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MANAGING GLOBAL CLIMATE CHANGE: A VIEW FROM THE SOCIAL AND DECISION SCIENCES

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Abstract

This report reviews the problem of decision making about global commons issues. It is contended that the range of such issues is being expanded by a social process of resource definition termed globalization. Global climate change due to emissions of CO_2 and other "greenhouse" gases is one such issue. The decision process is discussed first in terms of the two fundamental approaches to the problem, adaptation and prevention; and then in terms of three stereotypes of decision making styles, hierarchical or centralized, markets-oriented, and collectivist or consensus-oriented. It is pointed out that for this issue where there is great uncertainty about regional impacts and the stakes are very high, governments of different countries may perceive there to be winners as well as losers from global climate change. In these circumstances, effective climate-management decisions may not be made through formal treaties between nations, although such agreements may have significant symbolic value. Decisions may come rather from a process of both informal and formal interactions between people who have very different positions in society and points of view. Informal networks between scientists or environmentalists or power-system planners may lead to actions by various governments that are harmonious but not part of any international agreement. This kind of fuzzy consensus building may be the only way different cultures and decision making process preferences can be bridged.

CHAPTER 1

INTRODUCTION

More than a century has passed since the theory of what we now call the greenhouse effect was first promulgated by the French scientist, Jean Baptiste Fourier (Revelle 1985). At that time, the possibility of atmospheric warming by heat reradiated from the earth being trapped as in a hothouse excited no one. However, by 1924, the American biophysicist Alfred Lotka noted with concern that industrial processes were emitting ten times the amount of carbon dioxide that was produced in the natural process of breathing. Since the mid 1950s, especially following the International Geophysical Year of 1956-57, there has been increasing scientific concern about the potential for carbon dioxide and other trace gases to increase the ambient temperature of the planet by trapping the lower frequency reradiated heat in the earth's atmosphere (Clark 1986).

Thus, for more than a decade, scientists have pondered and debated the reality, implications, and urgency of the so-called greenhouse effect, especially in the light of continuing high levels of burning fossil fuels and rapid increases in the rate of global deforestation. Perhaps remarkably, in an era of elevated public and regulatory concern for the environment and human health, the issue largely has remained in the province of the scientific and technical community. The uncertainties inherent in modeling the complexities of the global climate system, the intricacies of atmospheric chemistry, the continuing uncertainties about the regional consequences (if any) of climate change, and the difficulties in identifying specific villains may have been factors that combined to displace the greenhouse effect from the policy

agenda in favor of more visible and tractable issues, such as acidic precipitation, nuclear energy, and toxic waste. However, in the last couple of years, changes in scientific knowledge, the expanding agenda of environmental public interest groups, and prominent world events have conjoined to place the issue of global climate change on the legislative agenda of the US Congress.

The Global Climate Protection Act, passed by the US Congress in 1987, cites growing scientific evidence that anthropogenic releases of carbon dioxide, chlorofluorocarbons, methane, and other trace gases into the atmosphere may be producing a long-term and substantial increase in the average temperature on earth. The act notes scientific concern about the effects of such changes on global weather patterns, influencing agricultural production and habitability, as well as effects on sea level due to thermal expansion of the oceans and partial melting of polar icecaps and glaciers.

The act charges the EPA with the tasks of summarizing for the Congress, by December 1989, the current international scientific understanding of the greenhouse effect and of identifying technical policy options for stabilizing the atmospheric concentration of greenhouse gases. However, the emphasis of the legislation is not merely on clarifying and summarizing scientific information about the greenhouse effect as the basis for Congressional action. Rather, the Global Climate Protection Act focuses on a related issue that has received only the scantest attention from the scientific community, which has dominated the greenhouse debate until now. The issue is the dual problem of how to achieve global agreement and coordinated action on any program to

stabilize the atmosphere, and how the US can decide on a national policy of its own that will contribute effectively to reaching international accord on global climate management.

Several factors seem to be involved in the emergence of the climate-change issue from the domain of science and technology researchers into the realm of policy makers. Not least of these factors is the very recent formation of a scientific consensus, albeit a fragile one, that indeed greenhouse gases have already contributed to a global warming trend that will continue if their discharge into the atmosphere continues unchecked. British researchers have combined temperature readings over land and oceans for the last 130 years to produce the first comprehensive estimates of global mean temperature. These readings reveal a distinct warming trend from about 1890 to the present (Jones et al 1986). The overall rise of about a half a degree celsius is consistent with the predictions made by the best greenhouse projections (Mathews 1987). Other research, based on temperature readings in the Alaskan Arctic permafrost, show a faster warming trend of two to four degrees celsius, which is consistent with theoretical predictions of warming at high latitudes being several times the global average (Lachenbruch and Marshall 1986). Furthermore, mean sea level has been measured over the last fifty years as rising at between two and two and a half millimeters per year, at least partly due to thermal expansion of seawater (Barnett 1984). The general consensus in the research community is that a greenhouse effect associated with a doubling of preindustrial levels of carbon dioxide would cause an average global surface temperature increase of between 1.5 and 4.5^{o}C, with the more recent estimates near the high

end of this range. At the current rate of emissions, an atmospheric commitment to such an increase is now expected as early as 2030, while commitment to warming between 0.9 to 2.6°C is predicted by the year 2000 (Mathews 1987). There is still widespread scientific uncertainty and disagreement among scientists about what the effects of such warming would be in different regions of the planet, but the fact that warming of two degrees celsius is beyond anything experienced in recorded human history is sufficient for most experts to agree that the possibilities for atmospheric stabilization are worth exploring.

Fragile scientific consensus alone may have been a necessary, but certainly not a sufficient condition for the present emergence of the greenhouse issue onto the Congressional legislative agenda; particularly in the form of the 1987 act's emphasis on the problems of developing international cooperation both to study the greenhouse effect and to limit global climate change. Independent of the development of scientific information about global warming, recent years have seen a social trend towards what we might term the globalization of environmental issues, and the redefinition of what hitherto were seen to be local or national resources as global commons.

Globalization occurs as the causes and effects of environmental problems that once were unrecognized or treated as small and local are viewed as large in scale or ramification, escalating to regional and, often, global dimensions. Worldwide concern over the potential extinction of endangered animal species represents an early manifestation of this phenomenon, and perhaps the best known. Whereas loss of a species once may have been observed locally with indifference or, in the

case of those classed as predators or vermin, with relief, it largely went unnoticed on the world stage. Alone, scientific concern about loss of species diversity was insufficient to stem human activities that were contributing to extinction, let to alone support national and regional rescue efforts. Species protection on a world scale only became a reality through a complex process of coalition building that involved national governments, scientific organizations, and grassroots environmental groups whose membership often is located a continent away from the species' natural habitat.

A similar process is currently at work with respect to tropical deforestation. A previously local issue has become regional as subsequent soil erosion causes silting of waterways in other countries downstream. The potential for loss of genetic diversity has become a concern of scientific and grassroots environmentalists worldwide. Hence, resources once treated as the property of local or national groups are being redefined beyond their own borders as global common property, to be managed by all humankind in its common interest.

Correspondingly, resources that hitherto have been regarded as open-access property, available without constraint to all comers, also are being redefined as global commons. Chief among these are the atmosphere and the oceans. It is our contention that this process of resource globalization has brought diverse constituencies and interests into the arena, to exert their claims to be legitimate stakeholders in any redefinition of the atmosphere that might move it from its present status, as an open-access resource, into global common management. From this standpoint, the recent treaty on protection of the ozone layer,

through control of fluorocarbon production, can be understood as the first step in a larger political process. Its very success in reaching agreement among diverse stakeholders, much wider than just the producing countries, can be interpreted as evidence of the larger political process that we describe. Although changes in scientific information about the greenhouse effect may have provided a necessary justification for the global climate issue to reach the Congressional agenda, we suggest that the political process of resource globalization is an equally important factor, particularly in understanding the Congressional emphasis on the decision making process and in answering the question "why just now?"

The globalization of resource and environment issues is not an isolated phenomenon. Rather it is one aspect of a ubiquitous expansion of interdependence that is the development of a global economic and technological system. The declining costs of transportation and communications since the second world war have contributed to the dramatic increase in the mobility of capital and technology.

Economic interdependence has been institutionalized to a considerable extent in a multitude of specialized agencies and forums (the EEC, GATT, World Bank, OECD, etc), and to a lesser extent with respect to technological development (IAEA, etc). But, as Harvey Brooks (1986) points out, the institutionalization of ecological interdependence lags far behind. The international institutions that do exist in this area are primarily scientific and technical in nature (WMO, UNEP, etc). Coordination of environmental and regulatory policy at an intergovernmental level is in its infancy. Where national governments do focus attention on common problems, such as acidic precipitation, often

as not, it is to dispute liability through challenging each other's scientific expertise.

Some scientists always will be more conservative than others about the weightiness and urgency of environmental problems or the wisdom of alternative corrective or regulatory policies. Governments and industries usually may be relied upon to favor those whose views correspond to their own perceptions of self interest. The ability of public-interest groups to harness scientific dissensus to their own agenda has been well documented in the United States and elsewhere (Douglas and Wildavsky 1982, Brickman et al 1985, Jasanoff 1986). However, despite the precedents set by the World Wildlife movement, the Nestlé boycott, etc. there has been relatively little attention paid to the process by which issues identified in the scientific community are communicated directly to grassroots organizations, which, in turn, drive those issues onto the legislative agenda of governments.

Ironically, these often are the same governments that financed the research in the first instance, but have tended to follow a conservative interpretation of the scientific results until forced to act by public pressure. From the viewpoint of scientific-technical rationality, such conservatism may be the most appropriate approach. We are not arguing here for a more interventionist role for government. Rather, we are speculating that the globalization of environmental issues, by an active and influential public constituency, has played an important role in bringing an issue that has been the object of intensive, international government-funded research for over a decade out of the hearing room and onto the legislative agenda of the United States.

answers, we raise the questions: Can independence survive interdependence? What are the implications of the related problems of international and intergenerational equity for sustainable global development? And, finally, does the concept of the global commons have any role to play in this or other international resource issue that may arise in the future?

CHAPTER 2

POLICY OPTIONS: ADAPTATION AND PREVENTION

A sensible place to begin an examination of the decision problems relating to global action on climate change is with the current conceptualization of the major policy alternatives as they are conceived by the scientific community that has been examining the greenhouse issue for some years. It has been observed (Ciborowski, Abrahamson, Geesaman 1984) or implied (World Climate Programme, Villach 1985; Golubev 1986; Schelling 1983) that the main division is between preventivists and adaptivists. That is, there is a dichotomy between those who call for action now (Doniger and Wirth 1986), to prevent climate change by curbing the industrial activities which cause the greenhouse effect, and those who accept anthropogenic climate change as inevitable, and recommend planning for adaptation to its effects (Golubev 1986).

Preventive strategies include reducing CO_2 and other greenhouse-gas production. One method is by changing land-use practices to maintain forests. More important methods include both conservation and replacing fossil fuels with other fuels, such as solar and nuclear (Lovins et al 1981). As part of, or an alternative to, these preventive measures, emissions could be decarbonized through energy-intensive technology (Pearce 1986), or carbon could be swept or removed from the atmosphere, for example, by growing and then fossilizing vast numbers of trees, perhaps by coating them in plastic (Baes et al 1980). The carbon from these measures would be sequestered deep underground or in the oceans, again through energy-intensive means. These latter measures are

sometimes referred to as mitigation, or melioration rather than as prevention (Kellog and Schware 1981).

Adaptive strategies could be of two major types. First, there are those aimed at making countervailing changes in climate, weather and and hydrology to counteract or counterbalance the changes generated by the greenhouse effect. For instance, weather could be changed by enhancing precipitation in target areas or modifying the course of hurricanes and tornadoes. Climate could be altered by putting other gases or particulates into the atmosphere, or by modifying albedo on the earth's surface. Hydrology could be modified or fundamentally transformed through small or great projects of water diversion. For example, water could be brought to the southwest from Lake Superior.

Second, there are those strategies directed to help people deal most effectively with the climate changes that cannot be avoided. Such strategies would include changing agricultural practices, developing new varieties of plants, changing dietary preferences, and changing water and land use regulations. This approach also would include changing the built environment, with its modes of construction, heating and cooling, systems of transportation, and health care. Migration to escape or to take advantage of a changed environment would be another adaptive strategy.

With all adaptive strategies there will be those who benefit and those who lose. Certainly, present generations, especially in some developed countries, may benefit by not curtailing fossil fuel use, but this could hurt future generations, perhaps especially in developing lands. In the future, almost everywhere, there will be some localities

and regions that will benefit by climate changes that penalize others. Adaptive strategies could include programs to redistribute wealth from winners to losers intranationally, internationally, and intergenerationally. Such measures could include taxing polluters in the present generation to pay for adaptations in the future (Nordhaus 1977; TCWP 1986).

