) "Two Lectures," in *Power/Knowledge. Selected Interviews and Other Writings 1972–1977* (ed. C. Gordon), London: Harvester, pp. 78–102.

Fox J., Dao Minh Truong, Rambo, A., Nghiem Phuong Tuyen, Le Trong Cuc, and Stephen Leisz (2000) "Shifting cultivation: a new old paradigm for managing tropical forests," *BioScience* 50: 6, 521–528.

Frankfurt, H. (1978) *On the Importance of What We Care About*, Cambridge: Cambridge University Press.

Fuller, S. (1993) *Philosophy, Rhetoric and the End of Knowledge: the Coming of Science and Technology Studies*, Madison, WI: University of Wisconsin Press.

Fuller, S. (2000) *The Governance of Science*, Buckingham and Philadelphia, PA: Open University Press.

Funtowicz, S. and Ravetz, J. (1985) "Three types of risk assessment: a methodological analysis," in Whipple, C. and Covello, V. (eds) *Risk Analysis in the Private Sector*, New York: Plenum.

Funtowicz, S. and Ravetz, J. (1992) "Three types of risk assessment and the emergence of post normal science," in Krimsky, S. and Golding, D. (eds) *Social Theories of Risk*, Westport, CT: Praeger.

Funtowicz, S. and Ravetz, J. (1993) "Science for the post-normal age," *Futures* 26: September, 739–756.

Gandy, M. (1997) "Ecology, modernity and the intellectual legacy of the Frankfurt School," in Light, A. and Smith, J. (eds) *Space, Place and Environmental Ethics: Philosophy and Geography I*, London: Rowman and Littlefield, pp. 231–254.

Geertz, C. (1963) *Agricultural Involution: the Processes of Ecological Change in Indonesia*, Berkeley, CA: The University of California Press.

Gelbspan, R. (1997) *The Heat is On: The High Stakes Battle over Earth's Threatened Climate*, New York: Addison-Wesley.

Giddens, A. (1973) *The Class Structure of the Advanced Societies*, London: Hutchinson University Library, New York: Harper and Row.

Giddens, A. (1990) *Consequences of Modernity*, London: Polity Press.

Giddens, A. (1994) *Beyond Left and Right: the Future of Radical Politics*, Cambridge: Polity.

Gieryn, T. (1999) *Cultural Boundaries of Science: Credibility on the Line*, Chicago, IL: University of Chicago Press.

Goldman, M. (2001) "The birth of a discipline: producing authoritative green knowledge, World Bank style," *Ethnography* 2: 2, 191–217.

Gore, A. (1992) *Earth in the Balance: Forging a New Common Purpose*, revised edn, London: Earthscan.

Gorz, A. (1983 [1975]) *Ecology as Politics*, London: Pluto Press.

Gorz, A. (1994 [1991]) *Capitalism, Socialism, Ecology*, London: Verso.

Goudie, A. (1990) *The Human Impact on the Natural Environment*, 3rd edn, Oxford: Blackwell.

Grainger, A. (1990) *The Threatening Desert: Controlling Desertification*, London: Earthscan.

Greenberg, J. and Park, T. (1994) "Political ecology," *Journal of Political Ecology* 1: 1–12.

Grimes, P. (1999) "The horsemen and the killing fields: the final contradiction of capitalism," in Goldfrank, W., Goodman, D., and Szasz, A. (eds) *Ecology and the World System*, Westport, CT: Greenwood Press, pp. 13–42.

Gross, P. and Levitt, N. (1994) *Higher Superstition: the Academic Left and its Quarrels With Science*, Baltimore, MA: Johns Hopkins Press.

Grossman, L. (1998) *The Political Ecology of Bananas: Contract Farming, Peasants and Agrarian Change in the Eastern Caribbean*, London and Chapel Hill: University of North Carolina Press.

Grove, R. (1995) *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1660–1860*, Cambridge: Cambridge University Press.

Grove-White, R. (1999) "Afterword: On 'sound science,' the environment, and political authority," *Environmental Values* 8: 277–282.

Grove-White, R., Macnaghten, P., Mayer, S., and Wynne, B. (1997) *Uncertain World: Genetically Modified Organisms, Food and Public Attitudes in Britain*, Lancaster: Centre for Study of Environmental Change, Lancaster University.

Grubb, M., Brack, D., and Vrolijk, C. (1999) *The Kyoto Protocol, a Guide and Assessment*, London: Earthscan and the Royal Institute of International Affairs.

Grubb, M., Koch, M., Munson, A., Sullivan, F., and Thomson, K. (1993) *The Earth Summit Agreements: a Guide and Assessment*, London: Earthscan and RIIA.

Guha, R. and Martinez-Allier, J. (1997) *Varieties of Environmentalism*, London: Earthscan.

Gupta, J. (1997). *The Climate Change Convention and Developing Countries: from Conflict to Consensus?* London, Dordrecht, Boston: Kluwer.

Guston, D. (2001) "Boundary organizations in environmental policy and science: an introduction," *Science, Technology and Human Values* 26: 4, 399–408.

Gyawali, D. (2000) *Water in Nepal*, Kathmandu: Himal Books.

Haas, P. (1992) "Introduction: epistemic communities and international policy coordination," *International Organization* 46: 1, 1–35.

Habermas, J. (1974) *Theory and Practice*, translated by John Viertel, Boston, MA: Beacon Press.

Habermas, J. (1981) "New social movements," *Telos* 49: 33–37.

Habermas, J. (1987 [1985]) *The Theory of Communicative Action, Vol. 2*, translated by Thomas McCarthy, Boston, MA: Beacon Press.

Hagel, Chuck, Senator (2001) Testimony to Senate Committee on Commerce, Science and Transportation, in *Notes from Senate Committee on Commerce, Science and Transportation hearing on Intergovernmental Panel on Climate Change (IPCC) Third Assessment Report, May 1*, Washington, DC: NOAA Office of Legislative Affairs.

Hajer, M. (1993) "The politics of environmental discourse: a study of the acid rain controversy in Great Britain and the Netherlands." Unpublished Ph.D. thesis, University of Oxford.

Hajer, M. (1995) *The Politics of Environmental Discourse*, Oxford: Clarendon.

Hallsworth, E. (1987) *Anatomy, Physiology and Psychology of Erosion*, Chichester: Wiley.

Hamilton, L. (1987) "What are the impacts of deforestation in the Himalayas on the Ganges–Brahmaputra lowlands and delta? Relations between assumptions and facts," *Mountain Research and Development* 7: 256–263.

Hamilton, L. (1988) "Forestry and watershed management," in Ives, J. and Pitt, D. (eds) *Deforestation: Social Dynamics in Watershed and Mountain Ecosystems*, London, New York: Routledge, pp. 99–131.

Hamilton, L. and Pearce, A. (1988) "Soil and water impacts of deforestation," in Ives, J. and Pitt, D. (eds) *Deforestation: Social Dynamics in Watershed and Mountain Ecosystems*, London: Routledge, pp. 75–98.

Hammond, A., Rodenburg, E., and Moomaw, W. (1991) "Calculating national accountability for climate change," *Environment* 33: 1, 11–15, 33–35.

Hanbury-Tenison, R. (2001) "The Greens must not be allowed to ruin our planet," *The Daily Telegraph*, July 19, 26.

Hannah, M. (1999) "Skeptical realism: from either/or to both-and," *Environment and Planning D: Society and Space* 17: 17–34.

Haraway, D. (1991) *Simians, Cyborgs, and Women: the Reinvention of Nature*, London: Routledge.

Hardin, G. (1968) "The tragedy of the commons," *Science* 162: 1243–1248.

Harding, S. (1986) *The Science Question in Feminism*, Ithaca, NY: Cornell University Press.

Hardoy, J., Mitlin, D., and Satterthwaite, D. (2001) *Environmental Problems in an Urbanizing World*, London: Earthscan.

Harré, R. (1986) *Varieties of Realism*, Oxford: Blackwell.

Harré, R. (1993) *Laws of Nature*, London: Duckworth.

Harré, R., Brockmeier, J., and Mühlhäusler, P. (1999) *Greenspeak: a Study of Environmental Discourse*, Thousand Oaks, CA: Sage.

Harré, R. and Krausz, M. (1996) *Varieties of Relativism*, Oxford: Blackwell.

Harris, D. (ed.) (1980) *Human Ecology in Savanna Environments*, London, New York: Academic Press.

Harrison, M. (1996) "'The tender frame of man': disease, climate, and racial difference in India and the West Indies, 1760–1860," *Bulletin of the History of Medicine* 70: 68–93.

Harvey, D. (1996) *Justice, Nature, and the Geography of Difference*, Oxford: Blackwell.

Hecht, S. and Cockburn, A. (1989) *The Fate of the Forest: Developers, Destroyers and Defenders of the Amazon*, London: Verso.

Hess, D. (1997) *Science Studies: an Advanced Introduction*, New York and London: New York University Press.

Hewitt, K. (ed.) (1983) *Interpretations of Calamity: from the Viewpoint of Human Ecology*, Boston, MA: Allen and Unwin.

Hicks, E. and van Rossum, W. (eds) (1991) Policy development and big science, special edition of *Verhandelingen der Koninklijke Nederlandse*, vol. 147.

Hoben, A. (1995) "Paradigms and politics: the cultural construction of environmental policy in Ethiopia," *World Development* 23: 6, 1007–1021.