This is a formidable array of possibilities, but it is not exhaustive. Many analysts share the view expressed in one National Academy Science Report (Carbon Dioxide Assessment Committee 1983) that the greenhouse climate change is a member of a class of complex problems with no solution in the sense that any single course of action can make the trouble disappear. These analysts will not search only for new actions, but will be willing to employ various combinations of preventive and adaptive approaches (Perry, et al. 1982). As Jessica Mathews (1987) points out, any realistic assessment of the situation requires adoption of a mixed strategy. Ultimately, continued doubling of atmospheric CO_2 will have to be curtailed for, logically, there must be some limits to adaptation. The dispute really is over how soon we will have to switch from adaptation to prevention. Similarly, however offended core preventivists may be by the prospect of adaptation, we are already committed to some atmospheric change. The question really is about how much adaptation ought we to tolerate. The debate is ethical as much as scientific.

Some of the measures that could be included in a hybrid approach would likely be rejected by fundamentalist supporters of either strategy. For example, although prevention could technologically include a nuclear

energy option, ideologically, core preventivists would reject it, just as they would probably reject mitigation (and certainly rebel at countervailing weather modification). For them a low climate-risk scenario is synonymous with a soft-energy path of using solar renewables and conservation, and is advocated as an end in itself (Lovins et al 1981).

For core adaptivists, the only realistic course is to prepare to adapt internationally, regionally and locally to climate change because nations will not pay the high costs of energy control (Golubev 1986). In support of the adaptivists' position, it has been argued that it is futile to expect that the coal-rich nations of China, the USSR and the USA will take heroic measures to curb their use of this resource (Schelling 1983).

The fact that people are committed to such varied positions reminds us that what is at issue is not simply choosing the right mix of technology and technique. The strategies, as presented, may sound chiefly like problems in technology and technique, but they arise in the context of broader sociocultural debates.

These different strategies seem to flow from different basic cosmologies, or world views. The preventivists focus on the vulnerability of the fragile ecosystem to the pollutants of industrial society, and the vulnerability of humans to climate change. They say that prudence lies in avoiding possible catastrophe by using energy and other resources in ways that, in any event, are more economical, more environmentally benign, and more socially acceptable.

The adaptivists emphasize not only the resilience of environment and the ability of humans to adapt situationally and locally to the dangers but, also, the opportunities in climate change. They advise actions to keep open rather than close options for continued adaptation in the future.

The preventivist-adaptivist dichotomy is not unique to the greenhouse climate change issue; it has much in common with the polar orientations that have informed debates over environmental protection, energy futures, and limits to growth. Stephen Cotgrove (1982) describes these orientations as catastrophist and cornucopian respectively.

The terms each refer to a contrasting orientation to nature. Catastrophists, including most but not all radical environmentalists, view nature as a fragile system, vulnerable to untrammelled exploitation by technological society, which is in danger of pushing the global ecosystem beyond absolute limits to development. In contrast, cornucopians, who include most industrialists, regard nature as an infinitely flexible resource that can be harnessed by technology, limited only by mankind's ingenuity. Although these are extreme viewpoints, and most people probably lie somewhere in between, they do seem to represent a reasonable approximation of different ways of viewing the world that are found by social scientists using diverse research methods and explanatory paradigms. For example, proponents of the cultural approach to risk analysis have found that cornucopian views tend to predominate in market organizations, while egalitarian groups tend to be catastrophist (Douglas and Wildavsky 1982). Hierarchical or bureaucratic organizations tend to

favor the view that nature is capable of sustainable development, given proper management by appropriate institutions.

Our purpose here is not to argue for any of these viewpoints, but to suggest that the scientific controversy over policy options reflects broader societal concerns of scientists as citizens, as much as it reflects technical considerations. There is a considerable literature in the sociology of science which suggests that the different orientations of scientists to nature and to the activity of science itself is related somewhat to their educational and disciplinary backgrounds, but mainly to variations in the social organization of the laboratories and other institutions in which they work (Bloor and Bloor 1982, Barnes and Edge 1982, Bloomfield 1986, Rudwick 1982, etc.)

How much difference does the cultural shaping of science matter? The answer appears to lie in the kind of science being done and, particularly, the maturity of any consensus that is reached among practitioners from different institutional or national scientific cultures. Funtowicz and Ravetz (1985) have described three kinds of science predicated by two variables, <u>systems uncertainty</u> and <u>decision stakes</u>. Whereas systems uncertainty contains the elements of inexactness, uncertainty, and ignorance encountered in technical studies, decision stakes involves the costs and benefits of the various policy options to all interested parties. This model generates three kinds of science, each with its own style of risk assessment (Figure 2.1).

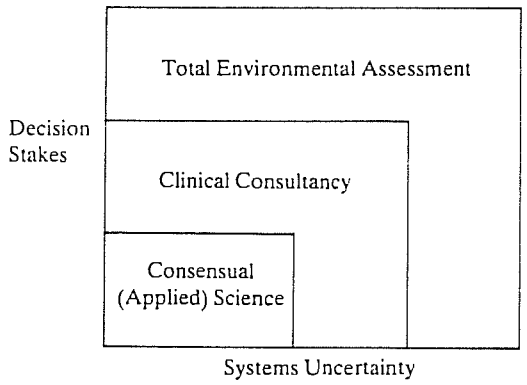

Figure 2.1 Funtowicz and Ravetz's three kinds of science

Low systems uncertainty and decision stakes describe situations in which data bases are large and reliable, and the technical community largely agrees on appropriate methods of investigation. Funtowicz and Ravetz call this applied science. We prefer the term consensual science because the adjective applied is commonly used to describe scientific activities that are designed to produce information for practical technical purposes, even where decision stakes and systems uncertainty are higher. The consensus referred to here is achieved, in part, by the low decision stakes. Controversies about scientific facts are unlikely to be heated where the symbolic loads that such facts carry are either well established or unimportant. Knowledge is likely to have a very strong component of natural feedback based on long-term practical interaction between the social systems represented here and the nonhuman

universe. The variations in perspective on risk derived by differing cultural perspectives are likely to be minor within this framework.

When both systems uncertainty and decision stakes are considerable, but professional expertise is still a useful guide to action, Funtowicz and Ravetz define a different style of activity, the clinical mode of technical consultancy. This kind of activity involves the use of quantitative tools, supplemented explicitly by experienced qualitative judgment. The exercise of this judgment increases the decision stakes for the consulting scientist and begins to bring to the fore differences of interpretation rooted in perhaps competing institutional, educational, and disciplinary cultures. There is some kind of unstable balance or alternation of overdetermination between natural feedback and cultural constraints on the knowledge process throughout this kind of activity.

Finally, when decision stakes and systems uncertainty are very high, Funtowicz and Ravetz present us with a scientific style they term total environmental assessment. This kind of activity is permeated by qualitative judgments and value commitments. Inquiry, even into technical questions takes the form largely of a dialogue, which may be in an advocacy or even an adversary mode. Although the proportion of risk assessments that fall into this mode is only a tiny proportion of the whole, they are often those of greatest political significance. As the authors of this typology note, total environmental assessment provides the most plausible opportunity for the variation in cultural perspective.

There are certain parallels between these three kinds of science and Weinberg's (1972) distinction between science and trans-science. It is instructive to note these in passing, partly to clarify the Funtowicz-

Ravetz model, and partly to emphasize that although natural feedback and cultural constraint may predominate at opposite ends of the knowledge spectrum, neither element will ever be entirely absent.

Initially, Weinberg distinguishes trans-scientific questions as those that attempt to deal with social problems through the procedures of science, yet cannot be answered by science. In other words, these are the culturally overdetermined (social) questions, as distinct from the questions that can be answered by manipulating information that is overdetermined by natural sources and that Weinberg, therefore, calls scientific. To his great credit, Weinberg recognizes the fuzziness of the boundary between these two types of activity. Only those with the proper credentials are allowed to participate - questions of propriety, of course, have little to do with whether a question can be answered by science in principle. Further into his argument, Weinberg seems to be saying that science is consensual knowledge arrived at through criticism, while trans-science is preconsensual criticism, beset by uncertainty, that may or may not at some future point converge on an agreed solution. Or, in cultural terms, trans-science is where cultural variation is dominant, science is where cross-cultural concensus about knowledge has been achieved, and confirmed by natural feedback. The fuzzy boundary corresponds to the clinical mode of Funtowicz and Ravetz.

The global coordination of scientific research into the climate change program represents a deliberate effort to move the climate issue closer to the origin on Funtowicz and Ravetz's graph (Figure 2.1). It is unsurprising for such a complex issue that there has been wide variation in the success of consensus building. Efforts such as the International

Geosphere-Biosphere Program (IGBP) represent attempts to force the pace of scientific consensus building by reducing uncertainties. The inclusion of scientists from many different countries and from diverse institutions may go a long way toward reducing the decision stakes for individual researchers or research teams, and assist rapid convergence on models and theories that are sufficiently robust to survive scrutiny from many different scientific cultures.

In these respects, the current trend toward global coordination of scientific effort promises to be of great benefit to efforts at global policy making. A mature scientific consensus undoubtedly would assist the formation of a global consensus on management strategies; although it would not guarantee it, of course. However, amid so much optimism, someone needs to play Casssandra and sound a note of caution. A difficulty to be overcome is knowing when a mature consensus has been reached. An initial perception of the climate issue as requiring urgent action may encourage the formation of an early, but seriously flawed picture. On the other hand, demands for time to ensure the robustness of the picture may allow the global community to commit itself to a level of warming that subsequently proves to be unacceptable.

Rapid convergence on a scientific consensus risks the early elimination of models that seem unpromising in their first formulations but may have proved invaluable given time to mature. Criticism of the consensus from the viewpoint of such models becomes impossible once they have been eliminated from serious contention by a centrally coordinated program. Independent work on heretical propositions is unlikely when major funding is contingent upon participation in a centralized or

tightly coordinated program. The opportunities for serendipitous discovery are thus reduced. Centralized program planners are prone to rational attempts at reducing redundancy of scientific effort. Although this may free resources for inquiry in other relevant fields, loss of redundancy reduces the error-finding capacity of the overall effort and, thus, may defeat the overall aim of resilience and robustness of the forced consensus.

This argument should not be interpreted as a dismissal of the IGBP nor of globally coordinated scientific action. It is rather an expression of concern that in the pursuit of rational objectives through rational means we do not lose sight of the benefits of muddling through. The realities of global politics, in any case, militate against the likelihood that any such rational scientific consensus could be translated directly into a global management strategy.

Of course, scientists are not unique in the cultural shaping of their ideas about the natural world. We all have views of nature that appear to be strongly related to our social experience, especially of the organizations in which we spend most of our daily lives (Douglas 1978, Gross and Rayner 1985, Mars 1982). The more uncertainty one has about an issue, and the higher the stakes involved in making a decision (Funtowicz and Ravetz 1985), the more we are likely to fall back on our basic convictions about the moral order of the universe, and interpret whatever scientific information we have in that light. Although scientists may reduce uncertainties, the decision stakes for everyone will remain high. The consequences of the greenhouse effect, therefore, form a perfect

issue around which protagonists can construct a debate about their rival views of what constitutes a proper global order.

It is difficult to overstate the gravity of this situation for global decision making over climate change. As the debate moves from scientific meetings to more overtly political arenas, the less it will be constrained by the conventions that unify scientific discourse, despite the inescapable cultural bias of scientists, and the more weight will be thrown behind rival moral preferences for procedures and outcomes. The obvious solution would be that adopted by conventional risk analysis as espoused by the National Academy of Science (NAS 1983); that is, to separate the scientific fact finding from the political-ethical evaluation of risk in the decision making process.

Alas, as with conventional risk analysis, the solution is no solution at all. Even if the sociologists of science were mistaken in attributing an inescapable bias to the production of scientific information under conditions of uncertainty, the protagonists in the public and political arena of policy making still would be sufficiently inventive to mold that information to fit their diverse preferences for how the world should be. Ultimately, global environmental management will be a political process and any scientific consensus about preventive, adaptive, or hybrid strategies will require sociocultural processes to be implemented.

Implicitly, this fact was recognized by the participants in the 1985 Villach meeting on climate change, who recommended that the "widest range of social responses aimed at preventing or adapting to climate change should be identified, analyzed, and evaluated" (World Climate Program

1985). Unfortunately, the social responses, the decision framework, the sociocultural and political dimensions of the problem, have yet to receive much attention. Across the world, the dominant research strategy has been to concentrate almost exclusively on researching the biophysical facts of the greenhouse effect and potential climate change.

CHAPTER 3

THE CONVENTIONAL APPROACH TO GLOBAL DECISION MAKING

Considerable effort currently is being expended by national and international bodies on reducing uncertainties in the models of anticipated atmospheric changes and on devising novel technical and policy options to prevent or mitigate their impacts. Often, scientists addressing climate change frame their research as efforts to determine the biophysical or ecological sustainability of existing technologies and patterns of resource use and economic development. But, it is necessary also to consider the sociocultural sustainability of ways to choose and implement policy alternatives.

This is a major decision-making problem for any means by which the global community will decide which of the competing predictions about climate change to act upon, as well as to choose between diverse policy options for prevention or mitigation. The challenge is to manage resources common to peoples of different societies and cultures, so that individual uses and actions lead to outcomes acceptable to all.

Despite its magnitude, little effort is being expended on this decision-making problem. The same neglect already besets the problems of managing acidic precipitation and soil erosion, where the technical uncertainties and decision stakes are lower. However, among those who have begun to examine the problem of managing the global commons, there are already two, quite different, views regarding how such decisions might be made. The more conventional of these is the subject of this chapter; a quite different orientation is described in chapter six.