Höfer, T. (1993) "Himalayan deforestation, changing river discharge, and increasing floods: myth or reality?" *Mountain Research and Development* 13: 3, 213–233.

Hohenemser, C., Kasperson, R., and Kates, R. (1985) "Causal structure," in Kates, R., Hohenemser, C., and Kasperson, J. (eds) *Perilous Progress: Managing the Hazards of Technology*, Boulder, CO: Westview Press, pp. 43–66.

Holden, C. (1996) "Social science: researchers find feminization a two-edged sword," *Science* 271: 5257, 1919–1920.

Holling, C. (1973) "Resilience and stability of ecological systems," *Annual Review of Ecology and Systematics* 4: 1–23.

Holling, C. (1979) "Myths of ecological stability: resilience and the problem of failure," in Smart, G. and Standbury, W. (eds) *Studies on Crisis Management*, Montreal: Butterworth, pp. 93–106.

Holling, C., Schindler, D., Walker, B., and Roughgarden, J. (1995) "Biodiversity in the functioning of ecosystems: an ecological synthesis," in Perrings, C., Mäler, K., Holling, C., and Jansson, B. (eds) *Biodiversity Loss: Economic and Sociological Issues*, Cambridge: Cambridge University Press, pp. 44–83.

Holmes, T. and Scoones, I. (2000) *Participatory Environmental Policy Processes: Experiences from North and South*, IDS Working Paper 113, Falmer: Institute of Development Studies.

Holton, G. (1993) *Science and Anti-Science*, Cambridge, MA: Harvard University Press.

Hörning, G. (1999) "Citizens' panels as a form of deliberative technology assessment," *Science and Public Policy* 26: 5, 351–359.

Howartb, J. (1995) "Ecology: modern hero or post-modern villain: from scientific trees to phenomenological wood," *Biodiversity and Conservation* 4: 786–797.

Hutchings, J. (2001) "Kaitiaki," *Genetics Forum*, May/June 2001 (http://www.geneticsforum.org.uk/).

Huxley, A. (1963) *The Politics of Ecology: the Question of Survival*, occasional paper of the Free Society, Center for the Study of Democratic Institutions, Santa Barbara, CA.

Huxley, J. (1947) *Conservation of Nature in England and Wales*, Cmd. 7122, London: HMSO.

Hynes, H. (1993) *Taking Population Out of the Equation: Reformulating I = PAT*, North Amherst, MA: Institute on Women and Technology.

ICRAF (International Ceuter for Agroforestry Research) (1999) *ICRAF in Southeast Asia*, publicity brochure, Bogor: ICRAF.

IPCC (Intergovernmental Panel on Climate Change) (1996) *Second Assessment Report* Watson, R., Zinyowera, M., and Moss, R. (eds). New York: Cambridge University Press.

IPCC (Intergovernmental Panel on Climate Change) (2000) *IPCC Special Report on Land Use, Land-Use Change and Forestry*, Bonn: IPCC (http://www.grida.no/climate/ipcc/land_use/index.htm).

IPCC (Intergovernmental Panel on Climate Change) (2001) *Third Assessment Report of the IPCC: Summary for Policymakers: Climate Change 2001: Impacts, Adaptation and Vulnerability* (http: //www.ipcc.ch).

Irwin, A. (1995) *Citizen Science: a Study of People, Expertise, and Sustainable Development*, London: Routledge.

Irwin, A., Simmons, P., and Walker, G. (1999) "Faulty environments and risk reasoning: the local understanding of industrial hazards," *Environment and Planning A* 31: 1311–1326.

Irwin, A. and Wynne, B. (eds) (1996) *Misunderstanding Science*, Cambridge: Cambridge University Press.

Ives, J. and Messerli, B. (1989) *The Himalayan Dilemma: Reconciling Conservation and Development*, London: Routledge/UNU.

Ives, J. and Pitt, D. (eds) (1988) *Deforestation: Social Dynamics in Watershed and Mountain Ecosystems*, London, New York: Routledge.

Jackson, C. (1995) "Radical environmental myths: a gender perspective," *New Left Review* 210: 124–140.

Jackson, C. (1997) "Women in critical realist environmentalism: subaltern to the species?' *Economy and Society* 26: 1, 62–80.

Jamison, A. (1996) "The shaping of the global environmental agenda: the role of non-governmental organisations," in Lash, S., Szerszynski, B., and Wynne, B. (eds) *Risk, Environment and Modernity*, London: Sage, pp. 224–245.

Jasanoff, S. (1987) "Contested boundaries in policy-relevant science," *Social Studies of Science* 17: 195–230.

Jasanoff, S. (1990) *The Fifth Branch: Science Advisers as Policymakers*, Cambridge, MA: Harvard University Press.

Jasanoff, S. (1996a) "Science and norms in global environmental regimes," in

Hampson, F. and Reppy, J. (eds) *Earthly Goods: Environmental Change and Social Justice*, Ithaca, NY and London: Cornell University Press, pp. 173–197.

Jasanoff, S. (1996b) "Beyond epistemology: relativism and engagement in the politics of science," *Social Studies of Science* 26: 2, 393–418.

Jasanoff, S. (1998) "The political science of risk perception," *Reliability Engineering and System Safety* 59: 91–99.

Jasanoff, S. (1999) "The songlines of risk," *Environmental Values* 8: 2, 135–152.

Jasanoff, S. (2000) "The "Science Wars" and American politics," in Dierkes, M. and van Grote, C. (eds) *Between Understanding and Trust: the Public, Science and Technology*, Amsterdam: Harwood, pp. 39–60.

Jasanoff, S. (2001) "Image and imagination: the formation of global environmental consciousness," in Miller, C. and Edwards, P. (eds) *Changing the Atmosphere: Expert Knowledge and Environmental Governance*, Cambridge, MA: MIT Press, pp. 309–338.

Jasanoff, S., Markle, C., Petersen, J., and Pinch, T. (eds) (1995) *Handbook of Science and Technology Studies*, Thousand Oaks, CA: Sage.

Jasanoff, S. and Wynne, B. (1998) "Science and decisionmaking," in Rayner, S. and Malone, E. (eds) *Human Choice and Climate Change*, Columbus, OH: Battelle Press, pp. 1–87.

Jewitt, S. (1995) "Europe's 'others'? Forestry policy and practices in colonial and postcolonial India," *Environment and Planning D: Society and Space* 13: 67–90.

Jewitt, S. (2000) "Unequal knowledges in Jharkhand, India: de-romanticizing women's agroecological expertise," *Development and Change* 31: 961–985.

Joerges, B. (1999) "Do politics have artefacts?' *Social Studies of Science* 29: 3, 411–431.

Johnson, C. and Forsyth, T. (2002) "In the eyes of the state: negotiating a 'rights-based approach' to forest conservation in Thailand," *World Development* 30: 9, 1591–1605.

Johnson, M. (ed.) (1992) *Lore: Capturing Traditional Environmental Knowledge*, Dene Cultural Institute, Canada; International Development Research Center.

Joss, S. (1999) "Public participation in science and technology policy- and decision-making – ephemeral phenomenon or lasting change?" *Science and Public Policy* 25: 5, 290–293.

Kaiser, J. (2000) "Ecosystem assessment: ecologists hope to avoid the mistakes of previous assessment," *Science* 289: 5485, 1676–1677.

Kasperson, J. and Kasperson, R. (eds) (2001) *Global Environmental Risk*, London: Earthscan.

Kasperson, J., Kasperson, R., and Turner, B.L. (1995) *Regions at Risk: Comparisons of Threatened Environments*, Tokyo, New York, and Paris: United Nations University Press.

Kates, R. (2000a) "Population and consumption: what we know, what we need to know," *Environment* 42: 3, 10–19.

Kates, R. (2000b) "Cautionary tales: adaptation and the global poor," in Kanes, S. and Yohe, G. (eds) *Societal Adaptation to Climate Variability and Change*, Dordrecht: Kluwer, pp. 5–17.

Kates, R. and Clark, W. (1996) "Environmental surprise: expecting the unexpected," *Environment* 38: 6–11, 28–34.

Katyal, J. and Vlek, P. (2000) *Desertification – Concept, Causes and Amelioration*, Bonn: Zentrum für Entwicklungsforschung, Universität Bonn.

Kearns, G. (1998) "The virtuous circle of facts and values in the New Western History," *Annals of the Association of American Geographers* 88: 3, 377–387.

Keck, M. and Sikkink, K. (1998) *Activists Beyond Borders: Advocacy Networks in International Politics*, Ithaca, NY and London: Cornell University Press.

Keller, E. Fox (1995) "The origin, history, and politics of the subject called 'gender and science': a first person account," in Jasanoff, S., Markle, C., Petersen, J., and Pinch, T. (eds) *Handbook of Science and Technology Studies*, Thousand Oaks, CA: Sage, pp. 80–94.

Kelly, P. and Adger, W. (1999) *Assessing Vulnerability to Climate Change and Facilitating Adaptation*, CSERGE Working Paper GEC 99–07, CESERGE: University of East Anglia, Norwich.

Khor, M. (1997) "Is globalization undermining the prospects for sustainable development?" Fifth Annual Hopper Lecture presented at the University of Guelph, 21 October, and the University of Prince Edward Island, 23 October.