The conventional view is derived chiefly from mainstream political science and neoclassical models of rational choice in economics. This view probably represents the dominant assumptions of governments and their political and scientific advisors. According to this view, global commons-management decisions, eg. to limit the consumption of fossil fuels, will follow rationally from the results of a careful analysis of various options for preventing or adapting to expected environmental changes.

Such an analysis would follow the conventional lines of risk analysis, involving cost-benefit estimates for each course of action being considered, with appropriate allowances for uncertainties in the probabilities and magnitudes of each outcome. The weights and values assigned to each perceived good and bad effect would be assigned by the analyst, reflecting his own knowledge and preferences. It is assumed that international action on the problem will reflect this rational technical assessment in the form of regional and global treaties that will be self policed by the nation states that are their signatories.

According to Norman Myers, who describes himself as an international ecology consultant (1985a), nation states hold the key to an environmentally and economically satisfactory future across the globe. Nations can help to achieve this future by mobilizing the political will to eliminate root problems that spread to become national and global environmental disasters. For example, he praises China for exercising its political will to enforce fertility control, thereby improving the standard of living for its stabilizing population. In contrast, he complains that political leaders in Black African nations have not

committed themselves to curb population growth. In a fashion typical of the globalizing ecologists, Myers then traces a chain of consequences leading to everspreading resource degradation. Overpopulation leads to overuse of lands and forests which leads to desertification, deforestation and degradation of regional watersheds. These regional catastrophes have wide reaching effects. Deforestation eliminates genetic resources that Africans could use for economic growth, and that the world community needs to produce adaptive new foods, medicines, and materials. Desertification and deforestation, he suggests, also contribute to global climate change.

How does a nation or a continent decide to exercise its political will to build ecologically sustainable development? There are a number of influences at work in these issues. Though the global ecologists picture ecological interdependence as self-evident, they nevertheless work very hard to warn people and their political leaders of ecological ruin if practices are not changed, and of a brighter future (Myers 1985b) if they are changed.

As an extension of this construction of culture, the environmentalist network has sought to persuade national and international development organizations, such as the World Bank and multinational corporations, to use their leverage to help institutionalize environmental protection. Presumably, national leaders in less-developed countries (LDCs) find the coupling of material aid to enviromental protection measures to be a strong inducement to apply those measures. Finally, and most conventionally, nations become officially obligated to participate in programs of environmental protection by

agreeing to international treaties; for instance, compacts to curb the use of ozone-depleting chlorofluorocarbons.

The process leading to the (1986) Vienna Convention on Protection of the Ozone Layer and the subsequent protocol signed in Montreal, often is cited by atmospheric scientists and government policy makers as the model for a future international agreement on the management of greenhouse gases. However, without demeaning the political and diplomatic achievements of getting a treaty at all, and ignoring for a moment the efficacy of the reductions called for in Montreal, the problem of CFC regulation is in any case of a qualitatively different order of complexity from that of managing CO_2 and methane.

CFC production is highly concentrated in a handful of American and European corporations that would be relatively easy to monitor for compliance. There are reasonable prospects that acceptable substitutes for ozone-depleting CFCs can be made available readily. Furthermore, global ozone depletion benefits no one and may harm everyone. It is worth noting that tropical nations initially were cool towards proposed CFC controls as their populations are less susceptible to skin cancer than those of temperate regions. However, they are more prone to cataracts, which also would increase in incidence as a result of increased UV light at the earth's surface.

The greenhouse effect, on the other hand, may be seen by some to bring benefits to regions of the earth that presently suffer from short growing cycles or ice-bound waterways and harbors. Production of greenhouse gases is more ubiquitous than CFCs, and involves agricultural (eg. rice cultivation) as well as industrial processes. Suggestions that

the greenhouse effect could be managed by the unilateral action of only four or five industrial federations may prove unrealistic in their assessment of the complexity of the problem, and certainly they ignore the phenomenon of globalization and the expansion of stakeholder claims.

Despite these difficulties, the national political-will approach of the global possibilists would follow the methods used in conventional decision making in the United States and Western Europe. A series of specialists identify a problem, assess the costs and benefits of various courses of action, and recommend a priority ordering of responses. From this, official decision makers select the option they consider best. To solve problems across nations, these procedures would be followed nation by nation. This approach accords with the theories of the realist political scientists (Morgenthau 1967, Waltz 1959, 1979) who argue that sovereign states comprise the main decision making bodies of the world community. States will cooperate with others only if they believe that their national interest is served.

Yet, for all of the acknowledged strengths of this possibilist nation-by-nation approach, weaknesses are apparent. One is that national decision makers do not accept uniformly the global possibilists' interpretation of problems or solutions. National leaders are aware that scientists differ among themselves about the causes and effects of major environmental problems, about the timetables within which decisions must be made, and about the likelihood that suggested remedies are feasible.

Additionally, the nation-by-nation approach of the possibilists displays an underdeveloped sense of the influence of culture and socio-cultural variation on the implementation of political will. For example,

if social scientists collaborated with Myers and his environmental science colleagues, they might well point out that the population control measures that the People's Republic of China can manage, given its national political culture, is different from what Kenya could manage. The steps that capitalist-oriented Kenya takes to control land use will be different from the measures that socialist Tanzania finds preferable. And just as these countries vary in their national, public, and political cultures, so it is that within nations there are many sub-cultures; many different constituencies or social groups, each with its particular cultural orientation.

In addition, people organize in groups around interests and occupations. Examples pertinent to environmental issues include groups of government officials, corporate executives, environmental activists, and scientists. Groups may be divided further into schools of thought; for example, within the scientific community, not all environmental scientists share the global- possibilist perspective. In any event, each of these groups can be said to have a particular institutional culture that has a distinctive adaptive or interpretive cosmological dimension. Among these cosmological divergences we include the cornucopian and catastrophist orientations to nature, which manifest themselves in the climate-change debate as adaptivist and preventivist strategies described in chapter two. These various institutional cultures contribute to the cultural pool (Goodenough 1971) of a nation, or indeed of the world, and are to be distinguished from the national public culture.

Therefore, considering the variety of cultural divisions within each nation, it is not enough for political leaders simply to propose action

based on ecologists' models of what nature demands, or on what policy specialists have decided is most rational according to universalistic criteria. It is necessary for decision makers to adapt their plans to fit cultural realities constraining preferences for processes as well as the realities of perceived self interest that shape preferences for the outcomes of global decision making. Such adaptation requires that we recognize the variety of actors claiming to be stakeholders in the climate-change debate.

The definition of stakeholder here is, of necessity, a broad one. We make no attempt to distinguish legitimate claims to be stakeholders from illegitimate ones; since criteria for legitimacy are themselves culturally constructed. For the purposes of our discussions, the role of stakeholder is self-defined. Any constituency claiming a role in the decision process and capable of mobilizing resources to intervene is included in our definition, even if its legitimacy is disputed by other participants in the process. In the following chapter we identify the major types of stakeholder in the climate-change issue, and their roles in the decision making process. This is followed in chapter five by a discussion of their decision making cultures.

CHAPTER 4

WHO ARE THE STAKEHOLDERS IN THE CLIMATE MANAGEMENT DEBATE?

The greenhouse climate change issue is a member of a class of problems that have no simple or elegant solution in the sense that any single course of action can be agreed upon to resolve the problem. There are too many uncertainties, too much unpredictability, and solutions cause new problems. Organizational action generates undesired reaction. This accords with the definition of a "turbulent field" advanced by Emery and Trist (1965, 1973). Turbulent fields are those socioecological environments in which resources and constraints change constantly, and organizations react to one another in conflict and cooperation. Emery and Trist argue that one effective strategy for coping with turbulence is the development of "organizational matrices," or interface organizations "that will maximize cooperation while still recognizing that no one organization could take over the role of the other." Who are the stakeholders that constitute the networks or matrices that would be involved in managing such turbulent fields as the greenhouse climate change issue?

The stakeholders presently active in the greenhouse climate change field are many, and they operate at national and transnational levels. They include government organizations, intergovernmental organizations, non-governmental organizations (NGOs), and corporations and voluntary groups. Each is institutionalized, but with greatly varying degrees of formality and official recognition. These stakeholders usefully can be

However, government organizations are not homogeneous. Members are divided in the approach they take to the greenhouse effect and its management. It is not clear that this follows party lines in any simple fashion, or that the bifurcations always run neatly along the preventivist-adaptivist fracture.

In the Federal Republic of Germany (FRG), the Green Party generally advocates prevention now through rapid societal conversion to a low climate-risk, soft-energy path. This preference accords with their customary critique of hard- path, industrial technology. But it is not clear that the Social Democrats will agree with this approach or that the rival Christian Democrats will categorically opt for adaptation. Even Green Party members, once they assume positions of decision making and policy implementation, often divide on social and economic matters. Some call for adaptation to the realities of running a modern industrial society, and some demand adherence to a purist ideology of egalitarianism and environmentalism (Mewes 1986).

In the USA, some indication of intragovernmental differences is found in the proceedings (Titus 1986) of an June 1986 conference sponsored jointly by the United States Environmental Protection Agency (EPA) and the United Nations Environment Programme (UNEP). Among those presenting papers or remarks were officials in the EPA and in the State Department. These officials all emphasized the importance of separating the process of risk assessment (determining the facts of and degree of risk) from the process of risk management (making policy decisions about what to do to deal with the risks) reflecting the Reagan Administration's apparent policy (Caldwell 1984) that it is best to be cautious about

assuming that there are environmental risks demanding action which might slow economic growth. They urge the "nations of the world" to develop a common understanding of the problem before they sit down together to find a common solution (Thomas 1986).

In contrast, a US senator at the conference (Chafee 1986) warned against "sticking to a wait and see approach." He urged the USA to take the lead in curbing the buildup of greenhouse gases, even if it must act unilaterally. He felt the sacrifice would be only temporary, since other nations would follow the US initiative. Another senator (Gore 1986) proposed an International Year on the Greenhouse Effect for domestic and international research on both the scientific and policy aspects of the problem.

Richard E. Benedick, then US Deputy of State for Environment, Health and Natural Resources, explains in his address to the joint conference that to deal with global environmental problems, such as depletion of the ozone layer and greenhouse-induced climate change, demands entering uncharted territory. In this territory, governments interacting conventionally cannot come up with solutions. Benedick observes that governments are relatively well equipped to deal with transboundary environmental problems where one nation can be identified as the polluter and the other as polluted. This is not the case in the greenhouse climate-change field. In this field, Benedick asserts, the international community needs a new paradigm. He indicates that this international community includes both governmental and intergovernmental bodies, and points to the possibilities of discovering new paradigms by considering

how these bodies have been collaborating thus far in developing international protocols to protect the ozone layer.

Intergovernmental Organizations

Like Benedick, climatologist William W. Kellog and political scientist Robert Schware explain that nations cannot rely on international law to resolve suits of injury or damage caused by climate change. They look to a variety of international "organizations for environmental cooperation" to find mechanisms that might evolve to handle these and other problems of the greenhouse effect (Kellog and Schware 1981). One of these, the World Meteorological Organization (WMO) was founded in 1873 and since 1951 has operated as one of the United Nations' specialized intergovernmental agencies. The WMO collaborates with many other organizations, governmental, intergovernmental, and extragovernmental. For example, the WMO collaborated with UNEP and with the International Council of Scientific Unions (ICSU) to organize the 1980 and 1985 conferences at Villach, Austria on the greenhouse climate change issue.

Among the many other intergovernmental organizations that, in fact or potentially, work in the climate risk domain are regional organizations, such as the Council of European Communities, the Organization for Economic Cooperation and Development, the Council for Mutual Economic Aid, the Association of Southeast Asian Nations, and the Latin America Free Trade Association (Kellog and Schware 1981). These organizations can establish committees or task forces to focus on atmospheric and climate change problems. The Council of European

Communities has established a European Climate Programme similar to the US National Climate Program. Nations, through their national academies of science, contribute to climate research internationally as well as nationally. For example, they cooperate through the International Institute for Applied Systems Analysis (IIASA) in the International Biosphere Program (Clark and Munn 1986).

International commissions operate as another important type of intergovernmental body. Examples include conciliation commissions, arbitrating tribunals, and commissions of inquiry. Kellog and Schware suggest that these may function as useful ad hoc devices to arbitrate or mediate carbon dioxide impact disputes, or to gather expert opinions on related controversial legal, political, or scientific matters. Of course, international conferences and workshops also function as nodes in bringing these various organizations together. Comprehensive treatments of the many institutions and organizations working intergovernmentally in environmental cooperation activities are described by Lynton Caldwell (1984) and Jan Schneider (1979).

In accomplishing their particular functions, these organizations spin webs of cooperation. The way in which a study conducted by Kellog and Schware entitled Climate Change and Society; Consequences of Increasing Atmospheric Carbon Dioxide was organized and supported provides a useful illustration of this cooperation.

Climate Change and Society was prepared under the auspices of the Aspen Institute for Humanistic Studies Program on Food, Climate and the World's Future. Following a workshop in 1974 at the University of Bonn, West Germany, the Climate Program of the International Federation of

Institutes for Advanced Studies (IFIAS) originated this extragovernmental organization. In 1978, WMO and UNEP sponsored another workshop on this subject at the Aspen Institute in Colorado. Aspen Institute has branches in various parts of the world and some of its officers and participants move in and out of positions in governmental and intergovernmental organizations. At this workshop, a group of experts explored the prospects of carbon dioxide warming and recommended the study later prepared by Kellog and Schware.

The Department of Energy sent representatives to this latter workshop and became the principal sponsor of the study. Additional support has come from private foundations, both in the USA and in Europe, NASA, and the Aspen Institute offices in the USA and in Berlin. The researchers give credit to the advice and guidance received from a Steering Committee that included distinguished scholars, university and corporation presidents, and members of the US Congress. In short, the project is a product of the interaction of governmental, intergovernmental and nongovernmental organizations.

Nongovernmental Organizations

Nongovernmental organizations involved in the greenhouse climate change field are more numerous and diffuse than the governmental and intergovernmental organizations. Some are official organizations. Some are ad hoc, spontaneous, and temporary, as is characteristic of groups at the cutting edge of social movements and societal change.

Peter Willetts (1982) offers a comprehensive typology of the non-governmental organizations that act, often in cooperation, as pressure

groups in issues common across national borders. He distinguishes between sectional groups and promotional groups. Professional organizations are a sectional group, that is, a group that aims to protect or advance the economic or other interests of particular sections of society. He classifies scientists and technical experts as a type of professional organization. Other sectional groups include business, industrial or agricultural lobbies, trade unions, and recreational clubs.

Willetts classifies environmental groups as a special type of promotional organization, seeking to promote social causes rather than to secure material interests. Some other promotional groups are nongovernmental welfare agencies, attempting to address the problems of the world's needy; religious organizations, promoting values in order to facilitate secular change; and communal groups, organized to help segments of society protect and promote their unique identity or advance their position. "Communal" is a useful term for all those who have particular ethnic, linguistic, territorial, or other characteristics that make them consider themselves endangered minorities.

Willetts recognizes that this is an ideal-typical classification and that, in reality, groups cannot be so neatly placed. For instance, material and attitudinal motives often overlap, so that the boundary between the sectional and the promotional may be blurred.

The boundary certainly is blurred among segments in the environmental movement. This is seen in many actions to protest a particular facility siting, or use of land (Gerlach 1979, Mazur 1981). Some protest groups consist mainly of those whose chief motive is to protect the stakes they hold in their neighborhood, termed "not-in-my-

backyard" or NIMBY organizations (O'Hare 1977). As the struggle evolves, others join who are members of established environmental organizations whose universal mission is to promote environmental quality or to challenge and change industrial society. Of course, as protest events continue, NIMBY activists are likely to define their purposes according to this more universal environmentalist ideology, since they can claim to be speaking for the common good, rather than only for one special interest against other special interests.

The universal environmentalist ideology also provides the umbrella under which many kinds of groups can integrate, some of which have interests that are more parochial and human-centered than environmental (Tucker 1977). Religious organizations may pursue environmentalist or welfare goals. Communal groups seeking to protest their territorial integrity may resist local resource-development projects by expressing environmentalist ideology (Gerlach and Palmer 1981).

Willetts refers to all of these nongovernmental organizations as pressure groups, since they do operate in the political arena, pressuring governments and intergovernmental organizations to accommodate their interests. Such groups are very diverse. It is possible to range them along a continuum from relatively placid and conventional interest groups, to very active, expanding, and often radical movements. Groups can move along the continuum as they become increasingly dynamic, less willing to work within the system, and more interested in fundamentally changing it.

What is the relationship of groups along this continuum to the process of governing nations and conducting cooperative relationships to

manage global resources and equity? Willetts explains that while conventional political theorists agree that pressure groups play important roles in the domestic politics of countries, they are essentially irrelevant in international relations. It is argued that this is because national governments alone can mobilize power to promote their respective interests in this sphere. Realist political theorists claim that few, if any, nongovermental interactions between countries have been of significance.

Increasingly, however, it is recognized that there are an ever greater number of important relationships between societies that do bypass national governments. Willetts makes the customary distinctions between power, authority, and legitimacy, but extends these to the transnational level. He theorizes that while nations and national governments have the power to transact international affairs, this power must be legitimized through international public approval. It is increasingly the pressure groups and the nongovernmental groups that generate or withhold such legitimacy.

CHAPTER 5

THREE DECISION STYLES

It is conventional to classify or group the stakeholders discussed in the last chapter according to the type of function that they perform. For example, we usually are comfortable talking about governments, NGOs, developed countries, LDCs, scientific and technical organizations, treaty organizations, industrial and commercial corporations, etc. as if they are natural categories. That is to say, we expect all members of the same category to resemble each other in all important respects more than they resemble players in the other categories.

In chapter three, we referred to the distinctive cultures of nations and organizations as a basis for affiliation among them; that is to say, groups are likely to line up with one another according to important similarities in the ways that they process information and reach decisions. In this chapter, we will indicate some criteria for identifying three styles of decision making that are indicated by the economics, political science, and anthropological literatures as being potentially important for global commons management. These decision-making styles are known by a variety of terms, of which the most accessible probably are hierarchies, markets, and collectives.

Hierarchies

There is a well-established distinction between hierarchies and markets as the basic organizing principles of national economies and governments (Lindblom 1977). Societies that invest their policy decision-making capabilities in formal bureaucracies are displaying a

cultural preference for decision making according to explicit rules for the pursuit of agreed ends. Authority is granted to centralized decision makers to pursue those ends through administrative decisions based on instrumental rationality in such a way as to achieve these ends at the least social cost. Authority is the key component of these cultures. As Lindblom points out, it exists whenever people explicitly, or tacitly, permit someone else to make decisions for them for some category of acts. Consent in these systems need be given only to the legitimacy of the decision maker. Once that is granted, the citizen is deemed to consent to any of the decisions made by the competent authority, irrespective of whether the citizen likes any particular decision.

Markets

By way of contrast, societies that opt for market decision making are exhibiting a different conception of how to serve the public good. Following Adam Smith rather than Thomas Hobbes, these cultures prefer the principle of the hidden hand, preserving the general interest through the rational pursuit of enlightened self interest by individuals. Market power rather than authority nominates decision makers, and willingness to pay rather than legitimacy is the key to consent.

This dichotomy has dominated economics and political science throughout their histories. Indeed, Lindblom points out that concern with government, or hierarchy, has dominated political science while economics (at least the neoclassical school) has defined itself as concerned with markets. It is interesting to reflect that, at least until recently, both disciplines have concerned themselves with the

climate change, as adaptation provides many more opportunities for the exercise of individual choice than prevention or sustainable development. The greatest concentration of preventivists may well be found in collectivist organizations, since their egalitarianism leads them to eschew risks that carry uneven distributions of costs and benefits, such as those that would result from northerly shifts in temperate agricultural zones. It would not be surprising to find sustainable development strategies favored by bureaucratic hierarchies, since one of their primary driving values is the maintenance of stable systems (Rayner 1984).

These organizational cultures may or may not be related to the instrumental mission of the organization. For example, at least at one level, environmental activists in the USA are much like those in West Germany and the United Kingdom. They have a common basis on which to act, and all tend towards egalitarian collectivism (Willetts 1982, Livingstone 1977). Likewise, personnel in industries challenged by activists in the USA are much like their counterparts in the Federal Republic of Germany and the United Kingdom. Similarly, various scientific institutions across the world share common institutional cultures, even though they vary on their national cultures. However, regulatory agencies in Britain tend to be authoritarian and hierarchical, regulating paternalistically, while those in the US operate confrontationally and closer to market principles, regulating according to political demand (Jasanoff 1986).

National differences occur because no matter how much the various constituencies in a process of science and technology decision making are

shaped by their particular adaptive strategies and tasks, they also are operating in, and from, a larger cultural context. They are products of their larger society and its culture - what Goodenough (1971) calls a public culture. In our terms, British corporations may tend to be more hierarchical than American, which are strongly influenced by decentralized, market, and egalitarian forms of organization. Certainly, until recently, market processes have not been admired publicly in cultural hierarchies like the USSR. However, America too has its ossified bureaucracies. Egalitarian collectivists trumpet their causes in Europe, while Soviet and Chinese leaders attempt to harness entrepreneurial talents to their cause. It is the particular mixture of institutional cultures that gives each country its characteristic national cultural flavor, a particular preference for the German, British, French, or American way of doing things (Rayner 1988b, Jasanoff 1986, Richardson and Watts 1985).

Hence, each decision making mode is present in all societies, but each society places a different emphasis on each one in its legislative, political, administrative, regulatory, judicial, economic, and social institutions. Some comparative studies have been made on national debates over certain technologies. For example, Nelkin and Pollack (1981) in comparing controversies over nuclear energy, have noted that the French are inclined towards greater centralized decision making than the Germans. Similar differences have been observed between Sweden and the US with regard to air quality (Lindquist 1980) and occupational safety and health policies (Kelman 1981). An IIASA study of liquified

natural gas siting in Europe and the US (Kunreuther et al 1982) focuses on different institutional arrangements for managing technology.

Many of these studies emphasize contrasts between the essentially hierarchical, cooperative approach to technology management in Europe and the more open, confrontational approach that predominates in the USA. As Jasanoff (1986) points out, the cultural determination of scientific issues has played a relatively small part in these studies. Their emphasis has been on the demands of interest groups and the responsiveness of political and legal institutions to rival claims about technology.

But, our argument extends further than this to claim that scientific and technological knowledge about the greenhouse effect is shaped by cultural interpretations into adaptivist, preventivist, or sustainable-developmentalist approaches. As an example of cultural shaping of scientific inquiry at the national level, Jasanoff (1986) brilliantly illustrates that information about established technologies, such as formaldehyde use, is differently interpreted by scientific advisory committees in different countries.

In particular, Brickman, Jasanoff, and Ilgen (1985) have argued that the decentralization of decision making in the USA both increases demand for scientific details of technological hazards and engenders competition between different explanations. Hence, there is more intensive public debate about regulation in the US than in France, Britain, or the Federal Republic of Germany.

To date, the climate-change debate has been dominated by the scientific and technical community. However, as policy makers

increasingly engage themselves in the issue, the demands of their various political and regulatory styles will further complicate the disagreements among scientists. Furthermore, the problems of communication about the issues involved will be exacerbated as scientific information is used in different ways to justify policy preferences.

The policy preferences themselves will be shaped by the cultures of decision making that are to be found at all levels of societies from families and small voluntary groups, through corporations, scientific institutions, and political parties, to nation states. All of the stakeholders and decision makers discussed in chapter four as likely role players at various levels in any global climate-management activity are going to possess the sort of cultural biases for decision process that we have outlined above. The next chapter examines the prospects for a global decision framework that could avoid crippling conflict between the players, and identifies some of the issue areas that can be anticipated as presenting particularly difficult social policy challenges to global environmental decision makers.

CHAPTER 6

AN ALTERNATIVE APPROACH TO GLOBAL ENVIRONMENTAL MANAGEMENT

This chapter outlines an alternative to the conventional approach to global decision making critiqued in chapter three. This alternative conceptualization derives principally from cross-cultural studies of decision making and institutional economics. From this standpoint, it is argued that many real-world decisions are not made according to rational and explicit canons of social utility maximization. In particular, the assignment of weights and values to potential outcomes is not really done by a few specialized analysts, but by the various constituencies of stakeholders that are directly affected and are able to make themselves heard.

That is not to say that formal risk and policy analysis is irrelevant. But that it is only one, albeit vital, input to the decision process. It is rather to say that the decision to proceed in one way or another is more likely to be the cumulative result of complex interactions among a variety of stakeholders leading, over time, to a fuzzy consensus.

Such decisions often do not look like decisions at all. This is because it is hard, if not impossible, to identify either the decision maker or the point at which the decision was made.

Although it relates to the incrementalist approach of some political scientists who view the evolution of policy as partisan adjustments and negotiation rather than rational analysis, this latter decision process is not well described outside of institutional economics and the

anthropological literature on small-scale societies. It is certainly poorly understood as it pertains to nation states, let alone on a world scale. Yet it is increasingly clear from cases such as the collapse of the international treaty on exploitation of the oceans, that the traditional view of cross-national decisions about global problems requires a supplementary perspective of this sort. This is especially the case with respect to anthropogenic climate change where it is not at all clear how the world will react to a growing perception of increasing environmental changes, when the more obvious remedies appear to be in conflict with the demands of economic development.

The call for translocal resource management is not made simply by a few speculators in the abstract; it is presented in the context of resource controversies by contesting participants. These organizations and individuals can be seen to fall into horizontal and vertical patterns. The participants in the global-climate management controversy both come from, and may officially or voluntarily represent, nation states or other territorially-based units. The participants possess a particular culture of adaptation and interpretation that shapes the way they view the problem and contributes to its resolution. Therefore, national culture constitutes the vertical dimension of social affiliation in the issue.

The participants also arrive playing particular roles as members of the various, often competing, interest groups in the disputes. Examples are government decision makers, multi-national business executives, scientific advisors, environmental activists, and others who successfully claim stakes in the issue. These roles constitute the horizontal

dimension of social affiliation in the dispute. Each role has its own particular, and often differing, interests and beliefs. Even within a particular role or constituency people may divide further along such lines as prevention versus adaptation.