Kienholz, H., Schneider, G., Bichsel, M., Grunder, M., and Mool, P. (1984) "Mapping of mountain hazards and slope stability," *Mountain Research and Development* 4: 3, 247–266.

Kingdon, J. (1984) *Agendas, Alternatives, and Public Policies*, Boston, MA: Little, Brown.

Klooster, D. (2002) "Toward adaptive community forestry management: integrating local forest knowledge with scientific forestry," *Economic Geography* 78: 1, 43–70.

Knorr-Cetina, K. and Mulkay, M. (eds) (1983) *Science Observed: Perspectives on the Social Study of Science*, London: Sage.

Knowledge Center, The (2000) "Threat that never was" (http://www.biotech-knowledge.monsanto.com).

Koertge, N. (ed.) (1998) *A House Built on Sand: Exposing Postmodernist Myths about Science*, New York and Oxford: Oxford University Press.

Kuhn, T. (1962) *The Structure of Scientific Revolutions*, Chicago, IL: University of Chicago Press.

Kukla, A. (1993) "Epistemic boundedness," *International Studies in the Philosophy of Science* 7: 2, 121–126.

Kull, C. (2000) "Deforestation, erosion, and fire: degradation myths in the environmental history of Madagascar," *Environment and History* 6: 423–450.

Kurian, P. (2000) *Engendering the Environment? Gender in the World Bank's Environmental Policies*, Aldershot: Ashgate.

Kwa, C. (1987) "Representations of nature modeling between ecology and science policy: the case of the International Biological program," *Social Studies of Science* 17: 413–442.

Kwa, C. (2001) "The steering of the International Geosphere–Biosphere Programme (IGBP)," Draft BCSIA Discussion Paper, Environment and Natural Resources Program, Kennedy School of Government, Harvard University.

Lahsen, M. (1999) "The detection and attribution of conspiracies: the controversy over Chapter 8," in Marcus, G. (ed.) *Paranoia Within Reason: A Case Book on Conspiracy and Explanation*, Chicago, IL: Chicago University Press.

Lakatos, I. (1978) *The Methodology of Scientific Research Programs*, Worrall, J. and Currie, G. (eds), Cambridge: Cambridge University Press.

Lambin, E.F., Turner, B.L., Geist, H.J., *et al.* (2001) "The causes of land-use and land-cover change: moving beyond the myths," *Global Environmental Change* 11: 4, 261–269.

Lamprey, H. (1988 [1975]) "Report on the desert encroachment reconnaissance in northern Sudan, 21 October to 10 November, 1975," *Desertification Control Bulletin* 17: 1–7.

Landy, M. (1995) "The new politics of environmental policy," in Landy, M. and Levin, M. (eds) *The New Politics of Public Policy*, Baltimore, MA: Johns Hopkins Press, pp. 207–227.

Landy, M., Roberts, M., and Thomas, S. (1994) *The Environmental Protection Agency: Asking the Wrong Questions*, New York: Oxford University Press.

Lankester, E. (1914) "Nature reserves," *Nature* 93: 2315, 33–35.

Latour, B. (1983) "Give me a laboratory and I shall raise the world," in Knorr-Cetina, K. and Mulkay, M. (eds) *Science Observed*, London: Sage, pp. 141–170.

Latour, B. (1987) *Science in Action: How to Follow Scientists and Engineers Through Society*, Cambridge, MA: Harvard University Press.

Latour, B. (1988) *The Pasteurization of France*, Cambridge, MA: Harvard University Press.

Latour, B. (1993 [1991]) *We Have Never Been Modern*, Hemel Hempstead: Harvester Wheatsheaf.

Latour, B. and Woolgar, S., with Salk, J. (1979) *Laboratory Life: the Social Construction of Scientific Facts*, Beverly Hills, CA: Sage.

Laudan, L. (1977) *Progress and its Problems*, London: Sage.

Laudan, L. (1990) *Science and Relativism: Some Key Controversies in the Philosophy of Science*, Chicago, IL: University of Chicago Press.

Law, J. (ed.) (1991) *A Sociology of Networks: Essays on Power, Technology and Domination*, London: Routledge.

Law, J. and Hassard, J. (eds) (1999) *Actor Network Theory and After*, Oxford: Blackwell and The Sociological Review.

Layne, L. (1990) "Motherhood lost: cultural dimensions of miscarriage and stillbirth in America," *Women and Health* 16: 3, 75–104.

Layne, L. (1997) "Breaking the silence: an agenda for a feminist discourse of pregnancy loss," Special edition of *Feminist Studies* 23: 2, 289–315.

Layne, L. (2001) "In search of community: tales of pregnancy loss in three toxically assaulted US communities," *Women's Studies Quarterly* 29: 1, 2, 25–50.

Leach, G. and Mearns, R. (1988) *Beyond the Fuelwood Crisis*, London: Earthscan.

Leach, M., Fairhead, J., and Amanor, K. (eds) (2002) "Science and the policy process: perspectives from the forest," Special edition of *IDS Bulletin* 33: 1.

Leach, M. and Mearns, R. (1991) *Poverty and Environment in Developing Countries, an Overview Study*, report presented to the Economic and Social Research Council and the Overseas Development Administration, Brighton: Institute of Development Studies.

Leach, M. and Mearns, R. (eds) (1996) *The Lie of the Land: Challenging Received Wisdom on the African Environment*, Oxford: James Currey.

Leach, M., Mearns, R., and Scoones, I. (1999) "Environmental entitlements: dynamics and institutions in community-based natural resource management," *World Development* 27: 2, 225–247.

Leach, M., Mearns, R., and Scoones, I. (eds) (1997) "Community-based sustainable development: consensus or conflict?' Special edition *IDS Bulletin* 28: 4.

Lederman, M. and Bartsch, I. (eds) (2001) *The Gender and Science Reader*, London and New York: Routledge.

Lee, N. and Hassard, J. (1999) "Organization unbound: actor-network theory, research strategy and institutional flexibility," *Organization* 6: 3, 391–404.

Leff, E. (1995) *Green Production: Toward an Environmental Rationality*, New York, London: Guilford.

Leggett, J. (ed.) (1990) *Global Warming: The Greenpeace Report*, Oxford: Oxford University Press.

Leiss, W. (1972) "Technological rationality: Marcuse and his critics," *Philosophy of the Social Sciences* 2: 34–35.

Leopold, A. (1933) *Game Management*, New York and London: C. Scribner's and Sons.

Leplin, J. (1984) "Truth and scientific progress," in Leplin, J. (ed.) *Scientific Realism*, Berkeley, CA, Los Angeles, CA, London: University of California Press, pp. 193–217.

Levidow, L. and Carr, S. (1997) "How biotechnology regulation sets a risk/ethics boundary," *Agriculture and Human Values* 14: 29–43.

Levin, M. (1984) "What kind of explanation is truth?" in Leplin, J. (ed.) *Scientific Realism*, Berkeley, CA, Los Angeles, CA, London: University of California Press, pp. 124–139.

Levitt, N. (1999) *Prometheus Bedeviled: Science and the Contradictions of Contemporary Culture*, New Brunswick, NJ: Rutgers University Press.

Lewis, J. (1990) "The vulnerability of small island states to sea level rise: the need for holistic strategies," *Disasters* 14: 3, 241–249.

Lewis, P. (1996) "Metaphor and critical realism," *Review of Social Economy* 54: 4, 487–506.

Light, A. and Katz, E. (eds) (1996) *Environmental Pragmatism*, London: Routledge.

Limerick, P. (1991) "What on earth is the new western history?" in Limerick, P., Milner, C., and Rankin, E. (eds) *Trails: Toward a New Western History*, Lawrence, KS: University of Kansas Press, pp. 81–88.

Lipietz, A. (1992) *Towards a New Economic Order: Postfordism, Ecology and Democracy*, translated by Malcolm Slater, Cambridge: Polity.

Lipietz, A. (2000) "Political ecology and the future of Marxism," *Capitalism, Nature, Socialism* 11: 1, 69–85.

List, M. and Rittberger, V. (1992) "Regime theory and international environmental management," in Hurrell, A. and Kingsbury, B. (eds) *The International Politics of the Environment*, Oxford: Clarendon, pp. 85–109.

Litfin, K. (1994) *Ozone Discourses: Science and Politics in Global Environmental Cooperation*, New York: Columbia University Press.

Little, C. (1995) *The Dying of the Trees: The Pandemic in America's Forests*, New York: Penguin.

Liverman, D. (1999) "Vulnerability and adaptation to drought in Mexico," *Natural Resources Journal* 39: 1, 99–115.

Lohmann, L. (1993) "Resisting green globalism," in Sachs, W. (ed.) *Global Ecology: a New Arena of Political Conflict*, London, Zed, Halifax, Novia Scotia: Fernwood, pp. 157–169.

Lohmann, L. (1995) "No rules of engagement: interest groups, centralization and the creative politics of 'environment' in Thailand," in Rigg, J. (ed.) *Counting the Costs: Economic Growth and Environmental Change in Thailand*, Singapore: ISEAS, pp. 211–234.

Lohmann, L. (1998) *Whose Voice is Speaking? How Opinion Polling and Cost–Benefit Analysis Synthesize New Publics*, Briefing Paper number 7, The Corner House, Sturminster Newton, UK (http://cornerhouse.icaap.org/).