This model of horizontal affiliation cutting across national loyalties at various levels of society indicates how barriers to coordination might be overcome, but it does not yet show how coordination can be institutionalized. The political science concept of regime (Krasner 1982) moves us further toward such understanding. The concept of regime provides a framework for understanding how congeries of individual nation states, or other independent political units, can cooperate in ways other than under centralized command or through the spontaneous order of markets.

Following Puchala and Hopkins (1982), we suggest that a regime consists of three elements.

1) Participants, often characterized as elites, represent the various interested governmental and non-governmental parties who can successfully claim a stake in decisions. These participants interact to form networks rather than hierarchies.

2) Principles, norms, and rules, whether explicit or implicit, are shared by these participants, and form their understandings about what to expect from each other; about what is legitimate, appropriate, or moral, and about the principles and purposes to uphold.

3) There also must be shared tenets, or implicit accommodations, about appropriate procedures for making decisions.

Just as participants interact in loose networks rather than tight hierarchies, these principles and procedures often are informal, implicit, and more subjective than objective.

A regime, in short, is a social network coordinated by shared designs for action and interaction, and by shared interpretations of a problem to be solved. This social arrangement resembles a particular kind of socio-cultural system that is among the oldest forms of human governance. Puchala and Hopkins (1982) suggest that stateless societies analyzed by anthropologists (Mair 1960) are governed by regimes. Another regime specialist, Keohane (1984), recommends that researchers study regimes the way Geertz (1973) says anthropologists should study cultures, as webs of significance.

Consider how these webs can be spun and how designs can be communicated across borders to be shared and implemented to deal with the greenhouse climate change problem. Scientists involved in its study have enough in common to be considered an international community (Koomanoff 1985). They help to weave common approaches into national and international decision making about managing the greenhouse effect. But, because scientists themselves are divided into major segments by their articulation to different national cultures and competing preventivist or adaptivist cosmologies, they help frustrate world policy closure on the subject. While this situation persists, these competing ideologies make it less likely that the world will rush into making the Big Mistake on the issue, and the way also is left open for diverse interests to participate in the debate and become part of the solution.

Participation in the global climate-change debate has, so far, consisted of national government agencies, elected officials, and non-governmental organizations like international, national, and even local environmentalist bodies. The issue has not yet triggered the participation of not-in-my-backyard groups (NIMBY) who might be looking for larger ideological rationales for their local strategies; however, the potential for this involvement is great. What could be more legitimate, open to wide interpretation, and therefore attractive to these grassroots groups, than protecting the global climate? When such organizations begin to construct global environmental issues to suit their local practical purposes, these issues will spin off in ways not yet perceived (Gerlach 1987).

This spin-off process, coupled with the globalization process that connects local environmental problems to global ecology, will elevate both the uncertainties and the stakes of decision making while motivating more groups to search in different ways for answers. Examples of the variety of responses include the recent decision by McDonald's not to use styrofoam food containers since the foaming agent is an ozone-depleting chlorofluorocarbon, Burger King's promise not to purchase beef from countries where grazing land is cleared from forests, and the recent World Bank decision to incorporate environmental concerns in its lending policies (Holden 1987). The World Bank example probably will be followed by similar actions in world financial organizations from international to local levels (IDP 1987). Environmental scientists and established activists are helping to promote these actions. It is noteworthy, therefore, that the World Bank decision was officially announced by its

president, Conable, in an address to the World Resources Institute, an environmental organization that had advised the World Bank to recognize the importance of ecological sustainability.

Ultimately, the various participants in the climate-change debates could generate global solutions, even if no central body of global decision makers officially and formally decides on a single course of action. That is, the problem-solving process could be moved forward by a form of organization that seems barely visible. This organization would have no single recognizable center but rather would be a many stranded, loosely coupled network (Gerlach and Palmer 1981). It would combine hierarchical and egalitarian approaches that would lead to both broad and narrow decisions.

Peace researcher Johan Galtung (1986) describes a similar process of international network building. He argues that while nation states constitute the basic building blocks for any international accords, national hierarchies are tied together in cooperative networks by relatively loosely structured non-governmental organizations operating at different levels. Participants in such structures are free to innovate in many small ways. Any single mistake need not feed through the network to bring it to disaster (J. Perry 1986), but its successes likely will be copied and expanded. Therefore, the various participants have chances to make little agreements and come to little understandings among themselves without having to face the challenge of accepting or rejecting a single big treaty.

The regime model of organizing global decisions offers several important adaptive properties that contribute to societal resilience in

the face of climate change. First, it facilitates effective coping with new environments (including both natural ecology and social setting). The opportunity for each stakeholder to contribute according to its particular aims and capabilities improves innovation, entrepreneurship, and trial-and-error problem solving. Information about successes and failures is communicated throughout the network and, since groups are not integrated under a central command, the failure of one does not jeopardize the whole.

A particularly strong example of a long lived resource-management institution that operates in this fashion is the Benedictine Order of monks. Established in the sixth century by St. Benedict, this order has an established ethic of protecting and preserving its natural resources for future generations. The order, with some fourteen monasteries worldwide, is not managed centrally by command, but rather is non-centralized, coordinated through networking. One of the functions of the structure is the coordination of the order's resource management over the centuries.

A second adaptive property of regimes is that heterogeneity among stakeholders encourages functional versatility. It means that some stakeholders will duplicate functions but, although this is seen as inefficient by proponents of centralized rationality, redundancy helps to ensure the accomplishment of necessary tasks. Landau (1969) has built upon the mathematical work of von Neumann (1956) to show how duplication, overlap, and redundancy of organizational components increase the reliability of the overall organization.

Third, regimes can recruit support from a wide range of people and organizations. Both individuals and groups are more likely to find others with whom they can cooperate productively in a diverse regime than in a centralized organization that is liable to impose a particular operational style on its members, thus excluding some potential participants whose preferences for the process of decision making are incompatible with centralized rationality.

CHAPTER 7

THE EMERGENCE OF GLOBAL COMMON PROPERTY

The process of regime building described in Chapter six is analogous to that by which the United States established its current management policy for nuclear energy; to continue research while holding a moratorium on implementation. This policy is clearly established, but no decision point or decision maker can be identified.

On an international scale, similar decision making occurs without fanfare; but, as with US nuclear power policy, this kind of diffuse decision process conveys the impression that important problems are left unresolved. This perception is given expression by those who call for a formal declaration of nuclear energy policy. Similarly, there are those who complain about the lack of clear decisions to protect the world from sliding into the greenhouse effect. Some suggest that the infamous tragedy of the commons is unfolding on a global scale (Ember et al 1986). This term describes the broad class of events in which individual actions that are rational in themselves lead inexorably to collectively irrational results (Hardin 1968, Olson 1965). In the climate change case, myriad rational activities of individual parties engaged in the core technologies of modern technology and traditional agriculture are leading to the atmospheric accumulation of greenhouse gases and related uncertainties about climate. Many specialists considering this dilemma claim that it is impossible for rational creatures to cooperate. Like Campbell (1985), they argue that escape from the dilemma can be found only through the imposition of institutions that do not rely upon voluntary cooperation or reciprocity.

In managing the environment, some have argued that only the imposition of regulations and controls through centralized and powerful authority will prevent resource overuse and account for the externalities of development (Ophuls 1973). Others call for quite the opposite approach, namely the privatization of all resources to allow the invisible hand of the market to work. The market advocates theorize that only when people privately own a resource will they internalize the costs of their uses, take care of it (Baden and Lucek 1984, Libecap 1984, Smith 1981), and also use it more efficiently (Feeny 1982).

Increasingly, however, there are challenges to the proposition that people cannot cooperate or negotiate resource management other than through the spontaneous order of the market or the imposed order of central command (Young 1982).

New evidence from a growing body of theoretical and empirical research indicates that people are becoming involved in many diffuse, loosely structured debates and negotiating informal agreements to construct common-property arrangements. These arrangements promise to enhance protection of the environment at both local and global levels. They constitute an emerging culture of resource management that, it is argued, is not susceptible to the tragedy of the commons.

For example, it has been argued (Ostrom 1986, Runge 1984, Stevenson 1984) that those who see tragic misuse as inherent in common property arrangements were misled to this conclusion by their commitment to very limiting game-theoretical approaches. Most important of these have been variations of the famous prisoner's dilemma game. One of the variations is the N-Person, Commons Dilemma Game (Dawes 1975). The players in this

game represent herdsmen in an open-access commons. Each of the players in the game will benefit most (the dominant strategy) by not cooperating with others. Each will try to avoid the worst result; cooperating while others do not. The equilibrium resulting from each player selecting this "best" or dominant strategy and avoiding the individually worst result is not the best joint outcome, since it leads to overgrazing. In respect to this and to so many other prisoner dilemma games, the strategy of non-cooperation is found to predominate (Sobel 1985). But, critics suggest this to be a function of the game, of its particular structure, not of human nature (Ostrom 1986). A growing number of scholars challenge the appropriateness of the prisoner's dilemma as a representation of the structure of real commons problems (Kimber 1981). They propose alternatives, such as a game in which players can assure each other that cooperation will pay off (Runge 1984a).

Researchers also call for and explore case studies of actual commons management or mismanagement (McCay and Acheson 1987, Ostrom 1986, Stevenson 1984). These studies show that there are conditions under which people can and do cooperate to manage the resources they use in common. These empirical studies support the proposition that the game theorists are too simplistic. The games are those of simple paradoxical situations. They are flawed because they operate only at the level of what Kiser and Ostrom (1982) call operational choice. But, real life presents opportunities at higher levels of choice. In an attempt to analyze these, Kiser and Ostrom (1982) further distinguish between collective choice and constitutional choice. Unlike real decision makers, the players in simple operational-choice games are unable to

change the cultural rules to achieve collective rationality. They are not previously linked in relationships of reciprocity or exchange, and cannot anticipate future exchanges or the imposition of positive or negative sanctions. Furthermore, the game players are not permitted to communicate and form alliances or coalitions to define and manage common resources.

In real life, people live in social situations and share cultural models that are far richer in possibilities for cooperation and also far more open to social and cultural change. A simple example can be imagined. We can guess that if the hypothetical prisoners were both members of some Mafia organization, they more likely would cooperate with each other. But we do not need to speculate. We can turn to actual case studies of resource management (McCay and Acheson 1987, Ostrom 1986, Stevenson 1984). We learn, for instance, how the real life herdsmen of Botswana do not follow the non-cooperative strategy of the dilemma game, but instead coordinate more ecologically wise uses of their pastures through adaptive strategies that are deeply imbedded in their whole system of life (Peters 1987).

It is by examining such cases that important principles can be developed about institutionalizing collective action effectively to manage common resources. We see the process at work in a contemporary North American case, that of the Basin of the Red River of the North. This multicultural and multijurisdictional area includes northwestern Minnesota, northeastern North Dakota, and southern Manitoba, Canada. It also is one in which there are three different systems of water law or tenure. The long standing water problem in the Basin has been that of

equitably controlling flooding and regulating the size and location of flood control dikes.

Tiring of the inability of state and national governments to coordinate water management and threatened by a major flood in the early 1980s, citizens throughout the Basin organized at the grassroots to build a non-governmental body, the International Coalition for Land and Water Stewardship in the Red River Basin. The organization has gone on to begin to deal with many other soil and water management issues, including that of pollution from agricultural chemicals. The main approach of the organization is to build awareness of environmental problems and to develop broad and grassroots consensus for remedial action. The International Coalition appears to have been successful in defining the resources to be managed as common property, defining the using and managing groups, and constructing concepts about reciprocal externalities and mutual responsibilities. However, even this example is not exempt from some characteristics of the other cases referred to here that may limit the extent to which models built from them may be transferred to the global climate warming case.

Most cases in this literature are those in which the group managing the resource is also the group using the resource. Such groups tend to be small and local, and their members share the same culture and social structure. Further, the members of the groups are cooperating to divide the profits of their enterprise. For example, there is a pasture or a forest to be used; there is a supply of fish to be caught and sold; or there is a supply of water to be distributed. Furthermore, in these cases feedback from resource use or abuse is relatively immediate,

direct, and visible, or at least it is relatively easy to make these apparent (Erasmus 1977).

In the case of global climate warming, the groups involved do not share the same culture. Historically, the atmosphere has been treated as an open-access resource, with no common rules for its exploitation. If the users are to share at least a common awareness of their ecological interdependence (Brooks 1986), this must be constructed through sociocultural process. This process may well be underway (Gerlach 1988), but its fulfillment and institutionalization is probably far in the future. Feedback from management and mismanagement of the atmosphere is very slow and unevenly distributed.

However, despite these differences, the small-scale case studies and the theories deriving from their analysis indicate some main general characteristics of common property arrangements. These arrangements consist of sets of rights, duties, privileges, and obligations accepted and sanctioned by members of a group with respect to a particular resource delineated by environmental or social factors. The four most important components of a common property arrangement are; the existence of a physically and/or socially defined resource, knowledge of who is involved in its management and use, the common realization that degradation of the resource will adversely affect all participants in the pact, and the institutionalized means of managing peoples' use of the resource.

Let us consider how these four components interact in an appropriate example. For convenience, we combine the first two components to ask how the resource is defined and how the using group is identified.

Ecologists are apt to say that the resource is ecologically defined by the properties and laws of nature, but the defining process clearly is also social and cultural. Christine Olsenius, vice president for education of The Freshwater Foundation, based in Minnesota and established to research and protect freshwater resources, shows this sociocultural aspect when she writes "our perception of a resource determines how we use or abuse a resource" (Olsenius 1985). She and her Foundation colleagues seek to shape this perception in order to support the careful management of water resources.

In the Foundation's 1985 publication, Journal of Freshwater, Richard G. Gray, sr., one of the Foundation's founders, writes about the threat agricultural chemicals pose to ground water. He illustrates the essay with a picture captioned "A prosperous-looking farm, a healthy-looking field," but goes on to warn that the pesticides and fertilizer that contribute to such appearances pose "unseen but everpresent risks" to human health and welfare. He explains that these chemicals eventually contaminate ground water that in turn contaminates most of the drinking and irrigation water, thus affecting the food we eat. The aim of this article, the journal, and, indeed, the Foundation, is to bring ground water into public view so that efforts can be made to protect it as a resource common to people across Minnesota, the Midwest, and the country.

Well known in the national water-management network, Foundation members undoubtedly contributed to the National Ground Water Policy Forum report, "Ground Water: Saving the Unseen Resource" (The Conservation Foundation 1985). Reviewing the Forum's report, water specialist David E. Burmaster (1986) welcomes its call for a comprehensive national policy

to integrate the efforts of all the states to protect this common resource. He agrees with the Forum's argument that the nation cannot afford to delay while each party waits for another to act.

Of course, one of the reasons ground water remains an unseen resource, and goals and programs for its protection remain confused, is because water specialists are still determining ground water ecology and its connections with other resources and human activities. Therefore, these quests of the specialists constitute a social process with important political and economic implications. For one, protection of ground water might require restrictions on the farmer's use of chemicals such as fertilizers, herbicides, and pesticides. Farmers and the agricultural industry worry that this might affect agricultural productivity and the ability of already embattled family farmers to survive (Fulton 1987). As a result, the profits of chemical companies and other farm-related businesses might be affected. Farmers also are troubled because their historic image as the salt of the earth may change to that of careless polluters. Above all, the definition of ground water as a resource common to large publics downstream from farmers can lead to restrictions on the farmers' use of their private property; their agricultural land. Ground water, then, and the activities that affect it are the subject of social controversy, and it is through this debate that the resources and the group of its users are being defined.

Processes of this type also are taking place with respect to the atmosphere. It is being made visible as a resource, and the human activities that affect it are being brought to the view of specialists, government decision makers, and the general public. In the 1960's and

'70's, people were made aware that industrial and automobile emissions were not just vanishing into the air, but were polluting it, often visibly. In southern California, for example, the Environmental Quality Lab of the California Institute of Technology collaborated with environmental, public interest, and government organizations to explain how photochemical processes in the atmosphere converted pollutants into smog (Gerlach 1979). The dangers to health posed by smog were emphasized. More recently, people across the western world have been learning how, beyond their vision, atmospheric pollution is returning to earth as acid rain. The evidence of this is given in the demise of fish in lakes and the death of forests. The mass media amplifies the alarm raised by the environmental community.

Now, people hear of ozone holes and the greenhouse effect; processes beyond their vision in the skies are changing the composition of gases in the atmosphere, and with this, the earth's radiative balance. Once again, the mass media carry the message, reporting how stratospheric ozone is decreasing while CO_2 and other greenhouse gases are increasing. Decision makers in government and business are faced with the realization that these gases are produced by human activities associated with urbanization and industrialization, notably the burning of fossil fuels, and the clearing of land for agriculture and the growth of cities. In a word, solving the problems will require steps that might affect the vital economic interests of modern societies.

"We are indeed facing the prospect of not being able to use fossil fuels in the next century," said Frank Press, president of the National Academy of Sciences at a US Senate hearing on global environmental change

(Engelman 1987). The hearing was sponsored by presidential candidate Senator Albert Gore Jr. (D-Tennessee), who has a reputation for congressional work on the global environment. In assembling scientists from agencies studying the global environment, Gore apparently gained at least qualified support for his conviction that the government can no longer wait for additional research on atmospheric degradation before acting to halt it. In any event, while scientists and decision makers continue to debate this matter, it does seem that there is agreement on one thing; both the atmosphere and the global climate are resources common to humankind.

However, is it not stretching the point to claim the tropical forests as global common resources? Why should it be of any concern to the world that the Nepalese are denuding their Himalayan mountains of trees? Why should the Digo of Kenya be told that the forests where their ancestors are buried have become national and international treasures, with the whole world as stakeholder in them? We have seen how the global environmentalists accomplish this stakeholding. They trace consequences up the ecological chain; trading up resources, so to speak. Forests help maintain the ability of regional watersheds to provide the world's people with food from irrigation systems and fisheries, and energy from dams. Forests are a store of genetic resources for the world's people into the future, and forests help to maintain the world's radiative balance that in turn stabilizes climate. And, of course, these causal loops are completed when it is shown how local forests are degraded by atmospheric pollution. It is in these ways that natural resources and their groups

of users are being defined. The processes of building common property arrangements at the global level is well underway.

Another important element in this process is showing that the impacts or externalities of the resource use are reciprocal; that they eventually affect everyone in the community of users. It is easy to demonstrate reciprocal externalization in the common use of a pasture by a group of cattle herders; all the herders are penalized if the pasture is depleted. It becomes more difficult to claim that externalization is reciprocal when it can be shown that some users are safely upstream or upwind of a resource facing such degradation. But, as we have seen, the globalizers are creative. In their view of the world, eventually everyone, or at least everyone's children, will bear the cost of environmental degradation. One day, the farmer who passes his pollution downstream will find it in his own aquifer and his own wells. Eventually, he will pay for this; maybe in taxes to bring in clean water, or maybe in the loss of markets downstream.

Hence, the diffuse, somewhat untidy networks of a culture of common property management are being spun. The pattern of this within societies resembles the pattern of regime building across societies. People across countries are learning how they are participating in a global community of humans who share in the costs and benefits of resource use. They are constructing culture, and in effect, setting the stage for the organizational actions that will work out the rights, duties, privileges, and obligations that characterize common property institutions.

It is through the lively social interactions that we have been exploring in this paper that people are negotiating and building the

explicit and implict rules of managing the resources being defined as common to the world community. These legal processes become part of the broader social processes through which people are constructing the culture of worldwide ecological, economic, and social interdependence.

This construction of a culture of interdependence is setting the stage for continuing action to institutionalize cooperation in common-resource management across traditional borders. However, those who set the stage or are willing to enter it as actors often are bound by traditional dichotomies of command or market alternatives. For many, national political will is the only anticipated savior. Even those who accept the regime model or share similar perspectives and, therefore, recognize that global resource-management strategies can be implicit and informal are likely to want them laid out more formally by explicit treaty (Caldwell 1984). In chapter two we sounded a note of caution about forcing the pace of scientific consensus formation. Similar considerations apply with efforts to force the pace of piecemeal policy decision making through centralized treaties. These are well illustrated by the efforts of UNEP, supported by the United States and the Nordic countries, to emplace a global treaty banning the aerosol use of chlorofluorocarbons. The effort failed, largely due to the intransigence of the European Common Market countries, which argued that such a ban would do little to resolve the ozone problem while other uses of CFCs were not controlled. Instead, the Europeans suggested a cap on production capacity, a somehat self-serving solution since European firms were producing at well below their capacity.

The failure to achieve compromise over the aerosol ban in 1985 spurred the US to institute a broad-based effort to build a global consensus for CFC limitations. This effort, led by Ambassador Richard Benedick, consisted largely of informal workshops that included scientists, NGOs, environmental groups, and policy makers within the US and abroad. This did not lead directly to consensus, as evidenced by the variety of positions advanced by the US, Canada, and the Nordic countries at Geneva in 1986. A certain amount of US coercion in the form of threatened trade restrictions helped to focus the process. However, the 1987 Montreal Protocols represent a much stronger regulatory decision, justified on a better scientific basis, than the aerosol ban would have been.

The irony, pointed to by some who were active in the process, is that had the aerosol ban been agreed, the Montreal Protocols probably never would have been achieved. It remains to be seen how far the process begun on the road to Montreal can be sustained after the formal decision has been made. There is a danger that the diplomatic triumph of achieving formal centralized treaties can curtail the momentum of the decision process. Already there is evidence that the limits imposed by the agreement at Montreal are quite inadequate, but the continued resilience of the process and its ability to achieve updated solutions are still to be tested. Whatever the role of formal treaties, the process of broadening the basis of global-resource management is underway as ever more people investigate and debate the global ecological connections and explore various management strategies.

CHAPTER 8

CHALLENGES TO BUILDING CLIMATE-MANAGEMENT REGIMES

In the last chapter we traced some of the possibilities for the development of global common property regimes to deal with global environmental issues like anthropogenic climate change. In the next few pages, we trace some of the big challenges that will face any efforts at regime building. We focus here on institutional trust and consent, international and intergenerational equity, and the perception of urgency.

Any process of decision making under uncertainty clearly raises questions of trust in decision makers and guiding principles. In particular, different levels of trust in centralized or decentralized decision making are likely to occasion conflicts between the stakeholders. These conflicts may be exacerbated by different preferences for market or collectivist solutions among those favoring decentralized procedures.

The establishment of centralized regulation is a classic response to problems of complex resource coordination (Ophuls 1973). This was the essential normative argument in biologist Garrett Hardin's (1968) seminal essay on the tragedy of the commons. Hardin drew inspiration from 17th century philosophers, particularly Thomas Hobbes (1651), who claimed that the inherent self-interest of individuals could be curbed only if their actions were shaped into cooperative endeavor through external sanctioning.

Hierarchies generally display a preference for centralized solutions because they are compatible with principles of bureaucratic rationality

and reliance on routine procedures for achieving clearly resolved goals. Where organizations have access to full information, the ability to ensure critical compliance, and are sufficiently flexible to maximize their utility, this can be a very effective mode of decision making. However, most bureaucratic organizations develop a more rigid preference for a particular way of doing business, a corporate or institutional culture that represents a commitment to a distinctive way of dealing with problems. The reality of centralized bureaucracy frequently is better characterized by partial information, bounded rationality, the extremes of mindless compliance or sabotage, and the creation of routines that combine disparate goals without resolving tensions between them (Cyert and March 1963).

In the past couple of decades, industrial psychologists and management professors have sought to combat these tendencies by the introduction of techniques such as Management by Objectives and other decision-making systems designed to promote centralized rationality within organizations. For the most part, these devices for ordering our priorities have failed, partly due to the resistance of bureaucratic culture, but also because they rely on high levels of information and low levels of uncertainty. The emphasis on technique to increase the power of centralized rationality may commit us to the more efficient pursuit of erroneous goals (Halberstam 1972). The result is a loss of the resilience that is inherent in decentralized muddling through.

With respect to climate decision making at the sub-national level of organization, conflict may be anticipated between those who trust scientific experts and policy makers to decide what is best, and those

who advocate the messier, but possibly more resilient approach of extending public participation. Other conflict may be anticipated between those who seek regulatory solutions and those who prefer the hidden hand of the market.

At the level of national government, western countries, such as Britain and the United States, have experienced recent reactions against centralized direction of social and economic life. Many LDCs and, indeed, some developed countries, are still struggling to integrate diverse peoples at the national level. There is little enthusiasm on the current scene for the political internationalism of the two decades following World War Two. The credibility of the United Nations as a centralized forum for world decision making is at a low ebb, both because of its constitutional inability to enforce compliance, and because of skepticism about the rationality of a centralized global decision maker.

However, increasingly, countries are driven towards cooperation by practical imperatives arising from the interconnectedness of the world economic system. Even as well-established nation states demonstrate their preparedness to go to war to protect their national integrity and economic welfare, they become involved in transactions and alliances that bind them together. In seeking to defend themselves, project their power, extend their ideology, or enhance their economic position, both new and established countries weave themselves into various supra-national political and economic networks. Most who are directly connected with it agree that the real value of the UN is not in the formal debates conducted in the General Assembly or Security Council

Chambers, but as a vital node for international networking conducted in its cafeteria and corridors.

While some countries, such as France and the USSR, may be said to exhibit preferences for centralized rationality, others, like the USA, prefer market conceptions in which states operate much like the representative individuals of neoclassical economic theory, seeking to wield market power. These national cultural preferences cannot be resolved simply in formal decision procedures and institutions that would be capable of enjoying the equal trust of all parties.

It seems inevitable that strategies to prevent or adapt to the greenhouse effect will all require a complex institutional response, innovating and building new institutions, both formal and informal, at local, regional, national, and international levels.

Some nations that presently have a planned, centrally managed, redistributive economy and policy may be able to use this system to manage prevention or adaptation within their countries or economic blocs. However, even in these cases, all is not what it seems from the outside. The Soviet system is far from being a monolith driven by centralized rationality. It is better characterized as a set of competing bureaucracies struggling to obtain control over scarce resources in pursuit of often conflicting goals. This system which, in some respects, resembles competition between large corporate entities in the West, is known to the Russians as <u>departmentalism</u> (Ziegler 1987).