Lohmann, L. (1999) *The Dyson Effect: Carbon "Offset" Forestry and the Privatisation of the Atmosphere*, Briefing number 15, The Corner House, Sturminster Newton, UK (http://cornerhouse.icaap.org/).

Lohmann, L. (2001) *Democracy or Carbocracy? Intellectual Corruption and the Future of the Climate Debate*, Briefing number 24, The Corner House, Sturminster Newton, UK (http://cornerhouse.icaap.org/).

Lomborg, B. (2001) *The Skeptical Environmentalist: Measuring the Real State of the World*, Cambridge: Cambridge University Press.

Long, N. and Long, A. (eds) (1992) *Battlefields of Knowledge: the Interlocking of Theory and Practice in Social Research and Development*, London: Routledge.

Longino, H. (1990) *Science as Social Knowledge: Values and Objectivity in Scientific Inquiry*, Princeton, NJ: Princeton University Press.

Lookingbill, B. (2001) *Dust Bowl, USA: Depression America and the Ecological Imagination, 1929–1941*, Athens, OH: Ohio University Press.

Losey, J., Raynor, L., and Carter, M. (1999) "Transgenic pollen harms monarch larvae," *Nature* 399: 214.

Low, N. and Gleeson, B. (1998) *Justice, Society and Nature: an Exploration of Political Ecology*, London: Routledge.

Lowe, P. and Rüdig, W. (1986) "Political ecology and the social sciences: the state of the art," *British Journal of Political Science* 16: 513–550.

Luhmann, N. (1989) *Ecological Communication*, Chicago, IL: University of Chicago Press.

Luke, T. (1999) *Capitalism, Democracy and Ecology: Departing from Marx*, Chicago and Urbana, IL: University of Illinois Press.

Luzzarder-Beach, S. and MacFarlane, A. (2000) "The environment of gender and science: status and perspectives of women and men in physical geography," *Professional Geographer* 52: 3, 407–424.

Lynch, M. and Woolgar, S. (eds) (1990) *Representation in Scientific Practice*, Cambridge, MA: MIT Press.

McComas, K. and Shanahan, J. (1999) "Telling stories about global climate change: measuring the impact of narratives on issue cycles," *Communication Research* 26: 1, 30–57.

McHenry, H. (2000) "Wild flowers in the wrong field are weeds! Examining farmers' constructions of conservation," *Environment and Planning A* 30: 1039–1053.

MacKenzie, D. (1990) *Inventing Accuracy: a Historical Sociology of Nuclear Missile Guidance*, Cambridge, MA: MIT Press.

McManus, P. (1999) "Histories of forestries: ideas, networks and silences," *Environment and History* 5: 2, 185–208.

McNaughton, P. and Urry, J. (1998) *Contested Natures*, London and Thousand Oaks, CA: Sage.

Malin, J. (1946) "Dust storms 1850–1900," *Kansas History Quarterly* 14: 129–144, 265–296.

Marcuse, H. (1964) *One Dimensional Man*, Boston, MA: Beacon Press.

Marcuse, H. (1969) *An Essay on Liberation*, Boston, MA: Beacon Press.

Marsh, G.P. (1864) *Man and Nature, or, Physical Geography as Modified by Human Action*, New York: Scribner.

Marshall, B. (1999) "Globalization, environmental degradation and Ulrich Beck's Risk Society," *Environmental Values* 8: 253–275.

Martens, P. (2000) "Malaria and global warming in perspective?" *Journal of Infectious Diseases* 6: 3, 313–314.

Martin, B. (1991) *Scientific Knowledge in Controversy: the Social Dynamics of the Fluoridation Debate*, Albany, NY: State University of New York Press.
Mason, M. (1999) *Environmental Democracy*, London: Earthscan.
Massey, D. (1999) "Space–time, 'science' and the relationship between physical geography and human geography," *Transactions of the Institute of British Geographers* NS 24: 261–276.
Mather, A. (1992) "The forest transition," *Area* 24: 367–379.
Mather, A. and Needle, C. (2000) "The relationships of population and forest trends," *The Geographical Journal* 166: 1, 2–13.
Matthews, J. and Ho, Mae-Wan (2001) "The new thought police," *Genetics Forum* September/October (http: //www.geneticsforum.org.uk/).
Maunder, W. (1992) *Dictionary of Global Climate Change*, London: UCL Press.
May, R. (1974) "Biological populations with non-overlapping generations: stable points, stable cycles and chaos," *Science* 186: 645–647.
Mayer, S. (2000) "Genetic engineering in agriculture," in Huxham, M. and Sumner, D. (eds) *Science and Environmental Decision Making*, Harlow: Prentice Hall, pp. 94–117.
Meadows, D., Meadows, D., Randers, J., and Behrens III, W. (1972) *The Limits to Growth: a Report for the Club of Rome's Project on the Predicament of Mankind*, New York: University Books.
Mehta, L. (2001) "The World Bank and its emerging knowledge empire," *Human Organisation* 60: 2, 189–196.
Mehta, L., Leach, M., Newell, P., Scoones, I., Sivaramakrishnan, K., and Way, S. (1999) *Exploring Understandings of Institutions and Uncertainty: New Directions in Natural Resource Management*, IDS Discussion Paper 372, Falmer: Institute of Development Studies.
Mehta, L., Leach, M., and Scoones, I. (eds) (2001) *Environmental governance in an uncertain world*, Special edition of *IDS Bulletin*, 32: 4.
Merchant, C. (1980) *The Death of Nature: Women, Ecology and the Scientific Revolution*, San Francisco, CA: Harper and Row.
Merton, R.K. (1973 [1942]) "The normative structure of science," in Merton, R.K., *The Sociology of Science*, Storer, N. (ed.), Chicago, IL: University of Chicago Press, pp. 267–278.
Metz, J. (1989) "Himalayan political economy: more myths in the closet?" *Mountain Research and Development* 9: 2, 175–181.
Metz, J. (1991) "A reassessment of the causes and severity of Nepal's environmental crisis," *World Development* 19: 7, 805–820.
Midgley, M. (1992) *Science as Salvation: a Modern Myth and its Meaning*, London: Routledge.
Miller, A. (1978) *A Planet to Choose: Value Studies in Political Ecology*, New York: Pilgrim Press.
Miller, C. (2001) "Hybrid management: boundary organizations, science policy, and environmental governance in the climate regime," *Science, Technology and Human Values* 26: 4, 478–500.
Millington, A. (1986) "Environmental degradation, soil conservation and agricultural policies in Sierra Leone, 1895–1984," in Anderson, D. and Grove, R. (eds) *Conservation in Africa*, Cambridge: Cambridge University Press, pp. 229–248.
Mol, A. (1996) "Ecological modernization and institutional reflexivity: environmental reform in the late modern age," *Environmental Politics* 5: 2, 302–323.

Mol, A. and Law, J. (1994) "Regions, networks and fluids: anaemia and social topology," *Social Studies of Science* 24: 641–671.
Monbiot, G. (2002) "Corporate phantoms: the web of deceit over GM food has now drawn in the PM's speechwriters," the *Guardian*, Wednesday 29 May.
Morgan, R. (1986) *Soil Erosion and Conservation*, Harlow: Longman Scientific and Technical Series.
Morris, A. and Mueller, C. (eds) (1992) *Frontiers in Social Movement Theory*, New Haven, CT: Yale University Press.
Morris, J. (1995) *The Political Economy of Land Degradation: Pressure Groups, Foreign Aid and the Myth of Man-Made Deserts*, London: Institute of Economic Affairs.
Morrow, R. (1994) *Critical Theory and Methodology* (Contemporary Social Theory, vol. 3), Thousand Oaks, CA, London, Delhi: Sage.
Morse, S. and Stocking, M. (eds) (1995) *People and Environment*, London: UCL Press.
Mortimore, M. and Adams, W. (1999) *Working the Sahel: Environment and Society in Northern Nigeria*, London: Routledge.
Mukta, P. and Hardiman, D. (2000) "The political ecology of nostalgia," *Capitalism, Nature, Socialism* 11: 1, 113–133.
Multinational Monitor (periodical) http: //www.essential.org/monitor/monitor.html.
Murdoch, J. (1997) "Inhuman/nonhuman/human: actor-network theory and the prospects for a nondualistic and symmetrical perspective on nature and society," *Environment and Planning D: Society and Space* 15: 6, 731–756.
Murdoch, J. and Clark, J. (1994) "Sustainable knowledge," *Geoforum* 25: 2, 115–132.
Murphy, R. (1994) *Rationality and Nature: a Sociological Inquiry into a Changing Relationship*, Bonlder, CO: Westview Press.
Murphy, R. (1995) "Sociology as if nature did not matter: an ecological critique," *British Journal of Sociology* 46: 4, 688–707.
Murton, J. (1999) "Population growth and poverty in Machakos, Kenya," *Geographical Journal* 165: 1, 37–46.
Myers, N. (1984) *The Primary Source: Tropical Forests and our Future*, New York: Norton.
Myers, N. (1990) "Tropical Forests," in Leggett, J. (ed.) *Global Warming: The Greenpeace Report*, Oxford: Oxford University Press, pp. 372–399.
Nader, L. (ed.) (1996) *Naked Science: Anthropological Inquiry into Boundaries, Power, and Knowledge*, London: Routledge.
Naka, K., Hammett, A., and Stuart, W. (2000) "Forest certification: stakeholders, constraints and effects," *Local Environment* 5: 4, 475–481.
Nash, R. (1973) *Wilderness and the American Mind*, New Haven, CT: Yale University Press.
Netting, R. (1993) *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture*, Stanford, CA: Stanford University Press.
Neumann, R. (1996) "Dukes, earls and ersatz Edens: aristocratic nature preservationists in colonial Africa," *Environment and Planning D: Society and Space* 14: 79–98.
Neumann, R. (1998) *Imposing Wilderness: Struggles over Livelihood and Nature Preservation in Africa*, Los Angeles and Berkeley, CA: University of California Press.
Nietzsche, F. (1979 [1873]) "On truth and lies in a non-moral sense," in Breazeale,

D. (ed.) *Philosophy and Truth: Selection from Nietzsche's Notebooks of the Early 1970s*, Sussex, Harvester Press, New Jersey: Humanities Press, pp. 79–80.
Nietzsche, F. (1967 [1901]) *The Will to Power*, translated by W. Kaufmann, edited by R. Hollingdale, New York: Vintage Books.
Norberg-Bohm, V., Clark, W., Bakshi, B., *et al.* (2001) "International comparisons of environmental hazards," in Kasperson, J. and Kasperson, R. (2001) *Global Environmental Risk*, London: Earthscan, pp. 55–147.
Norris, C. (1995) "Truth, science and the growth of knowledge," *New Left Review* 210: 105–123.
Nowotny, H. (1979) "Science and its critics: reflections on anti-science," in Nowotny, H. and Rose, H. (eds) *Counter Movements in the Sciences: the Sociology of the Alternatives to Big Science*, Dordrecht, Boston, MA, London: Reidel, pp. 1–26.
Nowotny, H. and Rose, H. (eds) (1979) *Counter Movements in the Sciences: the Sociology of the Alternatives to Big Science*, Dordrecht, Boston, MA, London: Reidel, pp. 1–26.
NRC (National Research Council, Board on Sustainable Development Policy Division) (1999) *Our Common Journey: A Transition Towards Sustainability*, Washington, DC: NRC.
O'Connor, J. (1996) "The second contradiction of capitalism," in Benton, T. (ed.) *The Greening of Marxism*, New York: Guilford Press, pp. 187–196.
O'Riordan, T. and Jordan, A. (1999) "Institutions, climate change and cultural theory: towards a common analytical framework," *Global Environmental Change* 9: 81–93.
Oba, G., Stenseth, N., and Lusigi, W. (2000) "New perspectives on sustainable grazing management in arid zones of sub-Saharan Africa," *BioScience* 50: 35–51.
Odum, E. (1964) "The new ecology," *Bioscience* 14: 7, 14–16.
Odum, E. (1969) "The strategy of ecosystem development," *Science* 164: 262.
Offe, C. (1985) "New social movements: challenging the boundaries of institutional politics," *Social Research* 52: 4, 817–868.
Olsson, L. and Ardö, J. (2002) "Soil carbon sequestration in degraded semi-arid ecosystems: perils and potentials," *Ambio* 31: 6, 471–477.
Openshaw, K. (1974) "Woodfuels in the developing world," *New Scientist* 31: 271–272.
Ortony, A. (1993) *Metaphor and Thought*, 2nd edn, Cambridge: Cambridge University Press.
Ostrom, E. (1990) *Governing the Commons: the Evolution of Institutions for Collective Action*, Cambridge: Cambridge University Press.
Pasuk Phongpaichit and Baker, C. (1995) *Thailand: Economy and Politics*, Oxford: Oxford University Press.
Patz, J., McGeehin, M., Bernard, S., *et al.* (2000) "The potential health impacts of climate variability and change for the United States: executive summary of the report of the health sector of the U.S. National Assessment," *Environmental Health Perspectives* 108: 367–376.
Peet, R. and Watts, M. (eds) (1996) *Liberation Ecologies: Environment, Development, Social Movements*, London: Routledge.
Pereira, H. (1989) *Policy and Practice in the Management of Tropical Watersheds*, Boulder, CO: Westview Press.
PERG (Political Ecology Research Group) (1979) *A First Report of the Work of the Political Ecology Research Group*, Oxford: PERG.

Perlman, M. (1994) *The Power of Trees: the Reforesting of the Soul*, Dallas, TX: Spring Publications.
Pickering, A. (1995) *The Mangle of Practice*, Chicago, IL: University of Chicago Press.
Pickett, S. and White, P. (1985) *The Ecology of Natural Disturbance and Patch Dynamics*, New York: Academic Press.
Pielke, R. (1999) "Nine fallacies of floods," *Climatic Change* 42: 2, 413–438.
Pirandello, L. (1998 [1922]) *Naked: a New Version by Nicholas Wright*, London: Nick Hern Books.
Plumwood, V. (1993) *Feminism and the Mastery of Nature*, London: Routledge.
Poincaré, H. (1958) *The Value of Science*, London: Dover.
Polanyi, M. (1962) "The republic of science: its political and economic theory," *Minerva* 1: 1, 54–73.
Popper, K. (1945) *The Open Society and its Enemies*, London: Routledge.
Popper, K. (1962) *Conjectures and Refutations: the Growth of Scientific Knowledge*, New York: Basic Books.
Popper, K. (1994) *The Myth of the Framework: in Defense of Science and Rationality*, edited by M.A. Notturno, New York: Routledge.
Porritt, J. (2000) *Playing Safe: Science and the Environment*, London: Thames and Hudson.
Postel, S. (1993) "Facing water scarcity," in Starke, L. (ed.) *State of the World 1993*, New York: W.W. Norton and Co., pp. 22–41.
Preston, D., Macklin, M., and Warburton, J. (1997) "Fewer people, less erosion: the twentieth century in southern Bolivia," *The Geographical Journal* 163: 2, 198–205.
Price, D. (1965) *The Scientific Estate*, Cambridge, MA: Harvard University Press.
Price, D. (1986) *Little Science, Big Science ... and Beyond*, New York: Columbia University Press.
Price, M. and Thompson, M. (1997) "The complex life: human land uses in mountain ecosystems," *Global Ecology and Biogeography Letters* 6: 77–90.
Princen, T., Finger, M., and Manro, J. (1994) "Translational linkages," in Princen, T. and Finger, M. *Environmental NGOs in World Politics: Linking the Local and the Global*, London: Routledge, pp. 217–236.
Proctor, J. (1998) "The social construction of nature: relativist accusations, pragmatist and critical realist responses," *Annals of Association of American Geographers* 88: 3, 352–376.
Psillos, S. (1999) *Scientific Realism: How Science Tracks Truth*, London: Routledge.
Radder, H. (1998) "The Politics of STS," *Social Studies of Science* 28: 2, 328–332.
Rangan, H. (2000) *Of Myths and Movements: Rewriting Chipko into Himalayan History*, London: Verso.
Rappaport, R. (1968) *Pigs for the Ancestors*, New Haven, CT: Yale University Press.
Rasmussen, D. (ed.) (1996) *The Handbook of Critical Theory*, Oxford: Blackwell.
Rasmussen, K., Fog, B., and Madsen, J.E. (2001) "Desertification in reverse? Observations from northern Burkina Faso," *Global Environmental Change* 11: 4, 271–282.
Raustilia, K. and Victor, D. (1996) "Biodiversity since Rio: the future of Convention on Biological Diversity," *Environment* 38: 4, 17–20, 37–45.
Reich, R. (1990) *Public Management in a Democratic Society*, Englewood Cliffs, NJ: Prentice Hall.

Reid, W. (1997) "Strategies for conserving biodiversity," *Environment* 39: 7, 16–20.
Reij, C., Scoones, I., and Toulmin, C. (ed.) (1996) *Sustaining the Soil: Indigenous Soil and Water Conservation in Africa*, London: Earthscan.
Reiter, P. (1998) "Global warming and vector-borne disease," *Lancet* 351: 1738.
Reiter, P. (2000) "Malaria and global warming in perspective?' *Journal of Infectious Diseases* 6: 4, 438.
Revenga, C., Murray, S., Abramovitz, J., and Hammond, A. (1998) *Watersheds of the World: Ecological Value and Vulnerability*, Washington, DC: World Resources Institute, and Worldwatch Institute.
Ribot, J., Magalhaes, A., and Panagides, S. (eds) (1996) *Climate Variability, Climate Change and Social Vulnerability in the Semi-arid Tropics*, Cambridge: Cambridge University Press.
Rich, B. (1994) *Mortgaging the Earth: the World Bank, Environmental Impoverishment and the Crisis of Development*, London: Earthscan and Boston, MA: Beacon Press.
Richards, P. (1952) *The Tropical Rain Forest*, Cambridge: Cambridge University Press.
Richards, P., Slikkerveer, L., and Phillips, A. (1989) *Indigenous Knowledge Systems for Agriculture and Rural Development: The CIKARD inaugural lectures*, Studies in technology and social change no. 13, Technical and social change program; Iowa State University, Adams, IA.
Robbins, P. (1998) "Paper forests: imagining and deploying exogenous ecologies in arid India," *Geoforum* 29: 1, 69–86.
Robbins, P. (2000) "The practical politics of knowing: state environmental knowledge and local political economy," *Economic Geography* 76: 2, 126–144.
Robertson, R. (1992) *Globalization: Social Theory and Global Culture*, Thousand Oaks, CA: Sage.
Rocheleau, D. (1995) "Maps, numbers, text, and context: mixing methods in feminist political ecology," *Professional Geographer* 47: 4, 458–466.
Rocheleau, D. and Edmunds, D. (1997) "Women, men and trees: gender, power and property in forest and agrarian landscapes," *World Development* 25: 8, 1351–1371.
Rocheleau, D. and Ross, L. (1995) "Trees as tools, trees as text: struggles over resources in Zamhrana-Chacney, Dominican Republic," *Antipode* 27: 4, 407–428.
Rocheleau, D., Ross, L., Morrobel, J., Malaret, L., Hernandez, R., and Kominiak, T. (2001) "Complex communities and emergent ecologies in the regional agroforest of Zambrana-Chacuey, Dominican Republic," *Ecumene* 8: 4, 465–492.
Rocheleau, D., Thomas-Slayter, B., and Wangari, E. (eds) (1996) *Feminist Political Ecology: Global Issues and Local Experiences*, London: Routledge.
Roe, E. (1991) "'Development narratives' or making the best of blueprint development," *World Development* 19: 4, 287–300.
Roe, E. (1994) *Narrative Policy Analysis: Theory and Practice*, Chapel Hill, NC: Duke University Press.
Roe, E. (1995) "Except Africa: postscript to a special section on development narratives," *World Development* 23: 6, 1065–1069.
Roquelpo, P. (1995) "Scientific expertise among political powers, administrations and public opinion," *Science and Public Policy* 22: 3, 175–182.
Rorty, R. (1989a) *Contingency, Irony, and Solidarity*, Cambridge: Cambridge University Press.