Furthermore, despite internationalist rhetoric, the centrally planned societies tend to be characterized also by strong concerns with national sovereignty and protection of their own governmental

prerogatives. It seems unlikely that they will accept command from a global authority, particularly if they feel that global decisions threaten their own economic plans. The Soviet requirements for exemptions from the timetable set by the Montreal protocols for the reduction of chlorofluorocarbons is but one relevant example.

If centrally planned societies are likely to encounter cultural and economic obstacles to centralized solutions for climate management, it seems even less likely that nations espousing democratic capitalism will be able to agree upon any single management structure empowered to enforce implementations across national boundaries. Within these nations, there are people and groups that can and will mobilize to protect individual, local, sectional (economic) interests, and communal (ethnic, gender, etc.) rights. Ironically, in the United States and certain European countries, many of these groups receive their support from the same people who, through citizens' environmentalist groups, are demanding global action to eliminate CFCs and, through charitable and political action, seek economic justice for the third world. It is unclear how this tension can be resolved for these groups. For others, such as those of the religious right, there is less ambiguity. We have already seen them organize to protest continued American membership of the United Nations and international economic and political efforts, like the Trilateral Commission, as conspiracies to subvert popular freedoms (Karpel 1977).

Participants in the climate-management decisions will favor one or another of at least three fundamentally different cultures of decision making; centralized regulation, decentralized markets, and communal

consensus. The problem of institutional trust between these different styles of decision making is omnipresent in labor relations, domestic politics, and international affairs. Given the diversity of stakeholders' interests, as well as organizational and national cultures that will be involved in any global agreement, the problem of trust presents a major challenge even for developing procedures for negotiating as well as for any potential management action.

The issue of trust is closely linked to that of consent. Addressing the specific issue of consent to risk, it has been suggested that different institutional cultures view the issue of what constitutes uncoerced agreement to a course of action very differently (Rayner 1984, Rayner and Cantor 1986). Collectivist decision makers favor the most easily recognizable form of consent; expressed preferences. This principle requires that all who may be affected by a decision be given all available information about a proposed action as the basis for consensual approval. Accordingly, no one should be subject to the consequences of an action to which he objects. Objectors may be requested, but not required, to defer to appeals based on explicit ranked values shared by the group. To act without explicit consent is seen as a violation of the natural rights of individuals.

In contrast to explicit consent, bureaucratic or hierarchical decision makers tend to favor a principle that is unrecognizable to collectivists as consent at all. This is sometimes called hypothetical consent (MacLean 1986). Here, a member or citizen is assumed to have entered into a social contract with the institution, whereby he may be deemed to assent to decisions made through the rational procedures of

that institution, even though he may not like a particular outcome. The acceptability of any course of action will, therefore, be determined by appeals to the constitutionality of the institutional structures for decision making. It is hardly surprising that there should be conflict between collectivists and bureaucrats over the legitimacy of decision-making procedures.

Policy makers in market organizations tend to favor a revealed-preference approach (Thaler and Rosen 1975) for obtaining consent, sometimes called implicit consent (MacLean 1986). According to this view, consent to a certain level of risk may be determined by analysis of purchasing behavior. Given equal information about several commodities that vary only in respect to linked differences in cost and safety, a purchaser is said to reveal a preference for a particular risk/cost tradeoff and, implicitly, to consent to the given level of risk associated with his choice. Under these conditions, environmental changes are likely to be seen as the legitimate and inevitable consequence of the pursuit of economic growth. Societies, as well as individuals, can, and do, reveal preferences of this sort in determining such things as levels of public-health expenditure.

Fundamentally different concepts of what constitutes agreement are likely to be brought to the problem by the various institutional and national participants in any attempt to devise a global response to climate change. These preferences for process also may influence preferences for solutions. For example, the third approach to consent meshes well with an adaptivist approach to climate change, since it allows, in principle, differential levels of response from country to

country or region to region. Unfortunately, this concept of consent violates the strongly held preferences of the other decision making cultures. Furthermore, not all countries are equally endowed by geographical latitude or resources with the ability to adapt to climate change. This leads us to consideration of the problems of international equity.

It has been widely recognized that the climate change issue confronts the world with major problems of distributive justice. Unlike a classic commons problem, in which everyone ultimately is a loser, climate change could conceivably bring benefits to certain regions, especially to countries like Canada and the USSR that have vast territories including potentially fertile land, where the growing season is currently very short.

The costs and benefits of climate change, or of any attempts at climate management, will be distributed unequally across the world, both between nations and between regions within nations. Within nations and regions, costs and benefits will be unequally distributed socioeconomically and, perhaps, ethnically, as will the ability to share and profit (Kellog and Schware 1981). Many of these developments will flow from, and exacerbate, present distributions of inequality. For example, the rich and technologically advanced parts of the world will be better able to anticipate and adapt to climate change. They have not only the money and technology to do this, but the political power to divert resource flows.

The challenge is particularly relevant to developing countries in both the short and long terms. These countries are confronted now by

problems associated with the use of woodfuels, urbanization, deforestation, and soil erosion, all of which contribute to regional and global ecosystem changes, including potential climate change. Regional management of these problems, at least partly, depends on forging common policies between diverse cultures and nations.

In the longer term, sustainable-development strategies for LDCs are heavily dependent on energy policies. Immediate energy needs in most countries are likely to be met by fossil fuels or fuelwood use. However, CO_2 emissions from such energy practices may contribute to global warming that would exacerbate existing problems of desertification in certain areas.

Moreover, global warming may lead to emissions-abatement measures, including pressures on developing countries to make major changes in their energy systems. In this connnection, climate change also raises difficult questions of cross-national equity. For example, to what extent is it justifiable for donor countries to use development aid as an incentive for developing countries to adopt atmospheric management strategies that are favored by their benefactors? Can and should the producers of atmospheric pollution be made to pay for their ability to externalize its environmental consequences? If so, should the non-polluting nations have the right to circumscribe polluting activities beyond their borders, or merely to obtain redress for injuries to their own environments? How might such costs be quantified?

Given the development priorities of China and the third world, it seems very likely that any emissions-reduction technologies advocated by the developed nations, would have to bring other benefits, such as

reduced costs, to the target economies. Otherwise, it seems unlikely that LDCs will pay voluntarily a further price for the development of the North. Improvements in end-use technologies might be a major tool for reducing LDC emissions. However, their rate of adoption and the difficulties of ensuring proper energy-conserving use in countries with low resources and poor communications will present major problems to decision makers.

Another possibility is that some developing nations will see themselves as potential beneficiaries from climate change. If so, what incentives do they have to join climate-management efforts? If the North/West has already received the benefits of industrialization, should these countries bear the burden of atmospheric clean-up while permitting the South/East to catch up? Conversely, is it more beneficial to preempt third-world commitment to industrial fossil-fuel use than to abandon it later? All of these considerations will extend the relevant arena of decision making to include constituencies concerned with development, but far from the energy and CO_2 issues per se.

Any attempt at building a global climate-management regime will have to take these matters into consideration. The principle that rich nations have duties to help poor nations or poor sectors of their populations already is well established at both ethical and policy levels (Benjamin 1980). With the support of citizen pressure groups in the wealthy countries, even the poorest peoples can pressurize both national and international systems by using tactics ranging from moral suasion, lobbying, mass demonstration or civil disobedience, to armed insurgency or terrorism.

Also, nations and international agencies have developed many governmental and non-governmental institutions for transferring capital and technology to promote equity and development (Willetts 1982). Such institutions routinely are defended by their managing bureaucracies as well as their clients, and the transfers are espoused as ethically proper by a broad range of religious and sociopolitical groups.

A major problem is that these transfers presently are made possible by the very patterns of resource development, economic growth, and cultural preferences that seem threatened by preventivist strategies for climate management. In the USA, there has been a popular belief that modern technology can extract resources from a rich environment in sufficient quantity to ensure that the gain of one did not have to be at the expense of others (Gerlach 1977). However, this cornucopian image of the infinitely expandable pie is anathema to those who see the resource base of spaceship earth as finite and unfairly distributed.

Culturally shaped concepts of fairness play a pivotal role here. Once again, there seem to be at least three important, supposedly incompatible, principles on which ethical judgements of distributive justice are based. These are;

o Consequentialist principles that hold actions as being pragmatically justified if they produce beneficial results, regardless of intention.

o Rights-based principles that hold actions to be justified in accordance with naturalistic or deontological ethical laws.

o Utilitarian principles that justify actions intended to produce the greatest happiness of the greatest number.

Interestingly, each of these meshes closely with market, collectivist, and hierarchical decision principles respectively. Not only does each principle form the basis of a fundamentally different decision approach to geopolitical equity, but also underlies approaches to the intergenerational distribution of possible effects of climate change and imposes distributions of costs and benefits on future generations who are unable to influence present decisions.

Present action may weigh heavily and unfairly upon future generations. As yet, the future is heavily discounted, and there is not a strong constituency mobilized to fight for generations still unborn. However, any sort of planning for the future raises different problems particular to each kind of institutional decision maker, because the social organization of each type leads to a strong tendency to view the future in a particular way (Rayner 1984). This variability in time perception has important implications for the sense of urgency brought to a problem by decision makers in different constituencies, as well as their approach to future generations.

In market institutions, expectations of the future are likely to be focused strongly on deadlines. Success in entrepreneurial activities depends largely on timing; planning for shifting market tastes, clinching deals at the right price, meeting delivery or publishing deadlines, or knowing when to sell your pork-belly futures. The emphasis is on short-term expectations and immediate returns on activities and investments. Long-term planning is not a feature of the entrepreneurial decision maker, but of the hierarchical corporation (whether it is ITT or an African lineage) which, in principle, is immortal.

Bureaucratic or hierarchical decision cultures encourage a strongly differentiated perception of history. Anniversaries of great events in the past are celebrated collectively and provide models for discriminating epochs of the future. Clear recognition of age-sets and generations, which are the basis of establishing seniority in the present, also engender clear expectations of an ordered future. The regimes of distinguished leaders (whether kings or company directors) also contribute to a long-term differentiated expectation of the future.

In collectivities too, history tends to be viewed as epochal but, because of the problems of resolving disputes in social organizations that are aggressively egalitarian (therefore dismissive of dispute resolution by claims to seniority or appeals to established procedures), those groups tend to frequent schism. Consequently, they have a foreshortened historical memory, typical of millenarian religious sects and political groups (Rayner 1982). The group's crusading mission may lead to a sense of historical self-importance that results in the view that the present epoch is the decisive historical moment; hence, their susceptibility to a heightened sense of urgency. To radical environmentalists, time is as rapidly diminishing a resource as any other.

While these contrasting perceptions of the future give rise to a different sense of urgency in each decision-making culture, they also give rise to quite different attitudes towards risk affecting future generations. These attitudes are particularly focused on the problem of obtaining consent discussed above.

In market cultures, it is assumed that future generations will make decisions on current market conditions and, therefore, will accept similar decisions of their predecessors. Hence, inter-temporal responsibility receives relatively little attention. At the extreme, it can be said that if future generations are not adaptive or innovative enough to deal with the legacy of today's technology, then they probably don't deserve to survive.

Bureaucratic cultures, on the other hand, tend to assume that future generations will recognize the same institutions as legitimate decision makers. Hence, the emphasis of long-term planning is on future system maintenance. Inter-temporal responsibility is strong and the future secured, provided the institutions themselves are nurtured and kept healthy.

In collectivist groups, inter-temporal responsibility is strong, but people have little trust in formal institutions. Since direct consultation with future generations is impossible, collectivists argue that we violate their rights (as well as collectivist egalitarian principles) by exposing the unborn to any anthropogenic risk.

The contrast between the approaches of the three principal decision-making cultures that operate at all levels from the local to the supra-national, illustrates the immense potential difficulties facing any attempt at global management of common resources such as the earth's atmosphere. The preferences of each kind of decision maker for distinctive processes and the concomitant perceptions of responsibilities across spatial and temporal boundaries are not new. They always have

beset cross-cultural decision making and characterized disputes about how complex organizations and societies should be run.

Violations of these preferences have led to domestic conflict and international wars throughout history. Conversely, agreements have been forged between different social units, often by selecting like decision makers for alliances, or through coercion of the weak by the strong. The particular challenge of global-climate management and other global-commons issues is to produce a desired result through the non-coercive collaboration of an exceptionally large population of very diverse stakeholders.

Respecting the diversity of preferences for processes of decision making almost certainly eliminates the possibility of effective action through a single formal protocol or institutional structure. To be completely acceptable to one type of stakeholder, any such procedure would almost certainly violate the strongly held preferences of one of the other types of decision maker.

Our sense is that effective decisions about managing the global commons may not easily be recognized as decisions at all. The value of any central protocol will not be so much instrumental as symbolic. As anthropologists, we would be the last people to underestimate the importance of symbols in building a common cause. However, as policy scientists, we also are interested in understanding how to build the instrumental cooperation that supports the visible symbol.

We believe that the real decisions about climate management will be made through the building of piecemeal regimes whose procedures may be left largely implicit at the edges where different decision cultures

interact. The interaction of these regimes will overdetermine the world-system response to the problem without, or perhaps despite, any rational centralized institutions or treaties. We will understand the process better through looking at the UN cafeteria rather than its chambers of formal debating and decision making. The practical lessons of the Montreal Protocols are to be learned from the informal scientific and diplomatic activity that surrounded the formal decision process rather than from the explicit terms of the final document.