Rorty, R. (1989b) "Solidarity or objectivity?" in Krausz, M. (ed.) *Relativism*, Notre Dame, IN: University of Notre Dame Press, pp. 35–50.
Rose, H. (1990) "Toward pragmatic realism in human geography," *Cahiers de Géographie du Québec* 34: 92, 161–179.
Ross, A. (1996) *Strange Weather: Culture, Science and Technology in the Age of Limits*, London: Verso.
Rosswall, T., Woodmansee, R., and Risser, P. (1988) *Scales and Global Change: Spatial and Temporal Variability in Biospheric and Geospheric Processes*, New York: John Wiley.
Rostand, E. (1985) *Cyrano de Bergerac*, translated and adapted by Anthony Burgess, London: Hutchinson.
Rouse, J. (1987) *Knowledge and Power: Toward a Political Philosophy of Science*, Ithaca, NY: Cornell University Press.
Royal Society (1992) *Risk: Analysis, Perception and Management*, London: The Royal Society.
Ruether, R. (1972) *Liberation Theology: Human Hope Confronts Christian History and American Power*, New York: Paulist Press.
Rundle, B. (1993) *Facts*, London: Duckworth.
Russell, B. (1940) *An Inquiry into Meaning and Truth*, London: Allen and Unwin.
Russett, B. (1967) *International Regions and the International System: a Study in Political Ecology*, Chicago, IL: Rand McNally.
Sabatier, P. (1987) "Knowledge, policy oriented learning and policy change," *Knowledge: Creation, Diffusion, Utilization* 8: 4, 649–662.
Sabatier, P. and Jenkins-Smith, H. (eds) (1993) *Policy Change and Learning: an Advocacy Coalition Approach*, Boulder, CO: Westview Press.
Saberwal, V. (1997) "Science and the desiccationist discourse of the 20th Century," *Environment and History* 3: 309–343.
Sachs, W. (ed.) (1993) *Global Ecology: a New Arena of Political Conflict*, London: Zed, Halifax, Novia Scotia: Fernwood.
Satterthwaite, D. (1997) "Environmental transformations in cities as they get larger, wealthier and better managed," *The Geographical Journal* 163: 2, 216–224.
Sayer, A. (1997) "Essentialism, social constructivism, and beyond," *Sociological Review* 45: 453–477.
Sayer, A. (2000) *Realism and Social Science*, Thousand Oaks, CA: Sage.
Schaefer, W. (ed.) (1983) *Finalization in Science*, Dordrecht: Reidel.
Schiebinger, L. (1993) *Nature's Body: Gender in the Making of Modern Science*, Boston, MA: Beacon Press.
Schmidt-Vogt, D. (1998) "Defining degradation: the impacts of swidden on forests in northern Thailand," *Mountain Research and Development*, 18: 2, 135–149.
Schön, D. and Rein, M. (1994) *Frame Reflection: Towards the Resolution of Intractable Policy Controversies*, New York: Basic Books.
Schumm, S. (1991) *To Interpret the Earth: Ten Ways to be Wrong*, Cambridge: Cambridge University Press.
Schuurman, F. (1993) "Introduction: development theory in the 1990s," in Schuurman, F. (ed.) *Beyond the Impasse: New Directions in Development Theory*, London: Zed, pp. 1–18.
Schwarz, M. and Thompson, M. (1990) *Divided We Stand: Redefining Politics, Technology and Social Choice*, Hemel Hempstead: Harvester Wheatsheaf.
Scoones, I. (1994) *Living with Uncertainty: New Directions in Pastoral Development in Africa*, London: Intermediate Technology Publications.

Scoones, I. (1998) *Sustainable Rural Livelihoods: a Framework for Analysis*, IDS Working Paper 72, Brighton, UK: IDS.

Scoones, I. and Thompson, J. (eds) (1994) *Beyond Farmer First: Rural People's Knowledge, Agricultural Research and Extension Practice*, London: Intermediate Technology Publications.

Scott, J. (1985) *Weapons of the Weak: Everyday Forms of Peasant Resistance*, New Haven, CT: Yale University Press.

Scott, J. (1998) *Seeing Like a State: How Certain Schemes to Improve the Human Condition have Failed*, New Haven, CT: Yale University Press.

Searle, J. (1995) *The Construction of Social Reality*, New York Free Press.

Sears, P. (1959 [1935]) *Deserts on the March*, Norman, OK: University of Oklahoma Press.

Sears, P. (1964) "Ecology – a subversive subject," *Bioscience* 14: 7, 11–13.

Segerstråle, U. (ed.) (2000) *Beyond the Science Wars: the Missing Discourse About Science and Society*, Albany, NY: State University of New York Press.

Seligman, A. (1997) *The Problem of Trust*, Princeton, NJ: Princeton University Press.

Sen, A. (1981) *Poverty and Famines: an Essay on Entitlement and Deprivation*, Oxford: Clarendon Press.

Shackley, S. (1997) "The IPCC: consensual knowledge and global politics," *Global Environmental Change* 7: 1, 77–79.

Shackley, S. and Wynne, B. (1995) "Global climate change: the mutual construction of an emergent science–policy domain," *Science and Public Policy* 22: 218–230.

Shackley, S. and Wynne, B. (1996) "Representing uncertainty in global climate change science and policy: boundary-ordering devices and authority," *Science, Technology and Human Values* 21: 3, 275–302.

Shah, M. and Banerji, D. (2001) "India needs vigilance against discredited technologies: GM crops and the world market" *The Hindu*, Thursday, 20 December.

Shapin, S. (1994) *A Social History of Truth: Civility and Science in Seventeenth-Century England*, Chicago, IL: University of Chicago Press.

Shapin, S. (2001) "Proverbial economies: how an understanding of some linguistic and social features of common sense can throw light on more prestigious bodies of knowledge, science for example," *Social Studies of Science* 31: 5, 731–769.

Shapin, S. and Schaffer, S. (1985) *Leviathan and the Air Pump: Hobbes, Boyle and the Experimental Life*, Princeton, NJ: Princeton University Press.

Shepard, P. and McKinley, D. (eds) (1969) *The Subversive Science: Essays Toward an Ecology of Man*, Boston, MA: Houghton Mifflin.

Shiva, V. (1993) "The greening of the global reach," in Sachs, W. (ed.) *Global Ecology: a New Arena of Political Conflict*, London: Zed, Halifax, Novia Scotia: Fernwood, pp. 149–156.

Shiva, V. (1999) "The global campaign against biopiracy and changing the paradigm of agriculture," speech made to the *International Forum on Globalization*, Seattle IFG Teach-In, 26 November 1999 (http://gos.sbc.edu/s/shiva3.html).

Shrader-Frechette, K. and McCoy, E. (1994) "How the tail wags the dog: how value judgments determine ecological science," *Environmental Values* 3: 107–120.

Shrum, W., Chompalov, I., and Genuth, J. (2001) "Trust, conflict and performance in scientific collaborations," *Social Studies of Science* 31: 5, 681–730.

Sillitoe, P. (1993) "Losing ground? Soil loss and erosion in the highlands of Papua New Guinea," *Land Degradation and Rehabilitation* 5: 3, 179–190.

Sillitoe, P. (1998) "It's all in the mound: fertility management under stationary shifting cultivation in the Papua New Guinea highlands," *Mountain Research and Development* 18: 2, 123–134.

Silverman, D. (1993) *Interpreting Qualitative Data: Methods for Analysing Talk, Text and Interaction*, London: Sage.

Simon, J. and Kahn, H. (eds) (1984) *The Resourceful Earth: a Response to Global 2000*, Oxford: Blackwell.

Simpson, A. (1998) "Can democracy cope with biotechnology?" *Genetics Forum* December 1998/January 1999 (http://www.geneticsforum.org.uk/).