APPENDIX A

A RESEARCH MANIFESTO FOR GLOBAL CLIMATE DECISION MAKING

The main thrust of this report has been to advocate an approach to global commons management that links understanding cultures of decision making within organizations and the process of regime building between institutions. The argument has been of a general nature, laying the foundation of a research program that is capable of understanding and contributing to the global commons management process. This appendix outlines some of our proposals for building a research effort for this purpose and presents a partial list of specific topics and approaches that could be researched usefully within that framework.

There are many social-science fields that seem to have immediate applicability to our program. Survey research is always a popular social-science tool in the US. Although we have argued for the widest definition of stakeholders, we do not believe that general population surveys will be of much help in understanding or promoting a global decision-making framework. The problem with this approach is twofold. First, attitude surveys are unreliable guides to actions. Second, their application in LDCs is severely limited for methodological reasons and because the experiences of respondents are likely to differ too much from those in industrialized countries for valid comparisons. For example, most third-world people will not have been affected by pictures of the earth from space transforming their consciousness of environmental vulnerability.

However, we know from extensive experience with social movements and public acceptance of technological risks, that the different understandings of risk issues among various stakeholder groups are important elements of public policy making in a democracy. Some survey of key stakeholders would be of considerable interest. However, we advocate reserving this avenue until we are considerably further advanced in our research program. We do not yet know what are the relevant questions to ask, nor of whom. A premature survey that is over inclusive wastes resources and creates noise.

We also urge restraint in the early use of macroeconomic and demographic approaches. These tools are used extensively in the development field, but so many development programs fail at the local level because the local people are contrary enough to refuse to conform to macro models or ethnocentric assumptions about micro behavior.

Furthermore, there are reasons for caution in attempting any approach that resembles global accounting of human behavior, or to catalogue and quantify all human activities that relate to climate change (or any other global-commons issue). There is a strong adaptivist bias among many natural scientists that social systems are artifice that can be molded, while technical systems are natural and somehow harder to change. However, many human activities are extremely resistant to change, as hunger workers are well aware. Some effort must be spent on identifying a much narrower range of activities (such as problems of local and global decision making) that are not only relevant to the problem, but in some useful sense can be transformed by better understanding.

Global risk analysis is another research approach that has been advocated. Here, we are mindful of the reification of "risk" in many of the

existing approaches to the study of risk perception and the practice of risk management. We prefer to see studies of sociotechnical systems treated as wholes, not just according to some abstract features that may lead us away from the crux of the issue; just as probabilities have led us away from understanding that equity is an intrinsic part of human risk behavior, not just a value issue added on after assessment. The NRC and the Academy are somewhat conservative in this respect. A research regime that balances their technical biases could be a useful counterweight to the development of US policies that impose inappropriate natural science models on the human dimensions of the problem, as has happened with risk analysis.

The topics adumbrated below represent only a partial list. At present it is somewhat unsystematic, but our discussion of the problems of global decision making suggest at least four general headings.

- o Scientific decision making in science for policy.
- o Decision making in formal resource management.
- o Societal factors and macro movements in environmental decision making.
- o Historical and ethnographic case studies of environmental management and of cross cultural cooperation.

Rather than beginning with large-scale empirical inquiries or all-encompassing grand-theoretical research designs, we suggest that such a research effort should select topics for research from an initial list of middle-range topics focusing on decision processes.

Decision Making in Science for Policy

The framing of scientific knowledge

We propose reflexive studies of research into global change to investigate how the disciplinary and institutional frameworks in which scientific knowledge is produced and communicated contribute to the shaping of policy options. Scientific knowledge traditionally is presented as if produced by a rational linear process of inquiry. It usually is presented in the passive voice, which is perceived by its producers to emphasize its objectivity and enhance its authority. This framing of scientific information is compatible with linear, hierarchical decision processes, but may not be incorporated so easily into the sort of fuzzy consensus building that we are predicting. In any case, the question of framing scientific knowledge for decision processes merits consideration in relation to the climate change issue because the arena, once dominated overwhelmingly by scientific and technical personnel, now is expanding rapidly to include policy makers and their advisors, whose organizational preferences and instrumental objectives may lead them to frame the problem quite differently, perhaps thus excluding some important considerations.

Decision making in a non-Bayesian world

The state of scientific knowledge and the long-term nature of global-commons problems ensures that policy analysts will not be given reliable probabilities about the state of the world under any set of scenarios at any point in time. Research in this area could explore ways to represent and manipulate uncertainty that better fit with existing uncertainties. This

work would build upon existing research in uncertainty management in expert systems. Specifically, attention should be focused on belief functions and possibility functions, and attempts to develop ways to calculate expected values using such exotic uncertainty representation schemes to facilitate comparison of policy alternatives.

Lessons from Environmental Impact Analysis at regional and local levels

Environmental professionals have accumulated a great deal of knowledge and (perhaps even more importantly) craft skills for understanding the complex interactions of society and environment at local and regional levels. Unfortunately, there also are many poor-quality and routine Environmental Impact Statements that follow a simplistic formula and contribute little to understanding even the specific case at hand. However, we consider that a review of high-quality Environmental Impact Analyses concerned with cumulative impacts in specific locations would be useful to understanding the relationships of human decision making to complex changes in social and natural systems at local and regional levels, and their implications for higher level analysis.

Societal Factors in Environmental Decision Making

The role of social movements in environmental change

Such a study would specifically reverse the tendency to technological determinism and examine how grassroots political action affects social thinking about the environment. It has been suggested that climate change

lacks three characteristics that usually are associated with grassroots action on such issues. These are:

1) local concentration of impacts,

2) an identifiable villain, and

3) immediacy of consequences.

However, several recent cases of social action on technological issues have been characterized by activists with no obvious interest in the issue who have, nevertheless, established their identities as legitimate stakeholders. Examples include the infant-formula boycott and wilderness preservation. There are indications that global climate change is finding local concerned constituencies. We would research the extent to which local and middle-level public-interest groups are incorporating the climate issue into their agenda and the impacts of this on policy making in different countries.

Independence versus interdependence

This kind of research would investigate the tensions between the independence and interdependence of political units at the national, regional, and global levels. The relative state of development of institutions of global economic, technical, environmental, and political interdependence should be investigated to assess the opportunities for innovation. This might include evaluation of the policy implications of regime theory and other organizational perspectives for global decision making.

The globalization process

Understanding the process by which local organizations develop interests in issues that are geographically far removed from the daily lives of their members offers important opportunites to convert "Think globally; act locally," into something more than just a slogan. However, if local action on global issues is to become a realistic instrument of deliberate policy, we need to understand how it has worked spontaneously in issues such as wildlife preservation (including loss of genetic diversity and deforestation) and technology transfer (such as infant formula in LDCs). We propose tracing the history of the globalization process in scientific and popular literatures, the discourse of various elites, and the mobilizations of grassroots groups. We would delineate the concepts that support globalization claims, such as ecology, systemic thinking, holism, etc. Finally, we would analyze the social dynamics that propel the globalization process and their potential to contribute towards solutions to global commons problems.

Ritual and symbol in environmental decision making

Studies in the sociology of science and of technology policy indicate that formal decision-making procedures, especially those involving public participation, tend to have very little influence on the policy outcome. These procedures frequently are of ritual or symbolic value for obtaining societal acceptance of a decision rather than serving a directly instrumental function. Both instrumental procedures and symbolic ones are important in determining and implementing public action. It would greatly assist policy makers to be able to identify to which mode a particular negotiation, institution, or action (such as an international treaty) belongs as well as

to be able to use ritual as a tool of policy promotion. Research on this topic would address directly the relationship between symbolic and instrumental action from local to international arenas relevant to the climate-change issue.

Formal Legal and Regulatory Decision Making

Regulatory styles and legal frameworks

We propose building on existing work by sociologists, anthropologists, and legal scholars on national regulatory styles and the frameworks of national and international law as they might influence adoption and implementation of policy responses to specific aspects of global climate change. This work should commence with a careful survey of the growing literature in this area conducted by someone familiar with the climate change issue. The objective would be to discover what regulatory measures are successful in which political, economic, and cultural frameworks. Such research may assist the search for non-obvious options for climate management strategies. Also the issue of transferability of regulatory frameworks from one cultural environment to another would be relevant to the evaluation of any strategy intended for implementation across countries or regions. Liability law as it affects governments and multinational corporations also may be important.

The role of financial institutions

Lending institutions have established a vital role in facilitating the development of natural resources and promoting economic growth. This

research would examine loan policies and capital availability as instruments of environmental policy in LDCs and the industrial world. The objective would be to inform foundations, governments, and the lending institutions themselves about how the global environment can be managed through the involvement of existing major institutions and to evaluate the usefulness of creating any new institutions. Case studies of specific financial institutions' roles in promoting environmental concerns related to activities that they underwrite would be conducted at the local, national, and international levels. The responses of loan or aid recipients in relation to the priorities that they attach to food, security, and the environment would also be worthy of attention in evaluating the effectiveness of financial policy as an instrument of global climate management.

Decision lag and emergent challenge

It is commonplace among military historians that countries prepare to fight the next war with the weapons and strategies that concluded the last war. We hypothesize that environmental decision makers also lag in their ability to recognize and deal with new problems because they have learned so effectively from their experience of the preceding controversy. An historical study of the management of environmental controversies, from the 1960s to the present, could reveal lessons that would enhance the flexibility of decision makers and their ability to recognize, at an early stage, how the dynamics of an issue are changing, particularly in relation to developing relationships between society and the natural environment.

Long-term management of the global environment and responsibilities to future generations

Serious questions arise over how we determine the responsibilities of present generations to future generations and whether these are being met in climate management decisions. We propose to examine the issues of who determines whether these responsibilities are being met, who will manage programs over decades to rectify problems, who decides about trade-offs between generations, and how to coordinate US programs with those of other nations. Research on this topic would attempt to describe how present institutions would respond to such responsibilities and speculate on new arrangements.

Incentives and distributive justice

What kinds of incentives would encourage those who have little to lose or, perhaps, something to gain, from climate change to participate in measures designed to stabilize the earth's atmosphere? Particularly, what associated benefits would be available to LDCs adopting measures designed to reduce CO_2 or other greenhouse gas emissions? Just as important as what would be attractive to recipients is the question of what kinds of incentives would be practicable and ethically acceptable to the nations that offer them.

Prevention and adaptation as contrasting strategies in environmental decision making

This research would investigate the extent to which adaptivist and preventivist strategies for global climate change are shaped by biophysical conditions relative to the influence of sociocultural factors such as

institutional context or national economic or political interests. Case studies involving similar disputes over the appropriate response strategy could be conducted for comparative purposes. The preventivist approach - "Just say 'No'!" - arises in other important public-policy contexts where it is associated strongly with an ethical objection to phenomena as diverse as AIDS, drugs, and nuclear arms. Adaptivists can be just as vehement in urging acceptance of so-called "realities" that necessitate some kind of accommodation with undesirable forces. Understanding the roles of both natural constraints and cultural influences in the framing of science for policy would be very useful for decision makers who have to choose between alternative strategies.

Historical and Ethnographic Case Studies

Environmental perception and management

There is a vast fund of information on the different ways in which cultures around the globe perceive and relate with their environments. Most however, is scattered throughout ethnographies that deal with many other aspects of culture and technological practices. We propose to survey the ethnographic literature to abstract and organize information on differing perceptions of the environment in both industrial and preindustrial societies, with a special emphasis on the relationship between traditional behavior and environmental sustainability. This information then will be evaluated in relation to the climate-change issue, both to seek non-obvious contributions to possible solutions as well as to identify culturally sensitive strategies for achieving agreement to, and implementation of,

global or regional responses to the problem. In particular, economists and legal scholars would be involved to investigate alternative permutations and combinations of private, common, and open-access property arrangements in the ethnographic record for their relevance to global commons management.

The history of technological revolutions

Historical research on this topic would particularly address issues of technology transfer and the relative malleability of social and natural/technical constraints in some well chosen case studies. This work would provide guidance for policy intervention based on precedents rather than on disciplinary biases of natural versus social scientists.

These are just examples of the sort of middle-level problems that we believe can be addressed usefully by social science and decision systems researchers in relation to global change. The structure that we plan to adopt to pursue these kinds of research reflects our characterization of the magnitude and range of the problems we seek to address. Rather than a centrally directed, tightly defined program, we propose to institute a more loosely articulated research regime that will bring together scientists from different sorts of research institutions to address problems of common or overlapping interest.

Presently, the Energy Division at Oak Ridge National Laboratory is taking the lead in strengthening existing relationships with the Energy, Environment, and Resources Center at the University of Tennessee and the Humphrey Institute of Public Affairs at the University of Minnesota. Researchers at all three institutions are in the process of establishing

other links in a network that will facilitate a loosely linked coherent approach to problems of global commons management. Our strength will lie in the institutional diversity of the participants and the mix of basic and applied researchers. Similarly, we seek a resilient progam that has the ability to draw funding support from a wide variety of sponsors of both basic and applied research.

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