Simpson, G. (1960) "The world into which Darwin led us," *Science* 131: 966–974.

Sismondo, S. (1996) *Science Without Myth: On Constructions, Reality, and Social Knowledge*, Albany, NY: State University of New York Press.

Sivraramakrishnan, K. (2000) "State sciences and development histories: encoding local forest knowledge in Bengal," *Development and Change* 31: 61–89.

Sluijs, J. van der, Eijndhoven, J. van, Shackley, S., and Wynne, B. (1998) "Anchoring devices for science in policy: the case of consensus around climate sensitivity," *Social Studies of Science* 28: 2, 291–323.

Smith, P. (1988) *Discerning the Subject*, Minneapolis, MN: University of Minnesota Press.

Smith, R. (1996) "Sustainability and the rationalization of the environment," *Environmental Politics* 5: 1, 25–47.

Snow, C.P. (1961) *Science and Government*, Cambridge, MA: Harvard University Press.

Social Learning Group (2000a) *Learning to Manage Global Environmental Risks: vol. 1, A Comparative History of Social Responses to Climate Change, Ozone Depletion, and Acid Rain*, Cambridge, MA: MIT Press.

Social Learning Group (2000b) *Learning to Manage Global Environmental Risks: vol. 2, A Functional Analysis of Social Responses to Climate Change, Ozone Depletion, and Acid Rain*, Cambridge, MA: MIT Press.

Sokal, A. (1996) "Transgressing the boundaries: toward a transformative hermeneutics of quantum gravity," *Social Text* 46/47, 217–252.

Solbrig, O. (1993) "Ecological constraints to savanna land use," in Young, M. and Solbrig, O. (eds) *The World's Savannas: Economic Driving Forces, Ecological Constraints, and Policy Options for Sustainable Land Use*, Man and the Biosphere Series 12, Paris: UNESCO.

Soper, K. (1995) *What is Nature?* Oxford: Blackwell.

Soulé, M. (1995) "The social siege of nature," in Soulé, M. and Lease, G. (eds) *Reinventing Nature? Responses to Postmodern Deconstruction*, Washington, DC: Island Press, pp. 137–170.

Soulé, M. and Lease, G. (eds) (1995) *Reinventing Nature? Responses to Postmodern Deconstruction*, Washington, DC: Island Press.

Spaagaren, G. and Mol, A. (1992) "Sociology, environment and modernity," *Society and Natural Resources* 5: 4, 323–344.

Spivak, G.C. (1988) "Can the subaltern speak?," in Nelson, C. and Grossberg, L. (eds) *Marxism and the Interpretation of Culture*, London: Macmillan, pp. 271–313.

Star, S. and Griesemer, J. (1989) "Institutional ecology, 'translations,' and boundary objects: amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–1939," *Social Studies of Science* 19: 3, 387–420.

Stebbing, E. (1937) "The threat of the Sahara," *Journal of the Royal African Society* 36: 1–35.

Stehr, N. (1994) *Knowledge Societies*, Thousand Oaks, CA: Sage.

Steinbeck, J. (1983 [1939]) *The Grapes of Wrath*, London: Landmark Heinemann.

Stocking, M. (1996) "Soil erosion: breaking new ground," in Leach, M. and Mearns, R. (eds) *The Lie of the Land: Challenging Received Wisdom on the African Environment*, Oxford: Currey, pp. 140–154.

Stott, P. (1999) *Tropical Rain Forest: a Political Ecology of Hegemonic Mythmaking*, London: Institute of Economic Affairs.

Stott, P. and Sullivan, S. (eds) (2000) *Political Ecology: Science, Myth and Power*, London: Arnold.

Swyngedouw, E. (1999) "Modernity and hybridity: nature, *regeneracionismo*, and the production of the Spanish Waterscape, 1890–1930," *Annals of the Association of American Geographers* 89: 3, 443–465.

Szerszynski, B., Lash, S., and Wynne, B. (1996) "Introduction: ecology, realism and the social sciences," in Lash, S., Szerszynski, B., and Wynne, B. (eds) *Risk, Environment and Modernity: Towards a New Ecology*, London: Sage, pp. 1–26.

Tandon, Y. (1995) "Grassroots resistance to dominant land-use patterns in Southern Africa," in Taylor, B. (ed.) *Ecological Resistance Movements: the Global Emergence of Radical and Popular Environmentalism*, New York: State University Press, pp. 161–176.

Taylor, B. (ed.) (1995) *Ecological Resistance Movements: the Global Emergence of Radical and Popular Environmentalism*, New York: State University Press.

Taylor, P. and Buttel, F. (1992) "How do we know we have Global Environmental Problems? Science and the globalization of environmental discourse," *Geoforum* 23: 3, 405–416.

Taylor, P. and Garcia-Barrios, R. (1995) "The social analysis of ecological change: from systems to intersecting processes," *Social Science Information* 35: 5–30.

Tennant, N. (1997) *The Taming of the True*, Oxford: Clarendon.

Tesh, S. (2000) *Uncertain Hazards: Environmental Activists and Scientific Proof*, Ithaca, NY and London: Cornell University Press.

Tewdwr-Jones, M. and Allmendinger, P. (1998) "Deconstructing communicative rationality: a critique of Habermasian collaborative planning," *Environment and Planning A* 30: 11, 1975–1989.

Thomas, D. and Middleton, N. (1994) *Desertification: Exploding the Myth*, Chichester: Wiley.

Thompson, G. (1985) "New faces, new opportunities: the environment movement goes to business school," *Environment* 27: 4, 6–11, 30.

Thompson, M. (1989) "Commentary: from myths as falsehoods to myths as repositories of experience and wisdom," *Mountain Research and Development* 9: 2, 182–186.

Thompson, M. (1993) "Good science for public policy," *Journal of International Development* 5: 6, 669–679.

Thompson, M. (2000) "Understanding the impacts of global networks on local social, political and cultural values," vol. 42 of Engel, C. and Keller, K. (eds) *First Symposium of the German American Academic Council's Project: "Global Networks and Local Values," Dresden, 18–20 February 1999*, Baden-Baden: Nomos Verlagsgesellschaft.

Thompson, M., Ellis, R., and Wildavsky, A. (1990) *Cultural Theory*, Boulder, CO: Westview Press.

Thompson, M. and Rayner, S. (1998a) "Risk and governance part 1: the discourses of climate change," *Government and Opposition* 33: 2, 139–166.

Thompson, M. and Rayner, S. (1998b) "Risk and governance part 2: the discourses of climate change," *Government and Opposition* 33: 3, 330–354.

Thompson, M., Warburton, M., and Hatley, T. (1986) *Uncertainty on a Himalayan Scale: an Institutional Theory of Environmental Perception and a Strategic Framework for the Sustainable Development of the Himalayas*, London: Ethnographica, Milton Ash Publications.

Tiffen, M. and Mortimore, M., with Gichuki, F. (1994) *More People, Less Erosion? Environmental Recovery in Kenya*, Chichester: John Wiley.

Tol, R. and Dowlatabadi, H. (2001) "Vector-borne diseases, development and climate change," *Integrated Assessment* 2: 171–183.

Touraine, A. (1981) *The Voice and the Eye*, Cambridge: Cambridge University Press.

Trimble, S. (1983) "A sediment budget for Coon Creek basin in the Driftless area, Wisconsin 1853–1977," *American Journal of Science* 283: 454–474.

Trudgill, S. and Richards, K. (1997) "Environmental science and policy: generalizations and context sensitivity," *Transactions of the Institute of British Geographers* NS 22: 5–12.

Turnbull, D. (1991) "Local knowledge and 'absolute standards': A reply to Daly," *Social Studies of Science* 21: 3, 571–573.

Turner, B.L. II (2002) "Contested identities: human–environment geography and disciplinary implications in a restructuring academy," *Annals of the Association of American Geographers* 92: 1, 52–74.

Turner, B.L. II, Clark, W., Kates, R., Richards, J., Mathews, J., and Meyer, W. (eds) (1990) *The Earth Transformed by Human Action: Global and Regional Changes in the Biosphere over the Past 300 Years*, Cambridge: Cambridge University Press.

Turner, M. (1993) "Overstocking the range: a critical analysis of the environmental science of Sahelian pastoralism," *Economic Geography* 69: 4, 402–421.

Turner, S. (2001) "What is the problem with experts?" *Social Studies of Science* 31: 1, 123–149.

UNCED (United Nations Conference on Environment and Development) (1992) *Agenda 21 and the UNCED proceedings*, edited by Robinson, N.A. with Hassan, P. and Burhenne-Guikmin, F., under the auspices of The Commission on Environmental Law of the World Conservation Union – The International Union for the Conservation of Nature and Natural Resources (IUCN), Third Series, International Protection of the Environment, New York, London and Rome: Oceania Publications (in six volumes).

UNEP (United Nations Environment Program) (2001) *Cultural and Spiritual Values of Biodiversity: a Complementary Contribution to the Global Biodiversity Assessment*, edited by Posey, D. and the Oxford Centre for the Environment, Ethics and Society, Oxford University, Nairobi: UNEP.

UNFCCC/SBSTA (2000) (United Nations Framework Convention on Climate Change/Subsidiary Body on Scientific and Technological Advice), *Methodological Issues: Land Use, Land Cover Change, and Forestry: Draft Conclusions by the Chairman of the Subsidiary Body on Scientific and Technological Advice*, UNFCCC/SBSTA/2000/CRP.11, The Hague, November.

USCEQ (United States Council on Environmental Quality) (1980) *The Global 2000 Report to the President: Entering the Twenty-first Century*. A report pre-

pared by the Council on Environmental Quality and the Department of State: Washington, DC: Department of State.
USCSP (1999) *Climate Change: Mitigation, Vulnerability, and Adaptation in Developing and Transition Countries*, Washington, DC: USCSP.
USDA (US Department of Agricultural Research Service) (1961) *A Universal Equation for Predicting Rainfall-Erosion Losses,* USDA-ARS special report, pp. 22–26.
van Zwanenberg, P. and Millstone, E. (2000) "Beyond skeptical relativism: evaluating the social constructions of expert risk assessments," *Science, Technology and Human Values* 25: 3, 259–282.
Vayda, A. (1996) *Methods and Explanations in the Study of Human Actions and their Environmental Effects*, CIFOR/WWF Special Publication, Jakarta: World Wide Fund for Nature (Indonesia).
Vayda, A. and Walters, B. (1999) "Against political ecology," *Human Ecology* 27: 1, 167–179.
Vogel, S. (1996) *Against Nature: the Concept of Nature in Critical Theory*, Albany, NY: State University of New York Press.
Wade, W. (1997) "Greening the Bank: the struggle over the environment, 1970–1995," in Kapur, D., Lewis, J., and Webb, R. (eds), *The World Bank: its First Half Century*, vol. 2, Washington, DC: Brookings Institution, pp. 611–734.
Walker, P. (1962) "Terrace chronology and soil formation on the south coast of New South Wales," *Journal of Soil Science* 13: 178.
Wallerstein, I. (1999) "Ecology and capitalist costs of production: no exit," in Goldfrank, W., Goodman, D., and Szasz, A. (eds) *Ecology and the World System*, Westport, CT: Greenwood Press, pp. 3–12.
Wallner, H., Naraodoslawsky, M., and Moser, F. (1996) "Islands of sustainability: a bottom-up approach towards sustainable development," *Environment and Planning A* 28: 1763–1778.
Walters, B. (2001) "Event ecology in the Philippines: explaining mangrove planting and its environmental effects," paper presented at the 97th Annual Meeting of the American Association of Geographers, New York City, New York, 27 February–3 March.
Wapner, P. (1995) "Politics beyond the state: environmental activism and world civic politics," *World Politics* 47: 311–340.
Ward, B. and Dubos, R. (1972) *Only One Earth,* New York: Deutsch.
Ward, S. (1996) *Reconfiguring Truth: Postmodernism, Science Studies, and the Search for a New Model of Knowledge*, Lanham, BO, New York, London: Rowman and Littlefield.
Warren, A. and Agnew, C. (1988) *An Assessment of Desertification and Land Degradation in Arid and Semi-Arid Areas*, London: IIED and University College, London.
Watts, M. (1983) *Silent Violence: Food, Famine and Peasantry in Northern Nigeria*, Berkeley, CA: University of California Press.
Watts, M. and McCarthy, J. (1997) "Nature as artifice, nature as artefact: development, environment and modernity in the late twentieth century," in Lee, R. and Wills, J. (eds) *Geographies of Economies,* London: Arnold, pp. 71–86.
WCED (World Commission on Environment and Development) (1987) *Our Common Future,* New York: Oxford University Press.
Weinberg, A. (1963) "Criteria for scientific choice," *Minerva* 1: 159.
Weinberg, A. (1972) "Science and trans-science," *Minerva* X: 2, 209–222.

Weingart, P. (1999) "Scientific expertise and political accountability: paradoxes of science in politics," *Science and Public Policy* 26: 3, 151–161.
Wells, D. and Lynch, T. (2000) *The Political Ecologist*, Aldershot: Ashgate.
Westra, L. and Lawson, B. (2001) *Faces of Environmental Racism: Confronting Issues of Global Justice*, 2nd edn, Lanham, MD: Rowman and Littlefield.
White, R. (1980) *Land Use, Environment, and Social Change: the Shaping of Island Country, Washington*, Seattle, WA: University of Washington Press.
Whitmore, T. (1984) *Tropical Rain Forests of the Far East,* 2nd edn, Oxford: Clarendon Press.
Wiens, J. (1977) "On competition and variable environments," *American Scientist* 65: 590–597.
Wiesenthal, H. (1993) *Realism in Green Politics: Social Movements and Ecological Reform in Germany*, edited by J. Ferris, Manchester: Manchester University Press.
Wilbanks, T. and Kates, R. (1999) "Global change in local places: how scale matters," *Climatic Change* 43: 3, 601–628.
Wildavsky, A. (1995) *But Is It True? A Citizen's Guide to Environmental Health and Safety Issues*, Cambridge, MA: Harvard University Press.
Williams, J. (2001) *The Rise and Decline of Public Interest in Global Warming: Toward a Pragmatic Conception of Environmental Problems*, Huntingdon, NY: Nova.
Williams, W. (1958) "Conservation: is it important?" *Journal of the Institute of Biology* 5: 4, 86–88.
Wilson, A.N. (2000) "Sermons on science from a royal soaphox," *The Sunday Telegraph* 12 November, p. 42.
Wilson, W. (1896) "A commemorative address delivered on October 21, 1896," in Wilson, W. (1992) *Papers of Woodrow Wilson 1896–1898*, Princeton, NJ: Princeton University Press.
Wittfogel, K. (1956) "The hydraulic civilizations," in Thomas, W. (ed.) *Man's Role in Changing the Face of the Earth*, Chicago, IL: University of Chicago Press, pp. 152–164.
Wolf, E. (1972) "Ownership and political ecology," *Anthropological Quarterly* 45: 3, 201–205.
Woodgate, G. and Redclift, M. (1994) "Sociology and the environment: discordant discourse?" in Redclift, M. and Benton, T. (eds) *Social Theory and the Global Environment*, London: Routledge, pp. 51–66.
Woodgate, G. and Redclift, M. (1998) "From a 'sociology of nature' to environmental sociology: beyond social constructivism," *Environmental Values* 7: 3–24.
Worster, D. (1977) *Nature's Economy: a History of Ecological Ideas*, Cambridge: Cambridge University Press.
Worster, D. (1979) *Dust Bowl: the Southern Plains in the 1930s*, Oxford: Oxford University Press.
WRI (World Resources Institute) (1990) *A Guide to the Global Environment*, New York: Oxford University Press.
WRM (World Rainforest Movement) (2000) "Sinks that stink," *WRM Bulletin*, June.
Wu, J. and Loucks, O. (1995) "From balance of nature to hierarchical patch dynamics: a paradigm shift in ecology," *The Quarterly Review of Biology* 70: 4, 439–466.
Wynne, B. (1992a) "Misunderstood misunderstanding: social identities and public uptake of science," *Public Understanding of Science* 1: 3, 231–304.

Wynne, B. (1992b) "Uncertainty and environmental learning: reconceiving science and policy in the preventive paradigm," *Global Environmental Change* 2: 111–127.

Wynne, B. (1994) "Scientific knowledge and the global environment," in Redclift, M. and Benton, T. (eds) *Social Theory and the Global Environment*, London: Routledge, pp. 169–189.

Wynne, B. (1996a) "May the sheep safely graze? A reflexive view of the expert–lay knowledge divide," in Lash, S., Szerszynski, B., and Wynne, B. (eds) *Risk, Environment and Modernity*, London: Sage, pp. 44–83.

Wynne, B. (1996b) "SSK's identity parade: signing-up, off-and-on," *Social Studies of Science* 26: 2, 357–391.

Wynne, B. (1998) "Reply to Radder," *Social Studies of Science* 28: 2, 339–342.

Wynne, B. (2001) "Creating public alienation: expert cultures or risk and ethics on GMOs," *Science as Culture* 10: 4, 445–481.

Yearley, S. (1992) "Green ambivalence about science: legal–rational authority and the scientific legitimization of a social movement," *The British Journal of Sociology* 43: 4, 511–532.

Yearley, S. (1994) "Social movements and environmental change," in Redclift, M. and Benton, T. (eds) *Social Theory and the Global Environment*, London: Routledge, pp. 150–168.

Yearley, S. (1996) *Sociology, Environmentalism, Globalization*, London: Sage.

Zimmerer, K. (1994) "Human geography and the 'new ecology': the prospect and promise of integration," *Annals of the Association of American Geographers* 84: 1, 108–125.

Zimmerer, K. (1996a) "Discourses on soil loss in Bolivia," in Peet, R. and Watts, M. (eds) *Liberation Ecologies: Environment, Development, Social Movements*, London: Routledge, pp. 110–124.

Zimmerer, K. (1996b) "Ecology as cornerstone and chimera in human geography," in Earle, C., Matthewson, K., and Kenzer, M. (eds) *Concepts in Human Geography*, Lanham, MD: Rowman and Littlefield, pp. 161–188.

Zimmerer, K. (2000) "The reworking of conservation geographies: nonequilibrium landscape and nature–society hybrids," *Annals of the Association of American Geographers* 90: 2, 356–369.

Zimmerer, K. and Young, K. (eds) (1998) *Nature's Geography: New Lessons for Conservation in Developing Countries*, Madison, WI: University of Wisconsin Press.

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